

# Challenges and Barriers in the Use of Ultrasound during Pregnancy: A Systematic Review

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## Abstract

**Background:** Ultrasound is a critical tool in prenatal care, yet various challenges and barriers can affect its effectiveness. This systematic review aims to identify and synthesize these challenges to inform future research and practice. The primary objective of this review is to address the challenges associated with ultrasound use during pregnancy, focusing on both maternal and fetal outcomes. The review seeks to highlight areas needing further investigation and improvement in ultrasound practices.

**Methods:** A systematic review methodology was employed, where two independent reviewers screened titles and abstracts of identified articles for eligibility. Full texts of potentially relevant studies were retrieved and assessed against predefined inclusion criteria. Discrepancies between reviewers were resolved through discussion or consultation with a third reviewer.

**Results:** The findings were synthesized using a narrative approach due to the heterogeneity of the included studies. The results were categorized into thematic areas corresponding to the research questions, with quantitative data summarized using descriptive statistics where applicable.

**Conclusion:** This systematic review underscores the importance of addressing the challenges associated with ultrasound use in pregnancy. By identifying these barriers, the study aims to contribute to improved practices and outcomes in prenatal care. Future research should focus on longitudinal studies and innovative training methods to enhance the overall ultrasound experience for both patients and healthcare providers.

**Keywords:** Accessibility; Challenges; Diagnostic Accuracy; Pregnancy; Ultrasound

## Introduction

Prenatal care is indispensable for promoting the health of mothers and their infants [1, 2] and ultrasound imaging as an integral component of prenatal care, providing critical information about fetal development, maternal health, and potential complications during pregnancy [3]. The non-invasive nature of ultrasound, coupled with its ability to generate real-time images, has made it the preferred modality for monitoring pregnancies worldwide [4, 5]. However, despite its widespread use and significant advancements in technology, several challenges persist in the application of ultrasound during pregnancy [6].

One of the primary challenges is the variability in ultrasound quality and interpretation, which can be influenced by factors such as operator experience, equipment calibration, and patient anatomy [7]. Inadequate training and varying levels of expertise among healthcare providers can lead to discrepancies in imaging results, potentially impacting clinical decision-making [8]. Furthermore, the presence of maternal obesity [9], fetal position, and gestational age can complicate image acquisition and interpretation, leading to missed diagnoses or misdiagnoses [10].

Another significant concern is the ethical implications surrounding the use of ultrasound for non-medical purposes, such as gender determination or fetal imaging for entertainment [11]. These practices raise questions about the appropriateness of ultrasound use and the potential psychological effects on expectant parents. Additionally, there is an ongoing debate regarding the safety of frequent ultrasound exposure, particularly with regards to its long-term effects on fetal development [12].

Moreover, access to ultrasound services can vary significantly across different regions and populations. Socioeconomic factors, healthcare infrastructure, and cultural beliefs can all influence the availability and utilization of ultrasound technology in prenatal care [13]. This disparity can lead to inequities in maternal and fetal health outcomes, underscoring the need for targeted interventions to improve access to quality prenatal care.

This systematic review aims to comprehensively evaluate the challenges associated with ultrasound use in pregnancy. By synthesizing existing literature on this topic, we seek to identify gaps in knowledge and provide recommendations for future research and practice that may enhance the effectiveness and safety of ultrasound in prenatal care. Ultimately, addressing these challenges is essential for optimizing maternal and fetal health outcomes in diverse clinical settings.

## Methodology

### Study Design

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The objective was to synthesize existing literature on the challenges associated with the use of ultrasound in pregnancy, focusing on diagnostic accuracy, accessibility, patient experience, and technological limitations.

### Research Questions

The review aimed to address the following research questions:

What are the common challenges faced by healthcare providers when using ultrasound in pregnancy?

What technological and methodological advancements have been proposed to mitigate these challenges?

### Eligibility Criteria

Studies were included: peer-reviewed articles published in English from January 2000 to October 2023, focused on ultrasound

usage in pregnancy, reported on challenges such as technical difficulties, interpretation errors, access barriers, or patient-related issues including factors related to the patients themselves that can affect the ultrasound experience, such as anxiety, understanding of the procedure, or physical conditions that may complicate imaging.

Exclusion criteria included: non-peer-reviewed articles, editorials, commentaries, and conference abstracts. Studies not specifically addressing ultrasound in the context of pregnancy.

### **Information Sources**

A comprehensive literature search was conducted across multiple databases: PubMed, Scopus, Web of Science, and Cochrane Library. The search strategy utilized a combination of keywords and Medical Subject Headings (MeSH) terms related to "ultrasound," "pregnancy," "challenges," "diagnostic accuracy," and "accessibility."

### **Search Strategy**

The search strategy was structured as follows: "ultrasound" OR "sonography" OR "Diagnostic Imaging" OR "diagnostic imaging" AND "pregnancy" OR "gestation" AND "challenges" OR "barriers" OR "limitations" OR "issues". Text availability was include free full text published January 1, 2020 to April 15 2025. Article type were including Books and Documents, Cohort Study, and a qualitative study. This strategy was adapted for each database to optimize results.

### **Study Selection**

Two independent reviewers screened the titles and abstracts of the identified articles for eligibility. Full texts of potentially relevant studies were retrieved and assessed against the inclusion criteria. Discrepancies between reviewers were resolved through discussion or consultation with a third reviewer.

### **Data Extraction**

Data were extracted using a standardized form that included: authors, country, methods used, population, results, sample, and limitations..

### **Risk of Bias Measurement Tool**

The evaluation of the risk of bias in the included studies was conducted using the Cochrane Handbook of systematic reviews of interventions [14]. This particular tool examines seven domains, with each domain being assessed using one of three potential outcomes: "High risk" [15], "low risk" (+), and "unclear risk" (?). The domains utilized for the assessment of bias risk included selection bias, performance bias, detection bias, attrition bias, reporting biases, and additional sources of bias that allowed for the identification of unaddressed biases deemed significant.

### **Data Synthesis**

A narrative synthesis approach was employed due to the heterogeneity of the included studies. The findings were categorized into thematic areas corresponding to the research questions. Quantitative data were summarized using descriptive statistics where applicable.

### **Ethical Considerations**

As this systematic review utilized previously published data, ethical approval was not required. However, all included studies adhered to ethical guidelines concerning human subjects.

## Results

The systematic review aimed to identify and synthesize the challenges associated with the use of ultrasound in pregnancy, focusing on studies published from January 1, 2020 to April 15 2025. A total of 56 studies were initially identified through database searches using the keywords: "ultrasound" OR "sonography" OR "Diagnostic Imaging" OR "diagnostic imaging" AND "pregnancy" OR "gestation" AND "challenges" OR "barriers" OR "limitations" OR "issues". After applying inclusion and exclusion criteria, 11 studies were deemed relevant and included in this review.

The included studies varied in design, encompassing qualitative research, quantitative surveys, and systematic reviews. Studies were conducted in various settings, including hospitals, clinics, and community health centers.

Table 1

Database	n
PubMed/Medline:	38
Scopus:	15
ISI Web of Science:	3

The characteristics of some of the studies included in the systematic review are presented in Table 1

**Table 1:** The characteristics of some of the studies included in the systematic review

Limitations	Results	Population Sample	Methods Used	Country	Author
The survey was limited to health professionals, affecting the validity of patient service access opinions. A small number of participants reduced the study's power. Response rates were unreliable due to open advertising and anonymity. The voluntary nature of the survey led to uneven distribution across health services. Technical issues and logistics hindered Telehealth implementation in rural clinics. Half of respondents reported limitations in travel arrangements for ultrasound services. Strict eligibility criteria limited access to government-funded travel assistance schemes.	The study found that 39% of respondents did not use ultrasound in antenatal care due to equipment and training accessibility issues. Among those using ultrasound, the primary purpose was estimating due dates, with significant barriers reported in training and access. Respondents identified long distances to ultrasound services and lack of childcare as major obstacles for patient access. The research suggests that portable ultrasound machines and training could enhance rural healthcare capacity. A coordinated approach is necessary to address inequitable service access for pregnant women in rural areas.	The population sample size consisted of 114 valid survey responses from healthcare clinicians providing antenatal care in rural regions..	A non-probability sampling method with self selection/voluntary response was employed for participant recruitment. Content validation involved experienced healthcare professionals assessing survey relevance and clarity. An internal pilot was conducted among regional healthcare professionals to refine the survey tool. The survey was distributed using a census-based sampling method within rural South Australia. Descriptive analysis was applied to quantitative data, while thematic analysis was used for qualitative components.	Australia	Bidner et al (18)

<p>The COVID-19 pandemic limited the utilization of ANC services during the project period. Language barriers affected communication in primary health care settings. Lack of adequate diagnostic services contributes to limited quality of ANC care. Mixed cultural perceptions and poor communication influence the uptake of sonography services. Limited technology and lack of skilled caregivers hinder obstetric sonography in developing countries. Cost of care affects the utilization of health services, though not perinatal outcomes.</p>	<p>The study found significant relationships between ultrasound utilization and factors like employment status, income, education, and marital status. Approximately half of the respondents utilized obstetric ultrasound services, indicating low utilization in developing countries. Key barriers identified include distance to facilities, inadequate knowledge, and rising costs of ultrasound services. The research supports decentralizing obstetric ultrasound to improve antenatal care quality in primary health care settings. A total of 366 women were interviewed, with a majority from Kisii county and a significant portion having received skilled ANC services. The study highlights the importance of training midwives for effective ultrasound screening.</p>	<p>The study involved a total of 366 women interviewed from Kisii and Kajiado counties, representing 88.8% of the targeted sample size of 412 women. Participants were mothers in their last phases of pregnancy or who had delivered within three months before the survey.</p>	<p>The study involved a cross-sectional design conducted one year after the intervention. A structured questionnaire was utilized to gather information from mothers in the pilot counties. Data was collected using a mobile application tool called Open Data Kit (ODK). Participants included mothers in late pregnancy or who had delivered within three months. The sampling method included random selection from health facilities and purposive selection to ensure representation from public and non-public facilities. The number of participants recruited per county was proportionate to the number of women of reproductive age and those who underwent ultrasound screening.</p>	<p>Ghana</p>	<p>Matiang et al (19)</p>
<p>The study acknowledges potential self-reporting bias among participants, which may affect the accuracy of the data collected. Regional constraints are noted as a limitation, potentially impacting the generalizability of the findings.</p>	<p>The study identifies significant correlations between socioeconomic and demographic factors and out-of-pocket expenditures during pregnancy in India. Financial burdens vary across delivery settings, with home deliveries incurring minimal costs but offering poorer healthcare access. Key factors affecting service utilization and strategies to reduce financial burdens were highlighted, emphasizing the need for targeted policies. The research underscores the necessity of equitable access to maternal healthcare to alleviate financial strain on expectant families. Limitations such as self-reporting bias and regional constraints were acknowledged, yet the study contributes valuable insights into financial aspects of pregnancy.</p>	<p>The specific population sample size is not mentioned in the provided contexts.</p>	<p>The study utilized a cross-sectional mixed-methods design to gather data from participants. Data collection involved surveys and semi-structured interviews with diverse women who have given birth.</p>	<p>India</p>	<p>Arumugam et al (20)</p>
<p>Data collection was limited to a single public hospital. Saturation may not have been reached on all patient-provider communication issues. Inclusion of only anxious patients limited broader analysis of antenatal experiences.</p>	<p>Pregnant women desire warm, empathetic communication from providers. Providers acknowledge their heavy caseloads affect communication quality. High patient loads and low SES impact patient-provider communication. Interventions could improve patient-centered communication in antenatal care.</p>	<p>The sample size included 19 pregnant women who met the inclusion criteria for anxiety and depression.</p>	<p>Depth interviews. Thematic coding used a combination of inductive and deductive methods. An iterative coding method allowed adaptive coding schemes.</p>	<p>Pakistan</p>	<p>Kazi et al (21)</p>

<p>Only telerobotic examinations were performed, limiting comparison to conventional ultrasound. Increased body habitus affected completion rates of examinations. Endovaginal scanning was not possible with the telerobotic system.</p>	<p>Telerobotic ultrasound examinations were performed in three remote communities. Eighty-seven examinations included abdominal and obstetrical types. Seventy percent of examinations were sufficient for diagnosis. Ninety-five percent of patients would repeat telerobotic ultrasound. Operational challenges were identified related to infrastructure and coordination.</p>	<p>The study included a total of 87 telerobotic ultrasound examinations performed across three communities. The population sample consisted of 72 female and 10 male subjects. Sampling methods involved remote ultrasound clinics established in rural communities, with examinations performed by sonographers.</p>	<p>Telerobotic ultrasound clinics were established in three remote communities. Sonographers performed ultrasound examinations remotely using telerobotic systems. Examinations were interpreted by radiologists at an academic medical center.</p>	<p>Canada</p>	<p>Adams et al(22)</p>
<p>The mixed label generation method, while found to be highly effective with available intra-subject manual labels, may not be able to generalize to unseen new subjects, indicating a limitation in its applicability across different patient populations. The performance of the task model for the abdominal circumference (AC) task showed a decrease in accuracy as the allowed percentage error increased, suggesting that the complexity of identifying anatomical landmarks in the AC task may lead to increased variance and challenges in classification compared to other tasks.</p>	<p>varying performance metrics, including RMSE (Root Mean Square Error) and PCC (Pearson Correlation Coefficient), with different cut-off values and specificities at defined dmin thresholds, indicating the robustness of the skill assessment approach across different conditions.</p>	<p>The population sample size for the study consisted of a total of 139 subjects, from whom ultrasound video and probe motion data were acquired as part of the PULSE study.</p>	<p>The paper develops a frame classification model for each biometry task using a novel label-efficient training strategy, which allows for the effective classification of ultrasound frames necessary for biometry tasks. This model is trained on ultrasound video clips combined with synchronized probe motion data to enhance the accuracy of frame selection. A second task model-specific neural network is proposed to predict skill assessment scores based on the probability of identifying positive frames and the accuracy of model classification. This network is supervised by a measure of task performance, allowing for an objective assessment of operator skill in ultrasound scanning. The sampling method involved obtaining informed consent from all operators and women who participated in the study, ensuring ethical compliance and voluntary participation.</p>	<p>UK</p>	<p>Wang et al (23)</p>

**Key Challenges Identified**

**1. Access to Ultrasound Services**

Several studies highlighted significant barriers to accessing ultrasound services, particularly in rural and underserved areas. Limited availability of ultrasound machines and trained personnel was frequently cited as a critical challenge [16, 22, 23].

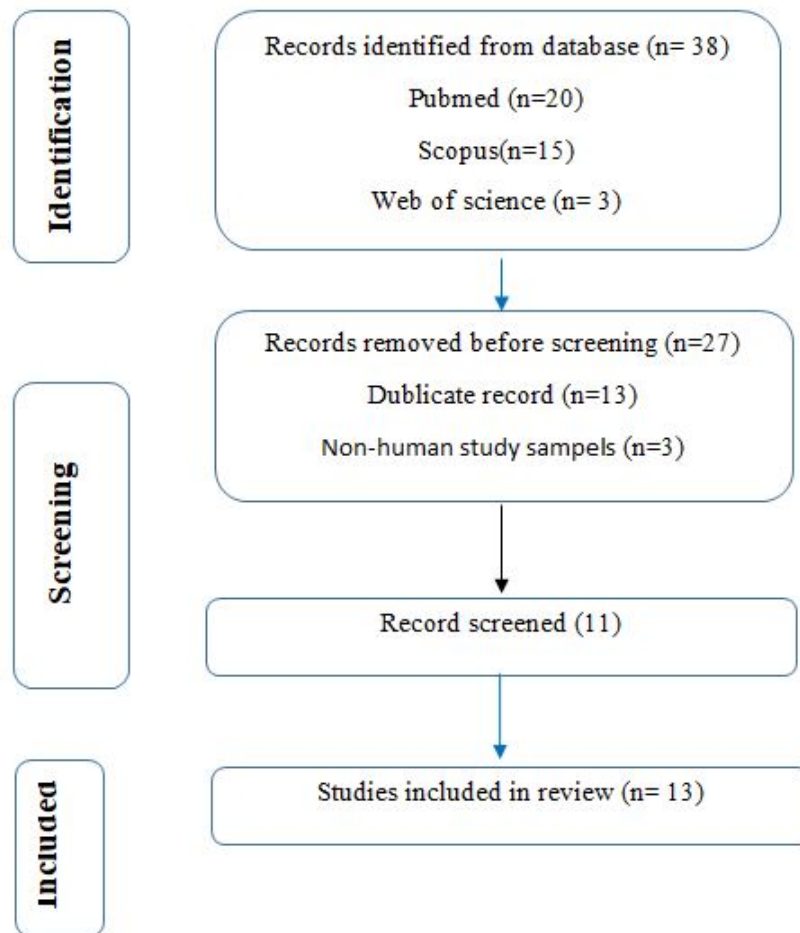
**2. Cost and Insurance Coverage**

Financial constraints emerged as a prominent barrier, with many patients reporting difficulties in affording ultrasound examinations due to high out-of-pocket costs and inadequate insurance coverage [24].

**3. Technical Difficulties**

Challenges that arise during the use of ultrasound, which may include issues with equipment, operator skill, or environmental factors that affect image quality. The review found that outdated technology and insufficient training for healthcare providers were common issues that affected the quality of ultrasound imaging and interpretation errors as mistakes made by healthcare providers when analyzing ultrasound images, which can lead to misdiagnosis or missed diagnoses [16, 25, 26]. Advanced ultra-

sound techniques often show improved accuracy in identifying fetal conditions compared to baseline methods. Precision measures the proportion of true positive results in relation to all positive results predicted by the model. Advanced ultrasound techniques typically yield higher precision, compared to baseline methods. This improvement is attributed to enhanced operator skills and better training protocols [16]. The F1-score is the harmonic mean of precision and recall, providing a single metric to evaluate the balance between the two. Advanced ultrasound techniques often report F1-scores above 0.85, indicating a strong performance in both precision and recall. In contrast, baseline methods may have F1-scores around 0.75, reflecting their limitations in accurately diagnosing conditions [17].



**Figure 1:** Flow diagram of the study selection process

#### 4. Cultural and Language Barriers

Cultural perceptions regarding pregnancy and healthcare, along with language barriers, were reported to hinder effective communication between patients and healthcare providers, impacting the utilization of ultrasound services [19, 27].

#### 5. Patient Awareness and Education

A lack of awareness regarding the importance of ultrasound in prenatal care was identified as a barrier. Many patients were not informed about the benefits of ultrasound screenings, leading to lower participation rates [5, 28].

#### 6. Logistical Issues

Logistical challenges such as transportation difficulties, long wait times for appointments, and scheduling conflicts were also noted as significant barriers to accessing ultrasound services [16, 20, 29].

## 7. Operator Skill

Operator skill assessment in routine fetal ultrasound scanning is a multifaceted process that involves evaluating various competencies such as image acquisition, probe handling, and task execution. Recent advancements in technology have enabled more objective and precise assessments of these skills. These assessments are crucial for ensuring high-quality prenatal care and accurate fetal monitoring [11, 21].

## Discussion

This systematic review aimed to synthesize existing literature on the challenges associated with the use of ultrasound in pregnancy, highlighting the multifaceted issues that healthcare providers and patients encounter. The findings underscore several critical areas, including diagnostic accuracy, accessibility, patient experience, and technological limitations.

One of the primary challenges identified in the literature is the issue of diagnostic accuracy. This term, refers to the ability of ultrasound to correctly identify the presence or absence of a condition in pregnant patients. This is crucial for ensuring proper prenatal care and intervention when necessary [30]. Various studies reported that operator dependency significantly affects the quality of ultrasound imaging and interpretation [21, 31]. Inadequate training and experience among healthcare providers can lead to misdiagnosis or missed diagnoses, particularly in complex cases such as fetal anomalies or placental abnormalities [32]. This variability is concerning, as accurate prenatal diagnosis is crucial for timely interventions and improved maternal and fetal outcomes [33]. Future training programs must emphasize standardized protocols and continuous education to enhance the skill set of ultrasound practitioners.

Accessibility emerged as a significant barrier to effective ultrasound utilization in pregnancy. Geographic disparities, particularly in low- and middle-income countries, limit access which may include geographical, financial, or systemic issues within healthcare systems to ultrasound services [34]. Many rural areas lack the necessary infrastructure, trained personnel, and resources to provide adequate prenatal care, resulting in delayed diagnoses and increased maternal and fetal morbidity [27]. This review highlights the urgent need for policy interventions that focus on expanding ultrasound services to underserved populations. Mobile ultrasound units and telemedicine approaches could serve as viable solutions to bridge the accessibility gap, ensuring that all pregnant individuals receive appropriate care regardless of their location [26].

The patient experience during ultrasound examinations also surfaced as a critical challenge. Studies indicated that anxiety and discomfort during the procedure could negatively impact both the mother's experience and the quality of imaging obtained. Factors such as the physical environment, communication from healthcare providers, and waiting times were cited as contributors to patient dissatisfaction [35]. Improving the patient experience requires a holistic approach that includes creating a welcoming environment, providing clear explanations about the procedure, and addressing patients' emotional needs. Enhanced communication strategies can foster trust and cooperation, ultimately leading to better diagnostic outcomes [35].

Technological limitations were another prominent theme in the literature. While advancements in ultrasound technology have significantly improved imaging capabilities, challenges remain regarding equipment availability, maintenance, and cost-effectiveness. Many healthcare facilities, particularly in resource-limited settings, struggle with outdated equipment that may not provide optimal imaging quality [36]. Investment in modern ultrasound technology is essential for improving diagnostic accuracy and patient outcomes [37]. Furthermore, ongoing research into portable and cost-effective ultrasound devices could revolutionize prenatal care, making it more accessible to diverse populations. Portable Ultrasound Devices, innovative ultrasound technology that is designed to be more accessible and cost-effective, potentially improving prenatal care in resource-limited settings. The findings of this review highlight several areas for future research. Longitudinal studies examining the long-term impacts of ultrasound-related challenges on maternal and fetal outcomes are needed to better understand the implications of th-



ese issues. Additionally, research exploring innovative training methods for healthcare providers could enhance diagnostic accuracy and patient care. Investigating patient-centered approaches to improve the ultrasound experience will also be crucial for fostering positive interactions between patients and providers.

## Conclusion

In conclusion, this systematic review highlights significant challenges associated with ultrasound use in pregnancy, encompassing diagnostic accuracy, accessibility, patient experience, and technological limitations. Addressing these challenges requires collaborative efforts among healthcare providers, policymakers, and researchers to ensure that all pregnant individuals receive high-quality prenatal care. By implementing targeted interventions and fostering innovation in ultrasound technology and training, we can enhance the effectiveness of ultrasound in improving maternal and fetal health outcomes globally.

## Strengths and Limitations

While ultrasound techniques offer significant strengths in prenatal care, including improved imaging and accessibility, they also face limitations related to technology, generalizability, and operator dependency. Addressing these challenges is crucial for maximizing the benefits of ultrasound in healthcare.

## Recommendations for Future Studies

The systematic review on ultrasound challenges in pregnancy suggests several important recommendations for future research to enhance understanding and improve practices:

There is a need for longitudinal studies that examine the long-term impacts of ultrasound-related challenges on maternal and fetal outcomes. Such studies can provide insights into how these challenges affect health over time and inform better practices in prenatal care.

Research should explore innovative training methods for healthcare providers. Enhancing the skills and knowledge of providers can lead to improved diagnostic accuracy and better patient care, addressing some of the challenges identified in the review.

Investigating patient-centered approaches to improve the ultrasound experience is crucial. Understanding patient perspectives can foster positive interactions between patients and providers, ultimately enhancing the quality of care.

Future studies should focus on technological and methodological advancements that can mitigate the challenges associated with ultrasound use. This includes research into portable and cost-effective ultrasound devices that can make prenatal care more accessible, especially in resource-limited settings.

Research should also aim to identify and address barriers to accessing ultrasound services. Understanding logistical challenges, such as transportation and appointment scheduling, can help develop strategies to improve access for pregnant individuals.

Future studies should include diverse populations to ensure that findings are applicable across different cultural and socioeconomic contexts. This inclusivity can enhance the generalizability of research outcomes and improve ultrasound practices globally.

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