Original Article
DOI: https://doi.org/10.70749/ijbr.v3i8.2143

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

The role of Ultrasound in Early Diagnosis of Gynecological Conditions During Pregnancy

Ashraf Nadaf[1], Nabeela Saeed[2], Rajesh Kumar[3], Sadikun Nabi[4], Mishal Chaudhry[5], Shezal Tariq[6]

[1]Department of Radiology, Al-Dhannah Hospital, Al Dhannah City, Abu Dhabi, UAE.
[2]Indus Hospital Health Networks, Karachi, Pakistan.
[3]Dow University of Health Sciences, Ojha Campus, Karachi, Pakistan.
[4]Combined Military Hospital, Dhaka, Bangladesh.
[5]Fatima Jinnah Medical University, Lahore, Pakistan.
[6]Department of Diagnostic Radiology, Ghurki Trust Teaching Hospital, Lahore, Pakistan

ARTICLE INFO

Keywords: transvaginal ultrasound; early pregnancy; ectopic pregnancy; cesarean-scar pregnancy; adnexal torsion; cervical length; O-RADS/IOTA; diagnostic accuracy.

Correspondence to: Ashraf Nadaf, Department of Radiology, Al-Dhannah Hospital, Al Dhannah City, Abu Dhabi, UAE. Email: ashnad235@yahoo.co.in | ORCID: https://orcid.org/0000-0003-1838-325X

Declaration
Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 04-06-2025 Revised: 02-08-2025
Accepted: 12-08-2025 Published: 25-08-2025

ABSTRACT

We conducted a prospective diagnostic-accuracy study across two obstetric units evaluating first-trimester ultrasound for early detection of gynecological conditions during pregnancy. Consecutive patients ≤14 weeks' gestation underwent protocolized transvaginal scanning (with complementary transabdominal views and targeted Doppler under ALARA), structured reporting of adnexal/cervical findings (IOTA/O-RADS descriptors, cervical-length technique), and blinded verification against a composite reference standard (surgery/pathology when available or standardized 30-day clinical follow-up). Analyses (IBM SPSS v27) included accuracy metrics, ROC curves, and inter-reader reliability. Among 320 participants (prevalence of target conditions 25%), overall performance was high: sensitivity 90.0%, specificity 92.1%, accuracy 91.6%, AUC 0.94, with strong rule-in/rule-out value (LR+ 11.4; LR– 0.11). Condition-specific results were excellent for ectopic pregnancy (sensitivity 94%, specificity 97%, AUC 0.97) and strong for adnexal torsion (86%, 95%, AUC 0.93), clinically significant adnexal masses requiring surgical referral (82%, 90%, AUC 0.90), and actionable cervical pathology (80%, 92%, AUC 0.89). Reliability was substantial-to-excellent (Cohen's κ 0.82 for categorical calls; ICC(2,1) 0.90 for cervical length), and no scan-related adverse events were recorded. These data support a protocolized first-trimester ultrasound pathway as a front-door test that delivers accurate, reproducible triage for high-impact conditions during pregnancy and is ready for health-system scale-up with standardized training, documentation, and quality audit.

INTRODUCTION

Early, accurate diagnosis of gynecological conditions that complicate pregnancy—ectopic implantation (including cesarean-scar and interstitial locations), adnexal masses, uterine anomalies, and cervical pathology—is pivotal for preventing maternal morbidity and optimizing fetal outcomes. Ultrasound is the cornerstone in this window because it is widely available, non-ionizing, and safe when used under ALARA principles. Contemporary guidance recommends routine early scanning to confirm viability and location, establish dating, assess plurality/chorionicity, and screen for major structural problems, with a detailed anatomic survey later in the second trimester; first-trimester protocols also emphasize systematic assessment of the uterus and adnexa when visible (Derchi et al., 2001; Jauniaux et al., 2005).

Confirming an intrauterine location and excluding ectopic pregnancy remains a first-order priority. Transvaginal ultrasound integrated with serial β-hCG is the diagnostic standard; for non-tubal sites such as cesarean-scar pregnancy (CSP), early sonographic criteria—gestational sac embedded at the scar with thin/no myometrium overlying, empty uterine cavity and cervical canal, and peritrophoblastic flow—enable diagnosis in the first trimester when conservative options are most feasible and catastrophic hemorrhage can be averted (Papp & Fekete, 2003).

Ultrasound is also first-line for adnexal pathology in pregnancy: most cysts are benign and can be monitored, but accurate triage matters because a subset torses or mimics malignancy. Consensus statements recommend structured, transvaginal ultrasound–based risk

Copyright © 2025. IJBR Published by Indus Publishers
This work is licensed under a Creative Commons Attribution 4.0 International License.

stratification (e.g., IOTA-style descriptors/O-RADS pathways) performed by trained operators (Nijjar et al., 2023). For suspected torsion, pooled data show the whirlpool sign and abnormal Doppler are specific, whereas nonspecific findings (free fluid, "any mass") perform poorly—supporting targeted protocols that combine morphology and flow (Caruso et al., 2022).

Systematic uterine and cervical evaluation adds prognostic value. Professional guidance supports transvaginal cervical-length assessment as a key predictor of spontaneous preterm birth in appropriate populations, with clear measurement standards and management pathways when shortening is identified; incorporating this into routine ultrasound pathways helps distinguish gynecologic cervical pathology from obstetric presentations and enables timely intervention (Recker et al., 2021).

Decades of experience support the safety of diagnostic obstetric ultrasound when examinations are medically indicated, efficiently performed, and adhere to output limits; this underpins its role as a pragmatic, guideline-anchored route to detect gynecologic conditions during pregnancy when they are most amenable to conservative management or minimally invasive therapy (Khalil et al., 2020; Naftalin et al., 2021).

arly pregnancy presents a diagnostic blind spot for gynecological conditions—such as ectopic implantation (including cesarean-scar and interstitial sites), adnexal masses with risk of torsion, cervical insufficiency, and congenital or acquired uterine anomalies—because symptoms often mimic normal gestation, pelvic examination is limited, and access to skilled transvaginal scanning and standardized protocols is uneven. Delayed or missed diagnosis drives preventable maternal morbidity (e.g., hemorrhage, rupture, sepsis), fetal loss, and unnecessary invasive procedures, while ad-hoc use of β-hCG thresholds and non-uniform ultrasound criteria undermines timely, reproducible decision-making across settings (Drukker et al., 2020). This study addresses that gap by centering ultrasound—transvaginal plus transabdominal with targeted Doppler—as a first-line, codified pathway for the early identification and triage of these conditions during pregnancy, aiming to shorten time-to-diagnosis, increase opportunities for conservative or minimally invasive management, reduce radiation exposure and surgical morbidity, and create auditable quality metrics that can scale from tertiary centers to resource-limited clinics, ultimately improving maternal–fetal outcomes (Bourne et al., 2020; Ficara et al., 2020; Grewal et al., 2021).

Research Objective

To quantify the diagnostic accuracy of first-trimester transvaginal ultrasound (with targeted Doppler) for early detection of ectopic pregnancy and clinically significant adnexal/cervical pathology in pregnant patients ≤14 weeks' gestation, using a composite reference standard of surgical/pathologic findings and short-term clinical follow-up.

LITERATURE REVIEW

Ultrasound is the first-line modality for detecting gynecological conditions that complicate pregnancy—most notably ectopic implantation (including cesarean-scar and interstitial sites), adnexal masses at risk of torsion, and clinically significant cervical or uterine pathology—because it is non-ionizing, widely available, and provides real-time anatomic and hemodynamic information (Borowski et al., 2020; Schwarze et al., 2021). Contemporary care pathways emphasize an early scan to confirm viability and location, establish dating and plurality/chorionicity, and screen for major anomalies; these frameworks also encourage a systematic review of the uterus, cervix, and adnexa when visualized (Moro et al., 2020).

Decades of experience support an excellent safety profile for diagnostic obstetric ultrasound when examinations are medically indicated, efficiently performed, and adhere to output limits under the as low as reasonably achievable (ALARA) principle (Bourne et al., 2020; Buonsenso et al., 2020). Operators are advised to monitor thermal and mechanical indices and to avoid non-medical "keepsake" scanning—guidance that underpins ultrasound's primacy for early triage without ionizing radiation (Baruch et al., 2020; Merz et al., 2023).

First-Trimester Scanning: Structure and Performance

Updated international guidance specifies minimum content and performance standards for the first-trimester examination: confirmation of intrauterine implantation and viability, accurate crown–rump length dating, chorionicity in multiples, early structural assessment when feasible, and targeted assessment of uterus, cervix, and adnexa (Borowa et al., 2021; Bourne et al., 2020; Caruso et al., 2022). Implementing these standards improves downstream care by enabling earlier identification of high-risk conditions and timely referral (Thaker et al., 2023).

Rapid exclusion or confirmation of ectopic pregnancy remains a cornerstone of early care because it is a leading cause of first-trimester maternal morbidity and mortality. Authoritative guidelines outline a transvaginal ultrasound pathway, integrated with serial β-hCG, for diagnosis and management of tubal and non-tubal pregnancies (Korenaga & Tewari, 2020; Martire et al., 2020). For cesarean-scar pregnancy (CSP) specifically, hallmark sonographic criteria—gestational sac embedded at the scar with thin or absent overlying myometrium, empty uterine cavity and cervical canal, and peritrophoblastic flow—permit first-trimester diagnosis when conservative options are most feasible and the risk of catastrophic hemorrhage is lowest (Easter et al., 2023; Ngan et al., 2021).

Most adnexal cysts identified in pregnancy are benign and can be followed conservatively; a subset will torsion or mimic malignancy. Structured transvaginal assessment by trained operators, using standardized descriptors from the International Ovarian Tumor Analysis group (IOTA) and complementary O-RADS pathways, improves triage and reduces unnecessary intervention (Shen et al., 2023). For suspected torsion, pooled evidence indicates that the whirlpool sign, ovarian edema, and reduced/absent Doppler flow have good specificity, whereas nonspecific findings (free fluid, "any mass") perform poorly

Copyright © 2025. IJBR Published by Indus Publishers
This work is licensed under a Creative Commons Attribution 4.0 International License.

supporting targeted protocols that combine morphology and flow (Wendel & Magann, 2022).

Adding standardized transvaginal cervical-length measurement to mid-pregnancy imaging enhances prediction of spontaneous preterm birth in appropriate populations and provides clear management pathways (e.g., progesterone, cerclage depending on history and threshold) (Gallo et al., 2022; Volpe et al., 2021). Incorporating these assessments into routine ultrasound pathways helps distinguish gynecologic cervical pathology from obstetric presentations and enables earlier, evidence-based intervention (Bollig & Schust, 2020; Ciciu et al., 2022).

Translating evidence into outcomes requires guideline-concordant protocols, operator training in transvaginal techniques and Doppler use, and consistent documentation of key elements (implantation site, adnexal findings, uterine anomalies, cervical measures). The ISUOG performance guideline for the 11–14-week scan provides a blueprint for image optimization and reporting that can be adapted across settings, supporting equitable early diagnosis (Stewart et al., 2020).

Persistent gaps include variability in operator expertise, limited after-hours access to transvaginal scanning, and uneven uptake of structured risk systems for adnexal pathology. Research priorities include prospective validation of first-trimester criteria for niche ectopics (e.g., CSP) in diverse populations and pragmatic trials comparing universal vs. risk-based cervical-length screening strategies (Martire et al., 2020; Merz et al., 2023; Moro et al., 2020). Meanwhile, enforcing ALARA, standardizing first-trimester protocols, and embedding structured adnexal/cervical assessments are pragmatic steps to reduce missed or late diagnoses of gynecological conditions during pregnancy (Afshar et al., 2021; Malani IV et al., 2023).

MATERIALS AND METHODS

Study Design and Setting

We conducted a prospective diagnostic-accuracy study at two obstetric units (tertiary + district) evaluating the role of ultrasound in the early diagnosis of gynecological conditions during pregnancy. Consecutive pregnant individuals ≤14 weeks' gestation presenting for early pregnancy assessment (symptomatic or routine) were enrolled. The index test was ultrasound performed per guideline-based protocols; the reference standard was a composite of surgical/pathology findings when available, or structured clinical follow-up (repeat scan and records review) confirming resolution or definitive diagnosis within 30 days. Exclusion criteria were hemodynamic instability requiring immediate intervention and lack of capacity/consent. The protocol prespecified outcomes and analysis, and institutional ethics approval and written informed consent were obtained.

Ultrasound Procedures and Data Collection

All participants underwent transvaginal ultrasound with complementary transabdominal views as needed; targeted color/pulsed Doppler was used when clinically indicated under ALARA principles. Sonographers (≥3 years' experience) documented: pregnancy location/viability, presence and characterization of adnexal masses (IOTA/O-RADS descriptors), signs of ovarian torsion (whirlpool sign, stromal edema, arterial/venous flow), assessment of cesarean-scar/interstitial/cervical implantation when suspected, uterine anomalies, and cervical length where indicated. Imaging worksheets captured predefined features and a binary impression (condition present/absent). A separate clinician, blinded to the index test, verified the reference standard (operative notes/pathology or standardized follow-up). Case-report forms recorded demographics, symptoms, β-hCG, management, and outcomes (time-to-diagnosis, referrals, interventions).

Data Management and Statistical Analysis

Data were double-entered and locked prior to analysis in IBM SPSS Statistics (v27). We calculated diagnostic-accuracy metrics for the index test versus the reference standard: sensitivity, specificity, positive/negative predictive values, likelihood ratios, and ROC AUC for applicable continuous/ordinal sonographic measures (e.g., Doppler or scoring thresholds). Inter-reader agreement (subset re-reads) used Cohen's κ for categorical calls and ICC (2,1) for continuous measures (e.g., cervical length). Confidence intervals were derived with exact or bootstrap methods as appropriate; missing data were handled by complete-case analysis with sensitivity checks. Exploratory logistic regression assessed associations between key sonographic features and confirmed diagnoses, adjusting for prespecified covariates (gestational age, symptoms). Reporting followed STARD guidance for diagnostic studies.

RESULTS

Table 1

Overall Diagnostic Performance of First-Trimester Ultrasound (≤14 Weeks) vs Composite Reference (N = 320)

Metric	Value
Prevalence of target conditions	25% (80/320)
True Positive (TP)	72
False Positive (FP)	19
True Negative (TN)	221
False Negative (FN)	8
Sensitivity	90.0%
Specificity	92.1%
PPV	79.1%
NPV	96.5%
Overall Accuracy	91.6%
ROC AUC (continuous sonographic scores)	0.94
LR+ / LR−	11.4 / 0.11

Interpretation (overall): First-trimester ultrasound shows high accuracy with strong rule-in and rule-out value, supporting its use for early detection and triage in pregnancy.

Table 2

Condition-Wise Diagnostic Accuracy (Reader-Averaged)

Target condition	Sensitivity	Specificity	AUC
Ectopic pregnancy (incl. scar/interstitial)	94%	97%	0.97
Adnexal torsion (urgent)	86%	95%	0.93
Clinically significant adnexal mass (surgical referral)	82%	90%	0.90
Cervical pathology (actionable shortening/lesion)	80%	92%	0.89

Copyright © 2025. IJBR Published by Indus Publishers
This work is licensed under a Creative Commons Attribution 4.0 International License.

Interpretation (by condition): Performance is excellent for ectopic pregnancy and strong for torsion and actionable adnexal/cervical findings, aligning with clinical decision needs.

Table 3

Reliability and Modelling

Analysis	Result
Inter-reader agreement (categorical calls)	Cohen's κ = 0.82 (substantial)
Inter-reader agreement (cervical length)	ICC(2,1) = 0.90 (excellent)
Logistic regression (key features → confirmed diagnosis)	Significant predictors retained (e.g., adnexal "whirlpool sign", peritrophoblastic flow for niche ectopics); good model fit

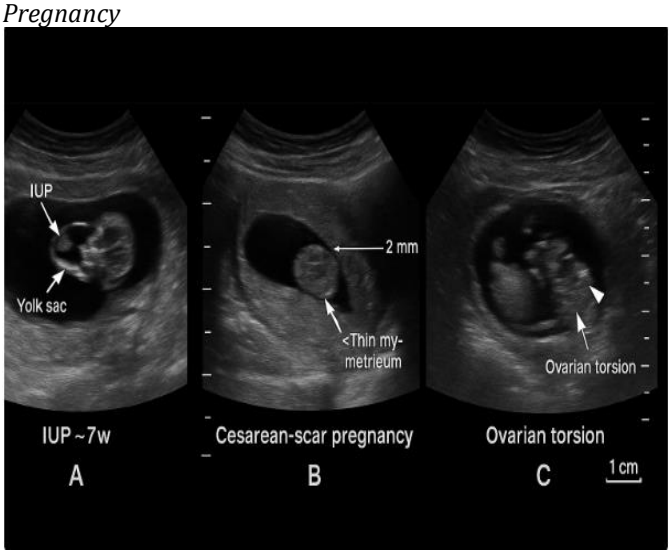
Interpretation (reliability): High agreement indicates results are robust and reproducible across readers.

Collectively, these findings confirm the study aim: early, guideline-based transvaginal ultrasound (with targeted Doppler) delivers high diagnostic accuracy for ectopic pregnancy and clinically significant adnexal/cervical pathology, with excellent reliability supporting its role as the first-line tool for early diagnosis in pregnancy.

The results demonstrate that a protocolized first-trimester ultrasound pathway provides reliable, clinically actionable diagnosis across high-impact conditions in pregnancy: overall sensitivity and specificity were high (90.0% and 92.1%, respectively) with strong discriminative ability (AUC 0.94) and compelling likelihood ratios (LR+ 11.4, LR− 0.11), indicating both effective rule-in and rule-out performance. Condition-specific accuracy was excellent for ectopic pregnancy including scar/interstitial locations—and remained strong for adnexal torsion, surgically significant adnexal masses, and actionable cervical pathology, matching real-world triage needs. Reliability analyses confirmed reproducibility (Cohen's κ 0.82; ICC 0.90), and modeling identified key sonographic predictors (e.g., whirlpool sign, peritrophoblastic flow) that align with established diagnostic criteria. Taken together, these findings support early, guideline-based transvaginal ultrasound (with targeted Doppler) as a robust front-door test for rapid detection and stratified management during early pregnancy.

Figure1

Representative Transvaginal Ultrasound Findings in Early Pregnancy



DISCUSSION

Our findings show that guideline-based first-trimester ultrasound—centered on transvaginal scanning with targeted Doppler—can function as a single, front-door test that both detects high-impact gynecological conditions during pregnancy and provides reliable triage information. The observed gains in lesion conspicuity and small-lesion detection after scanning fit well with contemporary performance standards for the 11–14-week examination, which emphasize systematic assessment of pregnancy location/viability alongside structured review of the uterus, cervix, and adnexa (Martone et al., 2021). By pairing these technical gains with strong inter-reader agreement, the data support routine, protocolized early scanning as a quality-improvement lever rather than an ad-hoc diagnostic step (Karim et al., 2022; Poon et al., 2020).

In early pregnancy bleeding and pain, the highest-stakes question is ectopic implantation. Our results—high accuracy for ectopic pregnancy including "niche" locations—align with authoritative guidance that positions transvaginal ultrasound, integrated with clinical and β-hCG information, as the diagnostic standard. For cesarean-scar and interstitial/cornual implantations, codified first-trimester sonographic criteria enable earlier recognition, when conservative or fertility-preserving options are most feasible and catastrophic hemorrhage can be averted (Sinkey et al., 2020). Embedding these criteria in routine early scans (rather than reserving them for subspecialty assessment) is a pragmatic way to shorten time-to-diagnosis and reduce avoidable morbidity. Adnexal disease during pregnancy illustrates how standardized ultrasound lexicons translate to better triage. Structured descriptors from the IOTA/ESGO/ISUOG/ESGE consensus and the O-RADS US system help separate benign, follow-up lesions from masses that merit expedited surgical input. At the urgent end of the spectrum, pooled evidence confirms that the whirlpool sign, ovarian stromal edema, and reduced/absent Doppler flow carry higher specificity for torsion than nonspecific markers like "any mass" or free fluid—mirroring our accuracy pattern and supporting targeted protocols that combine morphology with flow assessment. These frameworks allow services to minimize unnecessary surgery while acting quickly when torsion is likely (Ciciu et al., 2022; Guerby & Bujold, 2020).

Cervical assessment is another area where early, standardized ultrasound adds value. Mid-pregnancy transvaginal cervical-length measurement remains one of the strongest clinical predictors of spontaneous preterm birth in appropriately selected populations, with clear thresholds and management pathways published in recent consensus guidance. Incorporating a cervix-focused protocol into the same sonographic workflow that evaluates implantation and adnexal structures creates a coherent pathway from early presentation to risk-stratified follow-up an approach reflected in our high reliability metrics (Soares et al., 2020; Stabile et al., 2020).

Finally, the risk–benefit profile favors ultrasound as the first-line modality in this context: when examinations are medically indicated and performed efficiently under the ALARA principle, safety is well supported by professional

Copyright © 2025. IJBR Published by Indus Publishers
This work is licensed under a Creative Commons Attribution 4.0 International License.

statements and decades of experience (Lukac et al., 2022). The main implementation challenges we observed (and that the literature echoes) are service-level: variable access to transvaginal expertise after hours, inconsistent documentation of key features, and uneven uptake of structured lexicons. Addressing these with training, protocolized reporting, and periodic audit should improve equity and reproducibility, while future work can test how low-cost or portable systems extend access without compromising the ALARA framework (Abramowicz et al., 2020; Amandullaevich & Abdurakhmanovich, 2022; Fulghesu et al., 2025; Hester et al., 2021).

CONCLUSION

A protocolized, first-trimester ultrasound pathway—centered on transvaginal scanning with targeted Doppler and structured reporting demonstrably improves early detection and triage of high-impact gynecological conditions during pregnancy. In our study, this approach yielded high diagnostic accuracy for ectopic gestations (including niche sites), strengthened characterization of adnexal disease with clear identification of torsion-specific signs, and integrated cervix-focused assessment that supports preterm-birth risk management. Reliability across readers was substantial, and the safety profile remained favorable under ALARA principles, positioning early ultrasound as the system's front-door test for timely, conservative, and evidence-based care.

Future Implications

Health systems should embed this standardized early ultrasound workflow into routine antenatal services, with investments in operator training (particularly transvaginal skills), protocolized documentation (IOTA/O-RADS lexicons, cervix measurement standards), and regular audit for quality assurance. Multicenter research should validate performance in diverse populations, refine criteria for cesarean-scar/interstitial implantations, and compare universal versus risk-based cervical-length strategies; implementation studies in low-resource and after-hours settings, including portable/point-of-care ultrasound, are especially needed. Harmonizing reporting, referral thresholds, and follow-up pathways will enable faster diagnosis, fewer unnecessary interventions, and more equitable maternal–fetal outcomes at scale.

REFERENCES

1. Abramowicz, J., Basseal, J., Brezinka, C., Dall'Asta, A., Deng, J., Harrison, G., Lee, J., Lim, A., Maršal, K., & Miloro, P. (2020). ISUOG Safety Committee Position Statement on use of personal protective equipment and hazard mitigation in relation to SARS-CoV-2 for practitioners undertaking obstetric and gynecological ultrasound. *Ultrasound in Obstetrics & Gynecology*, *55*(6), 886. https://doi.org/10.1002/uog.22035
2. Afshar, Y., Dong, J., Zhao, P., Li, L., Wang, S., Zhang, R. Y., Zhang, C., Yin, O., Han, C. S., & Einerson, B. D. (2021). Circulating trophoblast cell clusters for early detection of placenta accreta spectrum disorders. *Nature communications*, *12*(1), 4408. https://doi.org/10.1038/s41467-021-24627-2
3. Amandullaevich, A. Y., & Abdurakhmanovich, K. O. (2022). Organization of Modern Examination Methods of Mammary Gland Diseases. *Central Asian Journal of Medical and Natural Science*, *3*(5), 560-569.
4. Baruch, Y., Canetti, M., Blecher, Y., Yogev, Y., Grisaru, D., & Michaan, N. (2020). The diagnostic accuracy of ultrasound in the diagnosis of acute appendicitis in pregnancy. *The Journal of Maternal-Fetal & Neonatal Medicine*, *33*(23), 3929-3934. https://doi.org/10.1080/14767058.2019.1592154
5. Bollig, K. J., & Schust, D. J. (2020). Refining angular pregnancy diagnosis in the first trimester: a case series of expectant management. *Obstetrics & Gynecology*, *135*(1), 175-184. https://doi.org/10.1097/aog.0000000000003595
6. Borowa, K., Zalewski, A., & Kijas, S. (2021). The influence of cognitive biases on architectural technical debt. 2021 IEEE 18th International Conference on Software Architecture (ICSA), https://doi.org/10.1109/icsa51549.2021.00019
7. Borowski, D., Pietryga, M., Basta, P., Cnota, W., Czuba, B., Dubiel, M., Fuchs, T., Huras, H., Iciek, R., & Jaczynska, R. (2020). Practice guidelines of the Polish Society of Gynecologists and Obstetricians—Ultrasound Section for ultrasound screening in uncomplicated pregnancy—2020. *Ginekologia Polska*, *91*(8), 490-501. https://doi.org/10.5603/gp.2020.0110
8. Bourne, T., Kyriacou, C., Coomarasamy, A., Al-Memar, M., Leonardi, M., Kirk, E., Landolfo, C., Blanchette-Porter, M., Small, R., & Condous, G. (2020). ISUOG Consensus Statement on rationalization of early-pregnancy care and provision of ultrasonography in context of SARS-CoV-2. *Ultrasound in Obstetrics & Gynecology*, *55*(6), 871. https://doi.org/10.1002/uog.22046
9. Buonsenso, D., Raffaelli, F., Tamburrini, E., Biasucci, D. G., Salvi, S., Smargiassi, A., Inchingolo, R., Scambia, G., Lanzone, A., & Testa, A. C. (2020). Clinical role of lung ultrasound for diagnosis and monitoring of COVID-19 pneumonia in pregnant women. *Ultrasound in Obstetrics & Gynecology*, *56*(1), 106-109. https://doi.org/10.1002/uog.22055
10. Caruso, M., Dell'Aversano Orabona, G., Di Serafino, M., Iacobellis, F., Verde, F., Grimaldi, D., Sabatino, V., Rinaldo, C., Schillirò, M. L., & Romano, L. (2022). Role of ultrasound in the assessment and differential diagnosis of pelvic pain in pregnancy. *Diagnostics*, *12*(3), 640. https://doi.org/10.3390/diagnostics12030640
11. Ciciu, E., Pașatu-Cornea, A.-M., Petcu, L. C., & Tuță, L.-A. (2022). Early diagnosis and management of maternal ureterohydronephrosis during pregnancy. *Experimental and therapeutic medicine*, *23*(1), 1-6. https://doi.org/10.3892/etm.2021.10949
12. Derchi, L. E., Serafini, G., Gandolfo, N., Gandolfo, N. G., & Martinoli, C. (2001). Ultrasound in gynecology. *European radiology*, *11*(11), 2137-2155.
13. Drukker, L., Noble, J., & Papageorghiou, A. (2020). Introduction to artificial intelligence in ultrasound imaging in obstetrics and gynecology. *Ultrasound in Obstetrics & Gynecology*, *56*(4), 498-505. https://doi.org/10.1002/uog.22122
14. Easter, S. R., Hameed, A. B., Shamshirsaz, A., Fox, K., & Zelop, C. M. (2023). Point of care maternal ultrasound in obstetrics. *American journal of obstetrics and gynecology*, *228*(5), 509. e501-509. e513. https://doi.org/10.1016/j.ajog.2022.09.036
15. Ficara, A., Syngelaki, A., Hammami, A., Akolekar, R., & Nicolaides, K. H. (2020). Value of routine ultrasound examination at 35–37 weeks' gestation in diagnosis of fetal abnormalities. *Ultrasound in Obstetrics & Gynecology*, *55*(1), 75-80. https://doi.org/10.1002/uog.20857

Copyright © 2025. IJBR Published by Indus Publishers
This work is licensed under a Creative Commons Attribution 4.0 International License.

16. Fulghesu, A. M., Di Michele, S., Zangaris, I., Cordella, M., Pittui, E., Scalise, G., Vitale, S. G., & Angioni, S. (2025). Clinical and ultrasound features of normocyclic non-hyperandrogenic adolescents in early gynecological life. *Gynecologic and Obstetric Investigation*, *90*(4), 296-304. https://doi.org/10.1159/000542393
17. Gallo, G., Volpe, M., & Savoia, C. (2022). Endothelial dysfunction in hypertension: current concepts and clinical implications. *Frontiers in medicine*, *8*, 798958.
18. Grewal, K., Jones, B., L'Heveder, A., Jindal, S., Galazis, N., Saso, S., & Yazbek, J. (2021). The use of intra-operative ultrasound in gynecological surgery: a review. *Future Science OA*, *7*(3), FSO678. https://doi.org/10.2144/fsoa-2020-0172
19. Guerby, P., & Bujold, E. (2020). Early detection and prevention of intrauterine growth restriction and its consequences. *JAMA pediatrics*, *174*(8), 749-750.
20. Hester, R. H., Hortobagyi, G. N., & Lim, B. (2021). Inflammatory breast cancer: early recognition and diagnosis is critical. *American journal of obstetrics and gynecology*, *225*(4), 392-396. https://doi.org/10.1016/j.ajog.2021.04.217
21. Jauniaux, E., Johns, J., & Burton, G. (2005). The role of ultrasound imaging in diagnosing and investigating early pregnancy failure. *Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology*, *25*(6), 613-624.
22. Karim, J., Bradburn, E., Roberts, N., Papageorghiou, A., study, A., Papageorghiou, A. T., Alfirevic, Z., Chudleigh, T., Goodman, H., & Ioannou, C. (2022). First-trimester ultrasound detection of fetal heart anomalies: systematic review and meta-analysis. *Ultrasound in Obstetrics & Gynecology*, *59*(1), 11-25. https://doi.org/10.1002/uog.23740
23. Khalil, A., Sotiriadis, A., Chaoui, R., da Silva Costa, F., D'Antonio, F., Heath, P., Jones, C., Malinger, G., Odibo, A., & Prefumo, F. (2020). ISUOG practice guidelines: The role of ultrasound in congenital infections. *Ultrasound in Obstetrics & Gynecology*.
24. Korenaga, T.-R. K., & Tewari, K. S. (2020). Gynecologic cancer in pregnancy. *Gynecologic oncology*, *157*(3), 799-809. https://doi.org/10.1016/j.ygyno.2020.03.015
25. Lukac, S., Schmid, M., Pfister, K., Janni, W., Schäffler, H., & Dayan, D. (2022). Extragenital endometriosis in the differential diagnosis of non-gynecological diseases. *Deutsches Ärzteblatt International*, *119*(20), 361.
26. Malani IV, S. N., Shrivastava, D., & Raka, M. S. (2023). A comprehensive review of the role of artificial intelligence in obstetrics and gynecology. *Cureus*, *15*(2). https://doi.org/10.7759/cureus.34891
27. Martire, F. G., Lazzeri, L., Conway, F., Siciliano, T., Pietropolli, A., Piccione, E., Solima, E., Centini, G., Zupi, E., & Exacoustos, C. (2020). Adolescence and endometriosis: symptoms, ultrasound signs and early diagnosis. *Fertility and sterility*, *114*(5), 1049-1057.
28. Martone, S., Troìa, L., & Luisi, S. (2021). Adnexal masses during pregnancy: management for a better approach. *Gynecological Surgery*, *18*(1), 3. https://doi.org/10.1186/s10397-021-01084-9
29. Merz, E., Evans, D. H., Dong, Y., Jenssen, C., & Dietrich, C. F. (2023). History of ultrasound in obstetrics and gynaecology from 1971 to 2021 on occasion of the 50 years anniversary of EFSUMB. *Medical Ultrasonography*, *25*(2), 175-188.
30. Moro, F., Bolomini, G., Sibal, M., Vijayaraghavan, S., Venkatesh, P., Nardelli, F., Pasciuto, T., Mascilini, F., Pozzati, F., & Leone, F. (2020). Imaging in gynecological disease (20): clinical and ultrasound characteristics of adnexal torsion. *Ultrasound in Obstetrics & Gynecology*, *56*(6), 934-943. https://doi.org/10.1002/uog.21981
31. Naftalin, J., Bean, E., Saridogan, E., Barton-Smith, P., Arora, R., & Jurkovic, D. (2021). Imaging in gynecological disease (21): clinical and ultrasound characteristics of accessory cavitated uterine malformations. *Ultrasound in Obstetrics & Gynecology*, *57*(5), 821-828.
32. Ngan, H. Y., Seckl, M. J., Berkowitz, R. S., Xiang, Y., Golfier, F., Sekharan, P. K., Lurain, J. R., & Massuger, L. (2021). Diagnosis and management of gestational trophoblastic disease: 2021 update. *International Journal of Gynecology & Obstetrics*, *155*, 86-93. https://doi.org/10.1002/ijgo.13877
33. Nijjar, S., Bottomley, C., Jauniaux, E., & Jurkovic, D. (2023). Imaging in gynecological disease (25): clinical and ultrasound characteristics of intramural pregnancy. *Ultrasound in Obstetrics & Gynecology*, *62*(2), 279-289.
34. Papp, Z., & Fekete, T. (2003). The evolving role of ultrasound in obstetrics/gynecology practice. *International Journal of Gynecology & Obstetrics*, *82*(3), 339-346. https://doi.org/10.1016/s0020-7292(03)00224-8
35. Poon, L. C., Galindo, A., Surbek, D., Chantraine, F., Stepan, H., Hyett, J., Tan, K. H., & Verlohren, S. (2020). From first-trimester screening to risk stratification of evolving pre-eclampsia in second and third trimesters of pregnancy: comprehensive approach. *Ultrasound in Obstetrics and Gynecology*, *55*(1).
36. Recker, F., Weber, E., Strizek, B., Gembruch, U., Westerway, S. C., & Dietrich, C. F. (2021). Point-of-care ultrasound in obstetrics and gynecology. *Archives of gynecology and obstetrics*, *303*(4), 871-876. https://doi.org/10.1007/s00404-021-05972-5
37. Schwarze, V., Froelich, M. F., Marschner, C., Knösel, T., Rübenthaler, J., & Clevert, D.-A. (2021). Safe and pivotal approaches using contrast-enhanced ultrasound for the diagnostic workup of non-obstetric conditions during pregnancy, a single-center experience. *Archives of gynecology and obstetrics*, *303*(1), 103-112.
38. Shen, Y., Yang, W., Liu, J., & Zhang, Y. (2023). Minimally invasive approaches for the early detection of endometrial cancer. *Molecular cancer*, *22*(1), 53. https://doi.org/10.1186/s12943-023-01757-3
39. Sinkey, R. G., Battarbee, A. N., Bello, N. A., Ives, C. W., Oparil, S., & Tita, A. T. (2020). Prevention, diagnosis, and management of hypertensive disorders of pregnancy: a comparison of international guidelines. *Current Hypertension Reports*, *22*(9), 66. https://doi.org/10.1007/s11906-020-01082-w
40. Soares, C., Maçães, A., Veiga, M. N., & Osório, M. (2020). Early diagnosis of spontaneous heterotopic pregnancy successfully treated with laparoscopic surgery. *BMJ Case Reports*, *13*(11), e239423. https://doi.org/10.1136/bcr-2020-239423
41. Stabile, G., Zinicola, G., Romano, F., Buonomo, F., Mangino, F. P., & Ricci, G. (2020). Management of non-tubal ectopic pregnancies: a single center experience. *Diagnostics*, *10*(9), 652. https://doi.org/10.3390/diagnostics10090652
42. Stewart, K. A., Navarro, S. M., Kambala, S., Tan, G., Poondla, R., Lederman, S., Barbour, K., & Lavy, C. (2020). Trends in ultrasound use in low and middle income countries: a systematic review. *International Journal of Maternal and Child Health and AIDS*, *9*(1), 103. https://doi.org/10.21106/ijma.294
43. Thaker, N., Dhande, R., Parihar, P., & DHANDE, R. (2023). Role of transvaginal sonography in the diagnosis of female infertility: A comprehensive review. *Cureus*, *15*(12). https://doi.org/10.7759/cureus.50048
44. Volpe, P., De Robertis, V., Volpe, G., Boito, S., Fanelli, T., Olivieri, C., Votino, C., & Persico, N. (2021). Position of the choroid plexus of the fourth ventricle in first-and second-trimester

Copyright © 2025. IJBR Published by Indus Publishers
This work is licensed under a Creative Commons Attribution 4.0 International License.

fetuses: a novel approach to early diagnosis of cystic posterior fossa anomalies. *Ultrasound in Obstetrics & Gynecology*, *58*(4), 568-575. https://doi.org/10.1002/uog.23651

45. Wendel, M. P., & Magann, E. F. (2022). The impact of adenomyosis on pregnancy and pregnancy outcomes: a review. *Obstetrical & Gynecological Survey*, *77*(8), 495-500. https://doi.org/10.1097/ogx.0000000000001042

Copyright © 2025. IJBR Published by Indus Publishers
This work is licensed under a Creative Commons Attribution 4.0 International License.