



# International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

**Operating Publisher**  
**SciFormat Publishing Inc.**  
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,  
Calgary, Alberta, T3E0A7,  
Canada  
+15878858911  
editorial-office@sciformat.ca

---

|                      |                                                                                                      |
|----------------------|------------------------------------------------------------------------------------------------------|
| <b>ARTICLE TITLE</b> | EARLY DETECTION OF ENDOMETRIOSIS – A LITERATURE REVIEW OF DIAGNOSTIC METHODS AND FUTURE PERSPECTIVES |
|----------------------|------------------------------------------------------------------------------------------------------|

---

|            |                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------|
| <b>DOI</b> | <a href="https://doi.org/10.31435/ijitss.3(51).2026.6129">https://doi.org/10.31435/ijitss.3(51).2026.6129</a> |
|------------|---------------------------------------------------------------------------------------------------------------|

---

|                 |              |
|-----------------|--------------|
| <b>RECEIVED</b> | 20 July 2026 |
|-----------------|--------------|

---

|                 |                   |
|-----------------|-------------------|
| <b>ACCEPTED</b> | 15 September 2026 |
|-----------------|-------------------|

---

|                  |                   |
|------------------|-------------------|
| <b>PUBLISHED</b> | 18 September 2026 |
|------------------|-------------------|

---

|                |                                                                                                                                                                                        |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LICENSE</b> | <br>The article is licensed under a <b>Creative Commons Attribution 4.0 International License</b> . |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

© The author(s) 2026.

This article is published as open access under the Creative Commons Attribution 4.0 International License (CC BY 4.0), allowing the author to retain copyright. The CC BY 4.0 License permits the content to be copied, adapted, displayed, distributed, republished, or reused for any purpose, including adaptation and commercial use, as long as proper attribution is provided.

# EARLY DETECTION OF ENDOMETRIOSIS – A LITERATURE REVIEW OF DIAGNOSTIC METHODS AND FUTURE PERSPECTIVES

**Izabela Harpula** (Corresponding Author, Email: harpulaizabela@gmail.com)  
Clinical Provincial Hospital in Rzeszów, Lwowska 60, 35-301 Rzeszów, Poland  
ORCID ID: 0009-0005-3167-159X

**Natalia Bębenek**  
Student Research Group, Faculty of Medical Sciences, Collegium Medicum, University of Rzeszów, Rzeszów, Poland  
ORCID ID: 0009-0006-6976-6698

**Benedykt Baljon**  
CM Łańcut Sp. z o.o., St. Michael the Archangel Hospital, 5 I. Paderewski St., 37-100 Łańcut, Poland  
ORCID ID: 0009-0008-0843-4627

**Justyna Bogdan**  
CM Łańcut Sp. z o.o., St. Michael the Archangel Hospital, 5 I. Paderewski St., 37-100 Łańcut, Poland  
ORCID ID: 0009-0002-8599-3656

**Radosław Ramotowski**  
Clinical Provincial Hospital in Rzeszów, Lwowska 60, 35-301 Rzeszów, Poland  
ORCID ID: 0009-0007-2880-7788

**Patryk Brzezicki**  
Infant Jesus Clinical Hospital UCC MUW (University Clinical Centre, Medical University of Warsaw)  
Address: 4 Lindleya Street, 02-005 Warsaw, Poland  
ORCID ID: 0000-0003-1788-807X

**Paulina Frączkiewicz**  
5 Military Clinical Hospital SPZOZ in Cracow, Wrocławska 1-3 Street, 30-901 Cracow, Poland  
ORCID ID: 0000-0002-4163-2843

**Gabriela Barszcz**  
Student Research Group, Faculty of Medical Sciences, Collegium Medicum, University of Rzeszów, Rzeszów, Poland  
ORCID ID: 0009-0004-0127-6225

**Monika Błądek**  
Student Research Group, Faculty of Medical Sciences, Collegium Medicum, University of Rzeszów, Rzeszów, Poland  
ORCID ID: 0009-0005-1939-0891

**Karolina Drygała**  
Student Research Group, Faculty of Medical Sciences, Collegium Medicum, University of Rzeszów, Rzeszów, Poland  
ORCID ID: 0009-0002-0049-3856

**Sylvia Wit**  
Student Research Group, Faculty of Medical Sciences, Collegium Medicum, University of Rzeszów, Rzeszów, Poland  
ORCID ID: 0009-0004-9866-2092

**ABSTRACT**

**Research objectives:** Endometriosis is a chronic disease that impairs the daily functioning and quality of life of many women. This literature review summarizes current diagnostic methods for endometriosis, their advantages and limitations, and discusses emerging approaches, particularly established and emerging imaging techniques.

**Scope of review:** Relevant publications were identified through searches of PubMed, Scopus, Web of Science, Google Scholar, and other scientific databases. This literature review focused on studies published between 2020 and 2025 that addressed established and emerging diagnostic approaches for endometriosis, including imaging techniques, biomarkers, and artificial intelligence.

**Findings:** Endometriosis commonly presents with chronic pelvic pain, dysmenorrhea, dyspareunia, and infertility. Current evidence indicates that imaging plays a central role in diagnosis. Transvaginal ultrasound remains the first-line imaging modality, while magnetic resonance imaging provides complementary information for disease staging and assessment of complex cases. Transrectal ultrasound may be useful in selected patients with suspected bowel involvement. Although numerous biomarkers have been investigated, none have demonstrated sufficient diagnostic accuracy for routine clinical use. Emerging technologies, including advanced imaging techniques and AI-based diagnostic models, show promising potential but still require further validation before clinical use.

**Conclusions:** Early diagnosis remains essential for improving patient outcomes and limiting disease progression. However, the disease is often diagnosed too late, which remains a major clinical challenge. Recent evidence supports imaging-based diagnostic strategies as the foundation of diagnosis, whereas biomarker-based approaches require further development. Future advances in AI and integrated diagnostic models may contribute to more accurate and timely detection of endometriosis.

---

**KEYWORDS**

Endometriosis, Diagnostic Methods, Transvaginal Ultrasound, Magnetic Resonance Imaging, Biomarkers, Imaging-Based Techniques, Artificial Intelligence

---

**CITATION**

Harpula, I., Bębenek, N., Baljon, B., Bogdan, J., Ramotowski, R., Brzezicki, P., Frączkiewicz, P., Barszcz, G., Błądek, M., Drygała, K., & Wit, S. (2026). Early detection of endometriosis – a literature review of diagnostic methods and future perspectives. *International Journal of Innovative Technologies in Social Science*, 3(51).  
[https://doi.org/10.31435/ijitss.3\(51\).2026.6129](https://doi.org/10.31435/ijitss.3(51).2026.6129)

---

**COPYRIGHT**

© The author(s) 2026. This article is published as open access under the Creative Commons Attribution 4.0 International License (CC BY 4.0), allowing the author to retain copyright. The CC BY 4.0 License permits the content to be copied, adapted, displayed, distributed, republished, or reused for any purpose, including adaptation and commercial use, as long as proper attribution is provided.

---

## 1. Introduction

According to statistics provided by WHO in 2025, 10% of women of reproductive age suffer from endometriosis, which could amount to as many as 190 million women worldwide [3]. Endometriosis is a chronic condition that presents with painful and heavy periods and chronic pelvic pain, which are among its most common symptoms. It can also cause problems with bowel movements, constipation and painful urination [4]. Furthermore, endometriosis can lead to difficulties with sexual intercourse and infertility, which, according to statistics, affects as many as 25–50% of women with the condition [3]. Infertility in young women attempting to conceive can often be linked to anxiety and stress, which increases their risk of developing depression [2,4]. The condition can cause non-specific symptoms and is sometimes difficult to detect using current methods, particularly in the early stages, which is why it may still be overlooked. Studies suggest that women with endometriosis may experience diagnostic delays of up to 12 years. This means that many patients have to cope with pain that hinders their daily functioning for years. Early diagnosis is therefore crucial in order to alleviate symptoms and slow the progression of the disease and its consequences. A clinical diagnosis of endometriosis can be made on the basis of a patient's symptoms and imaging tests such as transvaginal ultrasound (TVUS) or MRI, which are the most commonly used and proven imaging techniques. Imaging techniques used in the diagnosis of endometriosis are constantly evolving. New diagnostic tests for detecting endometriosis include blood tests, which may involve the use of biomarkers [3]. Biomarkers represent one of the most intensively researched areas in the development of non-invasive diagnostic tools for endometriosis. Current findings suggest that potential biomarkers include a wide range of biological factors, including inflammatory, hormonal, immunological, genetic, epigenetic and metabolic markers [7,26]. Moreover, it is recognised in the scientific literature that artificial intelligence-based solutions have significant potential for

the integration and analysis of clinical, imaging and biomarker data, thereby improving the accuracy and consistency of diagnosis [23]. This literature review aims to summarize current diagnostic methods used in the evaluation of endometriosis and to discuss emerging diagnostic approaches, including advanced imaging techniques, biomarkers, and artificial intelligence-based solutions. Particular attention is given to their advantages, limitations, and future potential in improving early disease detection.

## **2. Materials and Methods**

This literature review was conducted to summarize current diagnostic methods and clinical challenges associated with endometriosis. Relevant literature published between 2020 and 2025 was identified through searches of PubMed, Scopus, Web of Science, and Google Scholar. The search strategy included combinations of keywords related to endometriosis diagnosis. Additional relevant publications were identified through manual screening of references. Original research articles, review papers, and case reports addressing both established and emerging diagnostic approaches were considered. Publications were selected based on their relevance to the objectives of this review, particularly imaging techniques, biomarkers, early diagnosis, and emerging imaging methods. A total of 47 records were initially identified, of which 15 did not meet the eligibility criteria and were excluded from the review. Following the literature review process, 32 publications were included and analyzed to provide an overview of current diagnostic strategies, their limitations, and future directions in endometriosis diagnosis.

## **3. Literature Selection Criteria**

Publications were considered eligible if they were written in English and focused on the diagnosis of endometriosis. The review included original research articles, review papers, and reports. Particular attention was given to studies evaluating imaging techniques, biomarkers, and emerging diagnostic technologies. Studies focusing primarily on treatment rather than diagnosis, publications unrelated to endometriosis, and articles lacking sufficient information on diagnostic methods were excluded.

## **4. Common clinical symptoms reported by patients with endometriosis**

The most common symptoms experienced by patients that lead them to book an appointment with a gynaecologist include painful periods, painful sexual intercourse and infertility [2,4]. Pain is one of the key but often underestimated symptoms experienced by women with endometriosis. It may occur in conjunction with the menstrual cycle or may take the form of chronic pelvic pain [12]. This condition usually affects the pelvic and abdominal regions and may be associated with painful urination, painful bowel movements, and pain in the lower back or lumbosacral region, depending on the location of the lesions. Painful periods significantly restrict daily functioning and reduce quality of life, often leading to absences from school or work. Urinary symptoms may also occur, such as a sudden urge to urinate and painful urination [2,4]. Endometriosis is also associated with infertility, which may result from chronic inflammation, adhesions and changes in the anatomical structure of the pelvis, particularly in cases of intestinal endometriosis [13]. A major clinical challenge is the frequent delay in diagnosis resulting from the non-specific nature of the symptoms and their underestimation, leading to diagnostic delays lasting up to several years. Importantly, the severity of symptoms does not always correlate with the extent of the disease. Early recognition of clinical symptoms is crucial, as a delayed diagnosis can result in disease progression, increased inflammation and reduced fertility.

## **5. Challenges in early diagnosis**

The diagnosis of endometriosis is often delayed or inaccurate due to the complex interaction of clinical and systemic factors. The literature highlights that one of the main problems is the normalisation of menstrual pain by society, which leads to the symptoms being downplayed and patients seeking gynaecological consultation at a later stage [8,10]. A common diagnostic error is also the attribution of non-specific symptoms of endometriosis to other conditions, such as irritable bowel syndrome or pelvic inflammatory disease, resulting in incorrect diagnosis and the implementation of inappropriate treatment. [9,10] Furthermore, in clinical practice, there is a tendency to avoid diagnostic laparoscopy, particularly in young patients, which significantly prolongs the time taken to reach a definitive diagnosis, especially in patients with deep infiltrating endometriosis (DIE) [9,11]. Low public awareness and limited knowledge of the variety of symptoms of the disease also remain a significant problem, which further delays the implementation of appropriate diagnosis and treatment [8,11].

## 6. Imaging studies in early detection of endometriosis

According to the literature, the basic tests used to diagnose or rule out endometriosis are imaging methods such as transvaginal ultrasound (TVUS), magnetic resonance imaging (MRI), and transrectal ultrasound (TRUS), which are routinely used in clinical practice. These tests can reveal endometrial cysts, adhesions and abnormal areas of endometrial tissue located in the uterus, intestines or bladder.

**6.1** In current clinical practice, transvaginal ultrasound is typically the initial imaging modality used when endometriosis is suspected [20]. This technique enables a detailed assessment of pelvic anatomy and deep infiltrating endometriosis, with high sensitivity for detecting ovarian endometriomas, which are considered indicators of coexisting DIE. According to the Daniilidis et al. review, TVUS has a good overall diagnostic accuracy for both ovarian and extra-ovarian endometriosis. However, accurate diagnosis and staging of DIE is highly dependent on the experience of the examiner. Therefore, in patients with suspected DIE, magnetic resonance imaging should also be performed. The data suggest that the use of TVUS within standardised protocols, such as the IDEA approach, enables a structured assessment of the pelvis and improves the reproducibility of the diagnosis [6,20]. The IDEA protocol includes an assessment of the structure of the uterus and adnexa, soft markers, the sliding sign, and deep infiltrating nodules, which allows for a more accurate representation of pathological changes and the determination of the stage of the disease [14,22]. Nevertheless, the effectiveness of this method depends to a large extent on the skill of the person performing the examination and may be limited in cases of early or subtle symptoms of the disease, which highlights the importance of specialist training and standardised examination protocols. Beyond its diagnostic role, TVUS contributes to treatment planning, follow-up assessment, and preoperative evaluation of disease extent [20].

**6.2** Magnetic resonance imaging is a well-established second-line imaging method in the diagnosis of endometriosis, particularly useful for staging of DIE. It is particularly valuable for assessing disease extent and depth of infiltration, which is crucial for treatment planning. It is typically performed using a dedicated pelvic protocol, including high-resolution T2-weighted sequences in multiple planes and T1-weighted fat-suppressed images, which enhance the detection of hemorrhagic components and deep lesions [21]. MRI provides excellent soft-tissue contrast and a detailed multiplanar view of pelvic anatomy, enabling accurate identification of endometriomas as well as deep infiltrating endometriotic lesions involving the uterosacral ligaments, bowel, bladder, and rectovaginal septum [15]. According to the Arian et al. article, involvement of the genitourinary tract in endometriosis is generally considered the least complex pelvic compartment for diagnostic evaluation. Consequently, ultrasonography may serve as an effective first-line, cost-efficient imaging modality in many cases, while MRI should be reserved for inconclusive ultrasound findings or more complex cases, which require comprehensive assessment [21]. It also plays an important role in surgical planning by mapping disease distribution. Although MRI is highly accurate, it is generally used as a complementary tool to transvaginal ultrasound, which remains the main imaging method. Together with TVUS, MRI is a complementary imaging strategy for comprehensive evaluation of endometriosis, while MRI is mainly reserved for problem-solving and detailed preoperative assessment [17,15]. Yet, its use is limited by cost and availability. Its sensitivity may be lower for small peritoneal lesions, and overall diagnostic performance can depend on operator experience.

**6.3** Transrectal ultrasound is being used more frequently in the diagnostic work-up of deep infiltrating endometriosis, particularly when bowel involvement is suspected, alongside transvaginal ultrasound and MRI [20,14]. According to the literature, this technique enables high-resolution visualization of the rectal wall layers, allowing assessment of lesion depth and extension, which is useful for preoperative staging of rectosigmoid endometriosis [20,24]. Compared with other imaging methods, TRUS provides dynamic, real-time evaluation of bowel lesions nearby pelvic anatomical structures, which may improve lesion assessment in expert hands [14,24]. On the other hand, its diagnostic performance is highly operator-dependent and limited by restricted detection of extraintestinal pelvic disease, which reduces its utility as a standalone diagnostic tool [20]. TRUS can be useful as a complementary imaging modality in selected patients with suspected DIE involving the bowel, particularly when detailed assessment of rectal wall invasion is required [20,24].

## 7. Diagnostic Laparoscopy

Laparoscopy is considered the gold standard for confirming endometriosis, as it allows for direct visualisation of the lesions, the collection of samples for histological examination and, if necessary, concurrent surgical treatment [18]. Current clinical guidelines indicate a clear move away from using this method as a mandatory diagnostic procedure. Laparoscopy is currently recommended in situations where the results of non-invasive tests, such as TVUS or MRI, are inconclusive, or when surgical treatment is planned for the patient [29,30]. The latest guidelines recommend the use of early endometriosis diagnosis based on clinical assessment and imaging studies, whilst invasive methods are reserved for selected cases and are not used routinely in diagnosis. The aim is to reduce waiting times for diagnosis whilst minimising unnecessary surgery and the associated risks [30,28]. A negative result on imaging does not rule out the presence of endometriosis, particularly in its early or superficial forms, which can be difficult to detect [30]. At the same time, laparoscopy remains the gold standard for a definitive diagnosis, particularly in complex or atypical cases, as it allows for direct assessment of the lesion and histological confirmation. Despite its diagnostic and therapeutic advantages, it remains an invasive procedure associated with surgical and anaesthetic risks, which means that the potential benefits for each patient must be carefully weighed up before deciding to proceed [18,28].

## 8. Biomarkers in endometriosis diagnosis

Considerable research efforts have focused on identifying biomarkers that could support the development of reliable non-invasive diagnostic strategies for endometriosis. Studies show that potential biomarkers encompass a range of biological factors, including inflammatory, hormonal, immunological, genetic, epigenetic, and metabolic markers [7,26]. Elevated levels of pro-inflammatory cytokines, such as IL-6, IL-1 $\beta$  and TNF- $\alpha$ , are frequently observed in patients with endometriosis, particularly in blood serum and peritoneal fluid, reflecting the chronic inflammation associated with this condition. CA-125 is one of the most commonly tested clinical markers. On the other hand, despite its potential role as an aid, particularly in advanced stages of endometriosis, its diagnostic sensitivity and specificity remain limited [26]. The Brulport et al. study investigated 1107 potential biomarkers of endometriosis across biological compartments. Most potential biomarkers were not consistently confirmed and may be due to differences in methods or false positives. Only 4 biomarkers were reliably confirmed in different compartments and by different research groups. According to study, these few consistent markers, such as miRNAs and cytokines, may represent the most promising candidates for further investigation [7]. Among emerging biomarker candidates, microRNAs have received considerable attention because of their regulatory role in several biological processes implicated in endometriosis [7,26]. In patients with endometriosis, varied expression profiles of specific miRNAs have been observed. At the same time, these findings remain inconclusive and have not yet been clinically validated. Furthermore, research is ongoing into the potential role of non-coding RNAs, such as long non-coding RNAs (lncRNAs), in regulating pathological processes occurring in the endometrium. Biomarkers associated with metabolic and oxidative stress are also being investigated, including nitric oxide and other mediators of oxidative stress, although the evidence to date remains limited and requires further verification [7]. Despite these promising results, no single biomarker has demonstrated sufficient sensitivity and specificity to be used in clinical practice as an independent diagnostic tool. As a result, a multi-marker approach is being developed to improve diagnostic accuracy by combining biomarkers representing different biological pathways. Future directions include the potential development of biomarker panels. However, their clinical effectiveness and utility have not yet been validated [7,26].

## 9. Integrated diagnostic approach

Literature reviews suggest that patient interviews, symptom assessment, and physical examination form the basis for the early diagnosis of endometriosis. Symptoms such as painful periods, dyspareunia, and infertility are often non-specific and may vary between patients. A detailed clinical assessment is therefore essential to confirm suspected disease and guide further imaging. Physical examination may reveal tenderness of the uterosacral ligaments, nodularity, or reduced uterine mobility, supporting clinical decision-making [26]. An integrated diagnostic approach combines clinical evaluation with supplementary imaging techniques to improve diagnostic accuracy and assess disease stage. Evidence shows that the combination of multiple imaging modalities with expert interpretation significantly enhances the detection of pathological changes compared with a single modality [20]. Such an integrated strategy is considered essential for accurate diagnosis, treatment planning, and improved clinical outcomes in patients with endometriosis [17].

## 10. Emerging Imaging Techniques in endometriosis diagnosis

10.1 Transvaginal elastography is an ultrasound imaging technique that assesses tissue stiffness and may provide additional diagnostic value in endometriosis, particularly in DIE. According to Londero et al. study, elastography can differentiate endometriotic lesions from surrounding healthy tissue due to their increased stiffness, which is related to the fibrotic component of the disease. In the study, strain ratio and color score ratio were used to compare DIE and non-endometriotic tissue. The results showed higher values in DIE lesions, suggesting good discriminatory performance regardless of lesion location [31]. Although initial results indicate high diagnostic potential, elastography remains limited in the literature. Therefore, further validation in larger cohorts is needed before it can be used in routine clinical practice. Studies suggest that adding elastography to ultrasound may help assess treatment response and support future treatment planning [31,32]. In general, elastography appears to be a promising additional tool rather than a primary diagnostic method in endometriosis, yet still requires further research.

10.2 Studies have shown that endometriotic lesions may demonstrate heterogeneous enhancement patterns, including reduced or delayed enhancement and rapid washout compared with surrounding tissues, reflecting abnormal perfusion characteristics of the disease. The study by Zheng et al. suggest that contrast-enhanced ultrasound (CEUS) may provide additional diagnostic information particularly in deep infiltrating endometriosis, where lesions show altered vascular architecture and fibrotic stroma. This imaging method allows real-time assessment of tissue microvascularization using intravenously delivered contrast agents. According to the study, this imaging method can help identify vascular patterns of DIE lesions and may improve lesion characterization when added to standard transvaginal ultrasound [27,16]. In the case report by Li-li Chu et al., a 43-year-old woman had an ultrasound scan during cervical cancer screening, which revealed a heterogeneous mass extending from the uterine fundus with mixed internal echogenicity. CEUS showed a mixed cystic-solid mass with well-defined non-perfused areas and homogeneous enhancement of the solid component with peripheral vascularity. The lesion demonstrated low enhancement intensity with gradual washout, suggesting a benign nature. Therefore, CEUS enabled real-time assessment of microvascular patterns, supporting its potential as a non-invasive tool for differentiating pelvic endometriosis from malignant tumors [1]. Still, literature remains limited, and the diagnostic performance of CEUS is highly dependent on operator expertise, requiring further validation before routine clinical use.

10.3 Recent advances in imaging techniques have significantly improved the non-invasive diagnosis of endometriosis, particularly in the assessment of DIE. Transvaginal ultrasound and MRI are currently considered complementary imaging methods in the diagnosis of endometriosis, supported by technological advancements and diagnostic approaches [14]. Sonovaginography enhances the diagnostic performance of TVUS by improving visualization of the vaginal wall and posterior pelvic compartment. This technique has been shown to improve the detection of DIE, particularly lesions involving the rectovaginal septum and uterosacral ligaments [19,22]. In the study by Barra et al., sonovaginography demonstrated high diagnostic accuracy for DIE, with performance comparable to rectal water contrast-transvaginal ultrasonography, supporting its role as a complementary technique to TVUS in DIE [5]. Advanced MRI techniques, including diffusion-weighted imaging (DWI) and high-resolution sequences, improve the assessment of endometriotic lesion extent. These methods enable more accurate evaluation of lesion size and depth of infiltration, particularly in patients with DIE. As a result, MRI provides a more precise assessment of disease extent and supports preoperative planning [17]. These advances support a non-invasive approach to the diagnosis of endometriosis, but their accuracy still depends on operator experience and requires further development.

## 11. Future Perspectives

As artificial intelligence continues to develop, the question arises as to whether AI could also be used in the early detection of endometriosis. According to literature, artificial intelligence has the potential to analyse clinical, imaging and biomarker data, thereby improving the accuracy and consistency of diagnosis [23]. Artificial intelligence algorithms, such as machine learning, can help specialists detect endometrial lesions in ultrasound and MRI scans. This allows test results to be assessed more consistently and may reduce the time taken to reach a diagnosis. In addition, researchers are developing predictive models that analyze non-specific symptoms such as pelvic pain and painful menstruation, to help identify the disease earlier. FemTech is a technology sector that focuses on solutions designed to support women's health and wellbeing. Moreover, the potential role of FemTech solutions, which use artificial intelligence may help monitor patient's symptoms, educate patients and provide personalised care, increasing health awareness among women and encouraging

them to book an appointment with a gynaecologist. Despite these promising developments, recent evidence indicates that AI-based diagnostic tools remain at an early stage of development and validation. An article in The Journal of Medical Imaging and Interventional Radiology suggests that mainstream FemTech apps are not specifically designed to address the diverse symptom profiles of endometriosis. Key limitations include: small study groups, data that may not reflect the situation of all patients, potential algorithmic bias, and unequal access to digital health technologies [25]. Artificial intelligence may contribute to improving the detection and treatment of endometriosis, but further research is required before it can be commonly used in everyday clinical practice.

## 12. Discussion

Endometriosis remains a diagnostically challenging disease due to its variable symptoms, which most commonly include dysmenorrhea, dyspareunia, and infertility, but may also involve chronic pelvic pain and urinary or gastrointestinal symptoms. The literature reviewed in this article supports a diagnostic approach based on clinical evaluation combined with appropriate imaging methods. TVUS is the primary imaging method, while MRI plays a key role in disease staging and evaluation of complex cases, and transrectal ultrasound is reserved for selected patients with suspected bowel involvement. An integrated imaging approach improves diagnostic accuracy and helps support clinical decisions. MRI is considered the preferred imaging modality for the assessment of DIE involving the bowel, rectum, and rectovaginal septum, and uterosacral ligaments, while TVUS shows better performance in detecting ovarian endometriomas. Therefore, use of both techniques in the diagnostic work-up of endometriosis is recommended, as MRI provides better visualization of deep pelvic and intestinal disease [15,20,21]. Biomarkers are extensively studied as potential non-invasive diagnostic tools, but their clinical application is currently limited by poor reliability and limited validation [7,26]. At the same time, imaging techniques and artificial intelligence offer promising directions for improving early detection and lesion characterization. These methods remain largely experimental or insufficiently validated, and their role in routine clinical practice is not yet established. Overall, the literature suggests that the most effective diagnostic strategy currently relies on an integrated approach combining clinical assessment, standardized imaging techniques, and selective use of invasive or emerging diagnostic methods. Future advances are likely to depend on further standardization, and integration of novel diagnostic tools into clinical practice.

## 13. Conclusions

Further research is still needed to better understand and confirm the value of current diagnostic methods for endometriosis, including clinical assessment, imaging, biomarkers, and new technologies. Increased awareness and better access to ultrasound training for clinicians involved in diagnosing endometriosis, along with improvements in ultrasound technology, are likely to improve the diagnostic process in patients with endometriosis. Artificial intelligence may help improve the detection and management of endometriosis. Still, more high-quality research is needed before it can be routinely used in clinical practice. Future work should focus on standardisation of diagnostic protocols, and defining how these methods can best be integrated into everyday care.

## 14. List of Abbreviations

MRI - Magnetic Resonance Imaging  
AI – Artificial Intelligence  
TRUS – Transrectal Ultrasound  
TVUS – Transvaginal Ultrasound  
IDEA - International Deep Endometriosis Analysis  
DIE - Deep Infiltrating Endometriosis  
CEUS - Contrast-enhanced ultrasound  
TNF- $\alpha$  - Tumor necrosis factor  
CA 125 - Cancer antigen 125

**Author's Contributions:**

Conceptualization - Izabela Harpula  
 Literature Search - Benedykt Baljon, Patryk Brzezicki, Izabela Harpula  
 Data Analysis and Interpretation - Justyna Bogdan, Izabela Harpula  
 Methodology - Monika Błądek, Izabela Harpula  
 Check - Radosław Ramotowski, Izabela Harpula  
 Data curation - Sylwia Wit, Izabela Harpula  
 Writing – Original Draft - Izabela Harpula, Natalia Bębenek  
 Writing – Review & Editing - Izabela Harpula, Gabriela Barszcz  
 Supervision - Paulina Frączkiewicz, Izabela Harpula  
 Project Administration - Karolina Drygała, Izabela Harpula

**Conflict of Interest Statement:** The authors declare that they have no conflict of interest and they have read and agreed with the published version of the manuscript.

**Funding:** This research received no external funding.

**Declaration of the use of AI-assisted technologies in the writing process:** In preparing this work, the authors used ChatGPT AI for the purpose of checking language accuracy. After using this tool, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

**REFERENCES**

1. Chu, L.-L., Wu, M., Yang, W.-L., Cong, L.-H., & Li, L. (2025). Contrast-enhanced ultrasound findings of peritoneal polypoid endometriosis: A case report and literature review. *International Journal of Women's Health*, 1557–1562. <https://doi.org/10.2147/IJWH.S510066>
2. Brosens, I., Gordts, S., & Benagiano, G. (2013). Endometriosis in adolescents is a hidden, progressive and severe disease that deserves attention, not just compassion. *Human Reproduction*, 28(8), 2026–2031. <https://doi.org/10.1093/humrep/det243>
3. World Health Organization. (2025). *Endometriosis*.
4. Chauhan, S., More, A., Chauhan, V., & Kathane, A. (2022). Endometriosis: A review of clinical diagnosis, treatment, and pathogenesis. <https://doi.org/10.7759/cureus.28864>
5. Barra, F., Scala, C., Leone Roberti Maggiore, U., Evangelisti, G., Alessandri, F., Vellone, V. G., Stabilini, C., & Ferrero, S. (2021). A prospective study comparing rectal water contrast-transvaginal ultrasonography with sonovaginography for the diagnosis of deep posterior endometriosis. <https://doi.org/10.1111/aogs.14209>
6. Guerriero, S., Ajossa, S., Orozco, R., Perniciano, M., Jurado, M., Melis, G. B., & Alcazar, J. L. (2016). Accuracy of transvaginal ultrasound for diagnosis of deep endometriosis in the rectosigmoid: Systematic review and meta-analysis. *Ultrasound Obstet. Gynecol.*, 47, 281–289. <https://doi.org/10.1002/uog.15662>
7. Brulport, A., Bourdon, M., Vaiman, D., Drouet, C., Pocate-Cheriet, K., Bouzid, K., Marcellin, L., Santulli, P., Abo, C., Jeljeli, M., Chouzenoux, S., Chapron, C., Batteux, F., Berthelot, C., & Doridot, L. (2024). An integrated multi-tissue approach for endometriosis candidate biomarkers: A systematic review. *Reproductive Biology and Endocrinology*, 22, 21. <https://doi.org/10.1186/s12958>
8. Fryer, J., Mason-Jones, A. J., & Woodward, A. (2024). Understanding diagnostic delay for endometriosis: A scoping review using the social-ecological framework. <https://doi.org/10.1080/07399332.2024.2413056>
9. Li, W., Feng, H., & Ye, Q. (2025). Factors contributing to the delayed diagnosis of endometriosis: Systematic review and meta-analysis. *Front. Med.*, 12. <https://doi.org/10.3389/fmed.2025.1576490>
10. Harzif, A. K., Nurbaeti, P., & Wiweko, B. (2024). Factors associated with delayed diagnosis of endometriosis: A systematic review. <https://doi.org/10.1177/22840265241291120>
11. Wróbel, M., Wielgoś, M., & Laudański, P. (2022). Diagnostic delay of endometriosis in adults and adolescence-current stage of knowledge. *Advances in Medical Sciences*. <https://doi.org/10.1016/j.advms.2022.02.003>
12. Kozik, E. (2025). “Invisible” pain – social exclusion of patients with endometriosis: A qualitative analysis. <https://doi.org/10.14746/kse.2025.27.1.16>
13. Jiao, H., Feng, W., & Liu, H. (2026). Clinical diagnosis and treatment of bowel endometriosis and the distribution characteristics of lesions. *BMC Women's Health*, 26, 62. <https://doi.org/10.1186/s12905-025-04248-3>

14. Guerriero, S., Ajossa, S., Pagliuca, M., Borzacchelli, A., Springer, S., Pilloni, M., Taccori, V., Pascual, M. A., Deiala, F., Graupera, B., & Alcazar, J. L. (2022). Advances in imaging for assessing pelvic endometriosis. *Diagnostics*, 12, 2960. <https://doi.org/10.3390/diagnostics12122960>
15. Bausic, A., Coroleucă, C., Coroleucă, C., Manu, A., Frîncu, F., Comandasu, D., Matasariu, R., Mehedint, C., & Brătilă, E. (2022). Transvaginal ultrasound vs. magnetic resonance imaging (MRI) value in endometriosis diagnosis. *Diagnostics*, 12, 1767. <https://doi.org/10.3390/diagnostics12071767>
16. Zheng, Z., et al. (2023). Qualitative and quantitative features of deep endometriosis in contrast-enhanced ultrasound: An initial experience and literature review. <https://doi.org/10.3233/CH-231843>
17. Alonzo, L., et al. (2024). Magnetic resonance imaging of endometriosis: The role of advanced techniques. *J. Clin. Med.*, 13(19), 5783. <https://doi.org/10.3390/jcm13195783>
18. NICE. (2024). *Endometriosis: Diagnosis and management* [Guideline].
19. Arezzo, F., et al. (2022). The application of sonovaginography for implementing ultrasound assessment of endometriosis and other gynaecological diseases. *Diagnostics*, 12(4), 820. <https://doi.org/10.3390/diagnostics12040820>
20. Daniilidis, A., Grigoriadis, G., Dalakoura, D., D'Alterio, M. N., Angioni, S., & Roman, H. (2022). Transvaginal ultrasound in the diagnosis and assessment of endometriosis—An overview: How, why, and when. *Diagnostics*, 12, 2912. <https://doi.org/10.3390/diagnostics12122912>
21. Arian, A., Karimi, N., Ahmadinejad, N., Azadnajafabad, S., & Delazar, S. (2025). Refining MRI protocols for endometriosis: A comparative study of abbreviated and full MRI sequences. *British Journal of Radiology*, 98(1166), 287–295. <https://doi.org/10.1093/bjr/tqae230>
22. Alcazar, J. L., et al. (2022). Diagnostic accuracy of sliding sign for detecting pouch of Douglas obliteration and bowel involvement in women with suspected endometriosis: Systematic review and meta-analysis. <https://doi.org/10.1002/uog.24900>
23. Sivajohan, B., Elgendi, M., Menon, C., et al. (2022). Clinical use of artificial intelligence in endometriosis: A scoping review. *npj Digit. Med.*, 5, 109. <https://doi.org/10.1038/s41746-022-00638-1>
24. Zhang, X., et al. (2020). Comparison of physical examination, ultrasound techniques and magnetic resonance imaging for the diagnosis of deep infiltrating endometriosis: A systematic review and meta-analysis of diagnostic accuracy studies. <https://doi.org/10.3892/etm.2020.9043>
25. Luz, K. P., et al. (2025). Empowering women through intelligent care: A narrative review of AI-driven digital innovations for endometriosis diagnosis, education, and equity. <https://doi.org/10.1007/s44326-025-00061-2>
26. Kliber-Gałaszka, M., Kulczyńska-Figurny, K., Jagodziński, P. P., & Pławski, A. (2025). Potential biomarkers for early detection of endometriosis: Current state of art (what we know so far). *Journal of Applied Genetics*. <https://doi.org/10.1007/s13353-025-01021-y>
27. Avery, J. C., et al. (n.d.). Noninvasive diagnostic imaging for endometriosis part 1: A systematic review of recent developments in ultrasound, combination imaging, and artificial intelligence. <https://doi.org/10.1016/j.fertnstert.2023.12.008>
28. Goncalves, M. O., et al. (2021). Systematic evaluation of endometriosis by transvaginal ultrasound can accurately replace diagnostic laparoscopy, mainly for deep and ovarian endometriosis. <https://doi.org/10.1093/humrep/deab085>
29. Rogalska, A., et al. (2025). Diagnostic tools for endometriosis in Poland: A comparative assessment of reliability and out-of-pocket costs. <https://doi.org/10.3390/jcm14144935>
30. Becker, C. M., et al. (2022). *ESHRE guideline: Endometriosis*.
31. Xholli, A., et al. (2024). The benefit of transvaginal elastography in detecting deep endometriosis: A feasibility study. *Ultraschall Med*, 45(1), 69–76. <https://doi.org/10.1055/a-2028-8214>
32. Brunelli, A. C., Brito, L. G. O., Moro, F. A. S., Jales, R. M., Yela, D. A., & Benetti-Pinto, C. L. (2023). Ultrasound elastography for the diagnosis of endometriosis and adenomyosis: A systematic review with meta-analysis. 49(3), 699–709. <https://doi.org/10.1016/j.ultrasmedbio.2022.11.006>