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# From AI to Biomarkers: How Non-Invasive Endometriosis Diagnostics Shape Women's Quality of Life

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ABSTRACT

**Background.** Endometriosis is a chronic gynecological disorder that heavily impacts women's physical and psychosocial well-being. Reliance on surgical diagnosis causes extensive delays, prolonged symptoms, and reduced quality of life. Thus, developing non-invasive diagnostic strategies has become a major research priority.

**Aim.** To evaluate recent non-invasive diagnostic modalities for endometriosis and analyze their impact on women's health and quality of life.

**Material and methods.** A narrative review of English-language literature (2015–2025) was conducted using PubMed, Scopus, and Google Scholar. The focus included advanced imaging, biomarkers, genetic/molecular profiles, and artificial intelligence (AI) diagnostic tools.

**Results.** Advances in transvaginal ultrasound and MRI have substantially improved the detection of deep infiltrating endometriosis and ovarian endometriomas. While molecular biomarkers, genetic panels, and AI show immense potential, they currently lack the precision for independent

diagnosis. Clinical evidence suggests that multimodal diagnostic protocols yield the highest accuracy.

**Conclusions.** Transitioning to non-invasive pathways can minimize diagnostic delays, reduce surgical interventions, and significantly improve quality of life. An integrated model combining various non-invasive techniques is the most effective paradigm for early endometriosis management.

**Key words**

endometriosis; non-invasive diagnostics; biomarkers; artificial intelligence; quality of life; women's health; physical activity

## 1. INTRODUCTION

Endometriosis is a chronic gynecological condition characterized by the presence of endometrial-like tissue outside the uterine cavity. It affects approximately 10–15% of women of reproductive age and represents a significant clinical and public health challenge [1,2]. The disease is commonly associated with chronic pelvic pain, dysmenorrhea, dyspareunia, infertility, and a wide range of gastrointestinal and urinary symptoms, all of which substantially impair daily functioning and overall quality of life [3–5].

Despite its high prevalence, endometriosis remains underdiagnosed and frequently diagnosed with a considerable delay, often ranging from six to ten years after the onset of symptoms [6,7]. One of the main reasons for this delay is the lack of reliable, widely accessible, and non-invasive diagnostic tools [6]. Currently, laparoscopy with histological confirmation is considered the diagnostic gold standard; however, this approach is invasive, costly, and not suitable as a first-line diagnostic method [8]. As a result, many women experience prolonged periods of untreated symptoms, repeated medical consultations, and reduced psychosocial well-being [5,9].

In recent years, increasing attention has been directed toward the development of non-invasive diagnostic methods for endometriosis. Advances in imaging techniques, such as transvaginal ultrasound and magnetic resonance imaging, have improved the detection of specific forms of the disease, particularly ovarian endometriomas and deep infiltrating endometriosis [10,11]. Simultaneously, extensive research has focused on identifying serum, molecular, and genetic biomarkers that could facilitate earlier diagnosis without the need for surgical intervention [12,13]. Emerging technologies, including artificial intelligence–based image analysis and digital diagnostic tools, have further expanded the potential for non-invasive and patient-centered diagnostic strategies [3].

Early and accurate diagnosis of endometriosis is crucial not only for effective symptom management but also for preserving fertility, reducing the risk of disease progression, and improving long-term health outcomes [2,3]. Importantly, reducing diagnostic delay through non-invasive approaches may have a significant positive impact on women's mental health, social functioning, and overall quality of life [5,9]. From a broader perspective, improved diagnostic pathways may also contribute to more efficient healthcare utilization and better allocation of medical resources.

Research objective

The objective of this review is to analyze recent advances in non-invasive diagnostic methods for endometriosis and to assess their significance for women's health and quality of life.

## 2. MATERIALS AND METHODS

### 2.1. Data Sources

A narrative literature review was conducted using the following electronic databases: PubMed, Scopus, and Google Scholar. These databases were selected to ensure comprehensive coverage of medical, biomedical, and interdisciplinary literature related to endometriosis and non-invasive diagnostic approaches.

### 2.2. Search Strategy

The literature search was performed using a combination of Medical Subject Headings (MeSH) terms and free-text keywords. The main search terms included: endometriosis, non-invasive diagnosis, diagnostic methods, biomarkers, imaging techniques, ultrasound, magnetic resonance imaging, artificial intelligence, and quality of life. Boolean operators (AND, OR) were applied to refine the search strategy. The search was limited to articles published between 2015 and 2025 and written in the English language. Older studies were included if considered seminal.

### 2.3. Eligibility Criteria

Inclusion criteria comprised original research articles, systematic reviews, and narrative reviews addressing non-invasive diagnostic methods for endometriosis, with a focus on diagnostic accuracy, clinical applicability, or impact on women's health and quality of life. Full-text articles published in English were included. Exclusion criteria included case reports, conference abstracts, animal or in vitro studies, studies focused exclusively on invasive diagnostic techniques, and articles published before 2015 unless considered seminal.

### 2.4. Study Selection and Data Extraction

The titles and abstracts of identified articles were screened for relevance to the study objective. Full-text articles were subsequently assessed for eligibility. Data were extracted and qualitatively synthesized with particular attention to the type of diagnostic method, reported diagnostic performance, clinical relevance, and potential impact on women's health and quality of life.

### 2.5. Data Analysis

Given the heterogeneity of study designs, diagnostic methods, and outcome measures, a narrative synthesis approach was applied. The included studies were grouped thematically according to the type of non-invasive diagnostic method, and their findings were summarized and compared descriptively.

## 3. RESULTS

### 3.1. Imaging Techniques in Non-Invasive Diagnosis of Endometriosis

Imaging techniques play a central role in the non-invasive diagnosis of endometriosis and are often the first diagnostic step in clinical practice. Advances in imaging have significantly improved the ability to detect specific manifestations of the disease, particularly ovarian endometriomas and deep infiltrating endometriosis (DIE) [9,11,12]. Among the available modalities, transvaginal ultrasound and magnetic resonance imaging are the most widely used and extensively studied [11,12,14].

Transvaginal Ultrasound

Transvaginal ultrasound (TVUS) is currently the most accessible and commonly employed imaging method for the evaluation of suspected endometriosis. It is widely available, relatively inexpensive, and well tolerated by patients. TVUS is particularly effective in detecting ovarian endometriomas, which typically present as cystic lesions with homogeneous, low-level internal echoes, often described as a "ground-glass" appearance [11,15]. Numerous studies have demonstrated high sensitivity and specificity of TVUS for the diagnosis of ovarian endometriomas [15,16].

In recent years, the diagnostic utility of TVUS has expanded beyond ovarian involvement. The development of advanced ultrasound techniques and standardized examination protocols has improved the detection of deep infiltrating endometriosis affecting structures such as the uterosacral ligaments, rectovaginal septum, and bowel [11,16]. Targeted ultrasound mapping, combined with a detailed assessment of pelvic anatomy and tenderness-guided examination, has enhanced the ability to identify lesions previously considered difficult to visualize using conventional ultrasound [16,17].

Despite these advances, the diagnostic accuracy of TVUS remains highly operator-dependent. Adequate training and experience are essential to achieve reliable results, and the sensitivity of the method may be limited in cases of superficial peritoneal endometriosis [14,18]. Nevertheless,

TVUS is increasingly recognized as a valuable first-line, non-invasive diagnostic tool in the assessment of women with suspected endometriosis [9,14].

### Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is considered a complementary imaging modality, particularly useful in cases where ultrasound findings are inconclusive or when extensive disease is suspected [12,14]. MRI offers excellent soft tissue contrast and allows for comprehensive evaluation of pelvic anatomy without exposure to ionizing radiation. It is especially effective in the assessment of deep infiltrating endometriosis, including lesions involving the bowel, bladder, and posterior compartment [12,19].

MRI is also valuable in preoperative planning, as it provides detailed information on lesion size, location, and extent of infiltration. This information may guide surgical decision-making and help reduce intraoperative complications [19]. However, the higher cost, limited availability, and longer examination time compared to ultrasound restrict the routine use of MRI as a primary diagnostic tool [14].

### Limitations and Clinical Relevance

While imaging techniques have significantly improved the non-invasive diagnosis of endometriosis, they are not without limitations. Neither TVUS nor MRI reliably detect superficial peritoneal lesions, which remain a diagnostic challenge [14,18]. Consequently, a negative imaging result does not exclude the presence of endometriosis, particularly in women with persistent symptoms [7–9].

Nevertheless, imaging modalities play a crucial role in reducing diagnostic delay, guiding clinical management, and minimizing the need for diagnostic laparoscopy [9,14]. Their non-invasive nature contributes to improved patient comfort and may positively influence women's psychological well-being and quality of life by providing earlier diagnostic clarification and facilitating timely therapeutic interventions [4,5].

### 3.2. Serum and Tissue Biomarkers in the Non-Invasive Diagnosis of Endometriosis

The identification of reliable biomarkers for endometriosis has been a major focus of research, driven by the need for non-invasive, accessible, and cost-effective diagnostic alternatives to surgical procedures [9,13]. Biomarkers have the potential to facilitate earlier diagnosis, monitor disease progression, and assess treatment response. However, despite extensive investigation, no single biomarker has yet demonstrated sufficient accuracy to be implemented as a standalone diagnostic test [13,14].

CA-125 and Traditional Biomarkers

Cancer antigen 125 (CA-125) is the most extensively studied serum biomarker in endometriosis. Elevated CA-125 levels have been observed particularly in advanced stages of the disease and in the presence of ovarian endometriomas [9,13]. While CA-125 may be useful as an adjunct marker, especially for monitoring disease activity or treatment response, its diagnostic value is limited by low sensitivity in early-stage endometriosis and low specificity, as elevated levels can also be observed in other gynecological and inflammatory conditions [13,14].

Other traditional inflammatory markers, including C-reactive protein, interleukins, and tumor necrosis factor-alpha, have been evaluated as potential biomarkers. Although these markers reflect the inflammatory nature of endometriosis, their lack of disease specificity has restricted their clinical applicability in routine diagnostics [13].

Emerging Molecular Biomarkers

Recent advances in molecular biology have led to growing interest in circulating microRNAs (miRNAs) as potential non-invasive biomarkers for endometriosis. miRNAs are small, non-coding RNA molecules involved in post-transcriptional gene regulation and have been shown to exhibit disease-specific expression profiles [3,20,21]. Several studies have reported altered miRNA patterns in the blood of women with endometriosis, suggesting their potential role in early diagnosis[20,21]. However, heterogeneity in study design and analytical methods has limited the reproducibility of these findings [20,21].

Proteomic and metabolomic approaches have also been explored to identify panels of biomarkers associated with endometriosis. These high-throughput techniques allow for the simultaneous analysis of multiple proteins or metabolites, potentially increasing diagnostic accuracy. While promising, these methods remain largely experimental and require further validation before clinical implementation [22,23].

Tissue and Menstrual Fluid Biomarkers

In addition to serum-based markers, research has increasingly focused on biomarkers derived from endometrial tissue and menstrual fluid [3,18,24]. Menstrual effluent represents a readily accessible biological sample that may reflect local pathological processes associated with endometriosis [3,18]. Studies have identified differences in immune cell composition, inflammatory mediators, and molecular signatures in menstrual fluid from affected women [18,24]. Although these findings offer a novel and minimally invasive diagnostic avenue, standardized collection methods and large-scale validation studies are still lacking [24].

Clinical Implications and Limitations

Despite significant progress, the clinical use of biomarkers for the non-invasive diagnosis of endometriosis remains limited [13,24]. Most biomarkers demonstrate moderate sensitivity and specificity, and their performance varies depending on disease stage and phenotype [13,24]. Consequently, current evidence supports the use of biomarkers as part of a multimodal diagnostic approach rather than as independent diagnostic tools [9,13].

Nevertheless, continued research into biomarker discovery holds substantial promise. The development of reliable biomarker panels could significantly reduce diagnostic delay, decrease reliance on invasive procedures, and improve patient-centered care [7,9]. Earlier diagnosis through non-invasive biomarkers may ultimately contribute to better symptom control, improved fertility outcomes, and enhanced quality of life for women with endometriosis [4,5,10].

### 3.3. Molecular and Genetic Diagnostic Approaches in Endometriosis

Advances in molecular and genetic research have provided new insights into the pathogenesis of endometriosis and opened novel avenues for non-invasive diagnostic strategies [2,3,18]. These

approaches aim to detect disease-associated molecular alterations in easily accessible biological samples, thereby reducing the need for invasive diagnostic procedures [2,9].

### Circulating DNA and RNA-Based Markers

One of the most promising areas of research involves the analysis of circulating nucleic acids, including cell-free DNA (cfDNA) and RNA, in peripheral blood [25,26]. Altered gene expression profiles and the presence of disease-specific RNA signatures have been reported in women with endometriosis [25,27]. These circulating molecules may reflect pathological processes such as inflammation, aberrant immune responses, and abnormal tissue remodeling associated with the disease [3,18].

Similarly, circulating long non-coding RNAs and messenger RNAs have been investigated as potential diagnostic markers [27]. Although several candidate molecules have demonstrated diagnostic potential, variability in detection methods and limited sample sizes have hindered their translation into clinical practice [24,27].

### Epigenetic Alterations

Epigenetic modifications, including DNA methylation and histone modifications, play a significant role in the regulation of gene expression and have been implicated in the development and progression of endometriosis [28,29]. Aberrant methylation patterns in genes related to hormonal regulation, immune function, and cell proliferation have been identified in affected women [26,28]. The detection of epigenetic markers in peripheral blood or endometrial samples represents a promising non-invasive diagnostic strategy [26,29].

However, epigenetic profiles may be influenced by environmental factors, hormonal status, and disease heterogeneity, which complicates their use as universal diagnostic markers [28,29]. Further research is needed to establish standardized epigenetic signatures with sufficient diagnostic accuracy [29,30].

### Genetic Susceptibility and Risk Stratification

Genetic studies have identified multiple susceptibility loci associated with an increased risk of endometriosis [31]. Genome-wide association studies have revealed genetic variants linked to hormonal signaling pathways, inflammation, and immune regulation. While genetic testing alone is not suitable for diagnosing active disease, it may contribute to risk stratification and early identification of women at higher risk of developing endometriosis [2,31].

The integration of genetic information with clinical, imaging, and biomarker data may enhance diagnostic precision and support personalized diagnostic and therapeutic approaches [2,9].

Clinical Potential and Challenges

Molecular and genetic diagnostic approaches offer significant potential for improving the non-invasive diagnosis of endometriosis [2,18]. However, most of these methods remain in the research phase, and their clinical application is limited by methodological heterogeneity, high costs, and the need for advanced laboratory infrastructure [24,28].

At present, molecular and genetic markers are best considered as complementary tools within a multimodal diagnostic framework [9,18]. Continued advances in technology and large-scale validation studies are essential to translate these promising approaches into routine clinical practice and to further reduce diagnostic delay and its negative impact on women's health and quality of life [7,9,24].

### 3.4. Artificial Intelligence and Digital Diagnostic Tools in Endometriosis Diagnosis

The rapid development of artificial intelligence (AI) and digital health technologies has introduced new possibilities for improving the non-invasive diagnosis of endometriosis [32,33]. These tools aim to enhance diagnostic accuracy, support clinical decision-making, and reduce diagnostic delay by integrating complex datasets derived from imaging, clinical symptoms, and biomarker profiles [32,34].

AI-Assisted Imaging Analysis

Artificial intelligence, particularly machine learning and deep learning algorithms, has been increasingly applied to the analysis of medical imaging data [34,35]. In the context of

endometriosis, AI-based systems have demonstrated potential in improving the interpretation of transvaginal ultrasound and magnetic resonance imaging by identifying subtle patterns that may be overlooked during conventional image assessment [32,35]. Automated image segmentation and lesion detection algorithms may enhance the detection of deep infiltrating endometriosis and improve interobserver consistency [34,35].

Although preliminary results are promising, most AI-based imaging tools are still under development and have been evaluated primarily in retrospective studies [32,33]. Prospective validation and integration into routine clinical workflows are necessary before widespread implementation can be achieved [33,34].

### Symptom-Based Algorithms and Predictive Models

Beyond imaging, AI-driven predictive models have been developed to analyze patient-reported symptoms, medical history, and clinical variables [32,33]. These digital tools aim to identify symptom patterns associated with endometriosis and estimate disease probability, thereby supporting earlier referral and diagnostic evaluation [32]. Such approaches are particularly valuable in primary care settings, where awareness of endometriosis may be limited and access to specialized diagnostic procedures is restricted [7,8,33].

Mobile health applications and digital questionnaires have also been explored as tools for symptom tracking and patient engagement. By facilitating systematic symptom monitoring, these platforms may contribute to earlier recognition of disease patterns and improved communication between patients and healthcare providers [36].

### Integration of Multimodal Data

One of the key advantages of AI-based diagnostic tools lies in their ability to integrate multimodal data, including imaging findings, biomarker results, genetic information, and patient-reported outcomes [32,34]. Multimodal models may provide a more comprehensive assessment of disease likelihood than any single diagnostic modality alone [34]. This integrative approach aligns with the emerging concept of personalized medicine and may help overcome the limitations of individual non-invasive diagnostic methods [2,9].

### Challenges and Ethical Considerations

Despite their potential, AI and digital diagnostic tools face several challenges. These include data quality and availability, algorithm transparency, potential bias, and issues related to data privacy and ethical use [32,33,36]. Additionally, the implementation of AI-based systems requires appropriate regulatory frameworks, clinician training, and patient acceptance.

### Clinical Relevance

AI-assisted diagnostic tools have the potential to significantly improve the non-invasive diagnosis of endometriosis by reducing diagnostic delay, supporting clinical decision-making, and enhancing patient-centered care [32,33]. When used as adjuncts to imaging and biomarker assessment, these technologies may contribute to more efficient diagnostic pathways and ultimately improve women's health outcomes and quality of life [4,5,9,10].

## 4. IMPACT ON WOMEN'S HEALTH AND QUALITY OF LIFE

Endometriosis has a profound and multifaceted impact on women's health and quality of life, extending far beyond physical symptoms [3,10,42]. Chronic pelvic pain, fatigue, menstrual irregularities, and infertility significantly affect daily functioning, emotional well-being, and social participation [1,3,10]. The prolonged diagnostic delay commonly associated with endometriosis further exacerbates these challenges, often leading to frustration, psychological distress, and reduced trust in healthcare systems [7,8,41].

### Reduction of Diagnostic Delay and Disease Burden

The introduction and refinement of non-invasive diagnostic methods have the potential to substantially reduce the time to diagnosis [9,24]. Earlier identification of endometriosis allows for timely initiation of appropriate treatment strategies, which may alleviate symptoms, slow disease progression, and prevent complications [2,9,18]. Reducing diagnostic delay is particularly important for minimizing the cumulative burden of pain and improving long-term health outcomes [7,8].

## Impact on Reproductive Health and Fertility

Early diagnosis plays a critical role in preserving reproductive potential [2,43]. Non-invasive diagnostic approaches facilitate earlier referral to fertility-preserving interventions and individualized reproductive counseling [9,43]. By identifying endometriosis at earlier stages, clinicians may better tailor treatment strategies to balance symptom control with fertility goals, thereby improving reproductive outcomes and patient satisfaction [2,43].

## Psychological and Social Well-Being

Endometriosis is frequently associated with anxiety, depression, and reduced self-esteem, largely due to chronic pain, uncertainty, and delayed diagnosis [4,37,41]. Non-invasive diagnostic methods may contribute to improved psychological well-being by providing earlier diagnostic clarification and validation of symptoms [4,10]. Receiving a timely diagnosis can reduce feelings of uncertainty and stigma, enabling women to better understand and manage their conditio [37,42].

In addition, improved diagnostic pathways may enhance social and occupational functioning [5,6]. Reduced symptom severity and improved disease management can lead to fewer work absences, improved productivity, and greater participation in social activities, thereby positively influencing overall quality of life [5,39,40]. Furthermore, the reduction of pain and chronic symptoms achieved through early non-invasive diagnosis has a direct, positive impact on women's capacity to engage in regular physical activity and sports [3,9]. Chronic pelvic pain, dysmenorrhea, and debilitating fatigue frequently force patients to abandon exercise, leading to physical deconditioning and a profound decline in their sports-related quality of life [4,10,42]. By facilitating timely and tailored therapeutic interventions, non-invasive diagnostic pathways empower women to maintain or safely resume physical recreation and athletic pursuits [39]. This active engagement not only restores physical well-being but also serves as a vital non-pharmacological strategy for stress reduction and mental health preservation, directly optimizing the physical dimensions of quality of life [37,40,41].

## Patient-Centered Care and Healthcare System Implications

Non-invasive diagnostic strategies align with the principles of patient-centered care by minimizing physical discomfort and reducing the risks associated with invasive procedures [9,38]. Improved diagnostic efficiency may also decrease healthcare costs by limiting unnecessary surgical interventions and repeated consultations [5,7]. From a public health perspective, the widespread adoption of non-invasive diagnostic approaches may contribute to more equitable access to care and improved health outcomes for women affected by endometriosis [2,42].

Overall Quality of Life

Collectively, advances in non-invasive diagnostic methods have the potential to transform the diagnostic landscape of endometriosis [2,9]. By enabling earlier diagnosis, reducing invasiveness, and supporting individualized care, these approaches may significantly enhance physical, psychological, and social dimensions of quality of life [4,10,41]. Continued research and implementation of these strategies are essential to fully realize their benefits and to address the unmet needs of women living with endometriosis [9,42].

## 5. DISCUSSION

This review highlights the substantial progress made in the development of non-invasive diagnostic methods for endometriosis and underscores their growing importance in clinical practice [2,3,9]. Advances in imaging techniques, biomarker research, molecular and genetic approaches, and artificial intelligence–based tools have collectively expanded the diagnostic possibilities beyond traditional invasive procedures [3,9,12,32]. Nevertheless, despite these advancements, the non-invasive diagnosis of endometriosis remains a complex and evolving challenge [3,9,13].

One of the key findings of this review is that no single non-invasive diagnostic method currently provides sufficient accuracy to replace laparoscopy as the definitive diagnostic standard [9,13,14]. Imaging modalities such as transvaginal ultrasound and magnetic resonance imaging have demonstrated high diagnostic value for specific disease phenotypes, particularly ovarian endometriomas and deep infiltrating endometriosis [11,12,14]. However, their limited ability to

detect superficial peritoneal lesions underscores the need for complementary diagnostic strategies [12,14,18].

Similarly, biomarker-based approaches, including serum, molecular, and genetic markers, have shown promising results but remain constrained by moderate sensitivity, limited specificity, and methodological heterogeneity [13,21,24]. The variability in biomarker expression across disease stages and phenotypes further complicates their clinical application. These findings support the growing consensus that biomarkers are most effective when used as part of a multimodal diagnostic framework rather than as standalone tools [9,13,24].

The integration of artificial intelligence and digital diagnostic tools represents a particularly promising direction for future research. AI-assisted imaging analysis and predictive symptom-based models may enhance diagnostic accuracy, reduce interobserver variability, and support earlier referral and diagnosis [32,34,35]. Importantly, the ability of AI systems to integrate multimodal data aligns with the principles of personalized medicine and may help overcome the limitations inherent to individual diagnostic modalities [2,9,34].

From a clinical perspective, the implementation of non-invasive diagnostic approaches has significant implications for women's health and quality of life [4,10,42]. Earlier diagnosis facilitated by non-invasive methods may reduce diagnostic delay, improve symptom management, and support fertility preservation [2,7,43]. Moreover, minimizing reliance on invasive diagnostic procedures may enhance patient comfort, reduce psychological distress, and promote patient-centered care [4,9,41].

Despite these advances, several limitations must be acknowledged. Many of the studies included in this review were heterogeneous in design, sample size, and outcome measures, which limits the generalizability of their findings [13,24,32]. Additionally, the majority of emerging diagnostic tools require further validation in large, prospective clinical studies before they can be routinely implemented in practice [21,24,33]. Ethical considerations, data quality, and accessibility issues must also be addressed, particularly in relation to AI-based diagnostic systems [32,33,36].

Future research should focus on the development and validation of integrated diagnostic models that combine imaging, biomarker, molecular, and digital data [9,32,35]. Such approaches may offer

the most effective means of achieving accurate, non-invasive diagnosis while addressing the diverse clinical presentations of endometriosis [2,3,18]. Continued interdisciplinary collaboration and patient-centered research will be essential to translating these advances into tangible improvements in clinical care and quality of life for women affected by endometriosis [4,9,42].

## 6. CONCLUSIONS

Advances in non-invasive diagnostic methods have significantly expanded the possibilities for earlier and more patient-centered diagnosis of endometriosis. Imaging techniques, biomarker-based approaches, molecular and genetic tools, and artificial intelligence–assisted diagnostics each contribute valuable information, although none currently offers sufficient accuracy as a standalone diagnostic method.

The integration of multiple non-invasive approaches appears to be the most promising strategy for reducing diagnostic delay, minimizing the need for invasive procedures, and improving clinical decision-making. Earlier diagnosis facilitated by these methods may lead to better symptom management, preservation of fertility, and meaningful improvements in women's health and quality of life. Continued research and validation of integrated diagnostic models are essential to further enhance non-invasive diagnostic pathways in endometriosis.

## Disclosures

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