



International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

ARTICLE TITLE	MULTIMODAL TREATMENT STRATEGIES IN ENDOMETRIOSIS: A CONTEMPORARY SYSTEMATIC REVIEW OF MEDICAL AND SURGICAL MANAGEMENT
----------------------	---

DOI	https://doi.org/10.31435/ijitss.4(48).2025.4506
------------	---

RECEIVED	08 November 2025
-----------------	------------------

ACCEPTED	26 December 2025
-----------------	------------------

PUBLISHED	30 December 2025
------------------	------------------

LICENSE



The article is licensed under a **Creative Commons Attribution 4.0 International License**.

© The author(s) 2025.

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.

MULTIMODAL TREATMENT STRATEGIES IN ENDOMETRIOSIS: A CONTEMPORARY SYSTEMATIC REVIEW OF MEDICAL AND SURGICAL MANAGEMENT

Aleksandra Wójciak (Corresponding Author, Email: a.wojciak@onet.pl)

The New Hospital in Olkusz, Olkusz, Poland

ORCID ID: 0009-0003-2398-863X

Magdalena Zięba

Gabriel Narutowicz Municipal Specialist Hospital in Kraków, Kraków, Poland

ORCID ID: 0009-0009-3281-1725

Magdalena Morytko

The University Hospital in Kraków, Kraków, Poland

ORCID ID: 0009-0005-3913-4457

Maja Elertowicz

Ludwik Rydygier Memorial Hospital in Kraków, Kraków, Poland

ORCID ID: 0009-0002-8802-0323

Mikołaj Moskwa

Jagiellonian University Medical College, Kraków, Poland

ORCID ID: 0009-0006-4404-8243

Patrycja Herod

Ludwik Rydygier Memorial Hospital in Kraków, Kraków, Poland

ORCID ID: 0000-0002-4232-771X

Szymon Rudawski

The University Hospital in Kraków, Kraków, Poland

ORCID ID: 0009-0000-4793-3244

Kateryna Shtohryn

Jagiellonian University Medical College, Kraków, Poland

ORCID ID: 0009-0009-9134-4741

Hubert Gugulski

The University Hospital in Kraków, Kraków, Poland

ORCID ID: 0009-0004-1294-9835

ABSTRACT

Introduction: Endometriosis is a chronic, estrogen-dependent disorder characterized by ectopic endometrial-like tissue, chronic pelvic pain and impaired fertility. Optimal management requires balancing symptom control, recurrence prevention and preservation of reproductive potential. This review synthesizes evidence on contemporary pharmacological, postoperative and non-pharmacological strategies to inform multidisciplinary care.

Methodology: A literature review of PubMed, Scopus, and Google Scholar was performed, focusing on recent systematic reviews and meta-analyses evaluating surgical, pharmacological, non-pharmacological, and assisted reproductive strategies for endometriosis.

Results: Progestogens (notably dienogest) and continuous/extended COCs reduce dysmenorrhea and chronic pelvic pain and serve as viable long-term maintenance. Oral GnRH antagonists provide rapid, dose-dependent analgesia with add-back strategies mitigating hypoestrogenic harms. Surgical excision may yield superior symptom relief and lower recurrence in selected phenotypes but risks ovarian reserve loss, tissue-sparing techniques can attenuate this effect. Postoperative hormonal suppression (≥ 6 –12 months) reduces recurrence. Integrated non-pharmacological modalities improve pain coping, adherence and HRQoL. Endometriomas and deep disease negatively affect ovarian response and implantation, supporting individualized pre-ART planning.

Conclusion: Effective endometriosis management requires an individualized, multimodal approach integrating surgery, medical therapy, supportive care, and fertility planning. Holistic strategies enhance quality of life, reduce pain, and optimize reproductive outcomes. Interdisciplinary coordination is key to tailoring therapy according to patient phenotype, reproductive goals, and disease severity.

KEYWORDS

Endometriosis, GnRH Antagonists, Pharmacotherapy, Postoperative Management, Assisted Reproductive Technologies, Multimodal Care

CITATION

Aleksandra Wójciak, Magdalena Zięba, Magdalena Morytko, Maja Elertowicz, Mikołaj Moskwa, Patrycja Herod, Szymon Rudawski, Kateryna Shtohryn, Hubert Gugulski (2025) Multimodal Treatment Strategies in Endometriosis: A Contemporary Systematic Review of Medical and Surgical Management. *International Journal of Innovative Technologies in Social Science*. 4(48). doi: 10.31435/ijitss.4(48).2025.4506

COPYRIGHT

© The author(s) 2025. 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.

Introduction

Endometriosis is a chronic, estrogen-dependent condition characterized by the presence of biologically active endometrial-like tissue outside the uterine cavity, most commonly within the pelvic peritoneum, ovaries, uterosacral ligaments, or the rectovaginal septum [1]. The presence of ectopic endometrial implants leads to localized inflammation, fibrosis, and adhesions, which constitute the main causes of pelvic pain and dysfunction of pelvic organs. The etiology of endometriosis is complex and multifactorial. The classical Sampson theory of retrograde menstruation does not fully explain all cases. Contemporary concepts emphasize the roles of immune dysregulation, impaired apoptosis, oxidative stress, as well as genetic and epigenetic factors [1,2]. The pathophysiology also involves neuroangiogenesis and neural hypersensitivity, explaining the chronic and often pharmacologically refractory nature of pain [3]. Recent meta-analyses highlight the interaction between hormonal, inflammatory, and neurogenic components as key mechanisms sustaining the chronicity of the disease [1,2,4].

Endometriosis affects approximately 10% of women of reproductive age, whereas in populations with chronic pelvic pain or unexplained infertility the prevalence reaches 30–50% [1]. It carries substantial social and economic burdens—reducing work productivity, impairing daily functioning, and negatively affecting quality of life. Women with endometriosis have an increased risk of depressive and anxiety symptoms compared with the general population; psychological interventions (such as cognitive-behavioral therapy) may reduce pain perception and enhance quality of life. These observations underscore the need for a holistic therapeutic approach combining pharmacologic management, psychological support, and fertility-preserving strategies [5,6].

Chronic pelvic pain is the predominant symptom of endometriosis, frequently exacerbated during menstruation. Dysmenorrhea, dyspareunia, dyschezia, and dysuria commonly coexist, depending on lesion location [1,7].

In advanced disease, infertility becomes a significant concern. Meta-analyses have demonstrated reduced implantation rates and live birth rates in in vitro fertilization (IVF) cycles among women with endometriosis, particularly in higher disease stages [8,9]. Adjunctive therapy with GnRH agonists following surgical treatment may improve fertility outcomes in women planning pregnancy [10]. These findings highlight the heterogeneous and multifaceted clinical profile of endometriosis—an entity challenging both to diagnose and to treat effectively.

The pathophysiology of endometriosis involves interplay between hormonal, immunological, and inflammatory disturbances. Ectopic endometrial lesions exhibit increased expression of estrogen and progesterone receptors, resulting in enhanced proliferative activity and reduced progesterone responsiveness [1,2]. This is accompanied by chronic inflammation—macrophage activation, elevated production of prostaglandins (PGE₂) and pro-inflammatory cytokines (IL-1 β , IL-6, TNF- α), as well as heightened oxidative stress. These processes contribute to adhesion formation, fibrosis, and stimulate neuroangiogenesis, leading to peripheral and central sensitization responsible for persistent pain [1,2,3]. Systematic reviews focusing on deep infiltrating endometriosis (DIE) emphasize the importance of neuroimmune mechanisms in sustaining pain that is refractory to pharmacotherapy [3].

Methodology

This review was conducted using PubMed, Scopus, and Google Scholar, focusing on recent systematic reviews and meta-analyses evaluating surgical, pharmacological, non-pharmacological, and assisted reproductive strategies for endometriosis. Studies included reproductive-age women and reported outcomes such as pain, recurrence, quality of life, ovarian reserve, and IVF/ICSI success. Search terms included “endometriosis”, “progestins”, “combined oral contraceptives”, “GnRH antagonists”, “surgery”, “postoperative therapy”, “physiotherapy”, “acupuncture” and “assisted reproductive technology”.

Pharmacological Treatment of Endometriosis

Progestins and Other Progestogens

Progestogens constitute a cornerstone of hormonal therapy for endometriosis, acting by inhibiting ectopic endometrial proliferation, inducing endometrial gland atrophy, modulating local inflammatory responses, and reducing estrogen exposure to ectopic lesions [11]. Dienogest, administered at 2 mg daily, demonstrates a selective progestogenic effect without significant androgenic activity, resulting in effective control of dysmenorrhea and chronic endometriosis-related pain, as well as a reduction in postoperative recurrence risk [12]. Meta-analyses have shown a significant decrease in pain severity compared with placebo and comparable or superior efficacy relative to other progestin regimens, with a favorable tolerability profile compared with stronger estrogen-suppressive therapies (e.g., classical GnRH analogues) [11,12]. In the context of postoperative recurrence prevention, dienogest has demonstrated reduced recurrence rates and delayed onset compared with no maintenance therapy [12]. The safety profile of progestogens primarily includes menstrual irregularities (spotting or breakthrough bleeding), mood changes, and weight gain in some patients; severe long-term adverse effects are rare, allowing for prolonged treatment in many cases [11,13].

Combined Oral Contraceptives (COCs)

Estroprogestins in the form of COCs remain a widely used first-line treatment for endometriosis-associated pain, providing therapeutic benefit alongside contraception and cycle regulation. Their mechanism involves suppression of the hypothalamic-pituitary-ovarian axis, inhibition of ovulation, reduction of menstrual bleeding volume, and modulation of the local hormonal milieu within endometriotic lesions, leading to decreased dysmenorrhea and, in some cases, non-menstrual pain [14]. While classical systematic reviews note a limited number of high-quality randomized studies comparing different COC formulations or COCs with other therapies, meta-analyses and network analyses confirm the benefits of COCs in reducing dysmenorrhea and improving quality of life, particularly with continuous or extended regimens [15]. Comparisons with long-acting progestins and other hormonal options suggest similar long-term pain control in selected patient groups, though the effect depends on disease phenotype, patient preference, and concurrent contraceptive needs [16]. Evidence regarding recurrence prevention is inconclusive, making the choice of COCs for postoperative maintenance therapy individualized, taking into account risk factors and reproductive goals [14,15].

GnRH Antagonists

Oral GnRH receptor antagonists offer rapid, reversible suppression of the gonadal axis, with dose-dependent modulation of estradiol inhibition, allowing better balance between analgesic efficacy and hypoestrogenic effects [17]. Phase 2/3 studies of elagolix, relugolix, and linzagolix demonstrated clinically meaningful reductions in dysmenorrhea, non-menstrual pelvic pain, and dyspareunia compared with placebo, with a faster onset of action than laparoscopic surgical interventions [17,18]. Higher doses induce a medical menopausal state with risks of vasomotor symptoms and bone loss; however, “add-back” therapy (low-dose estrogen $\pm$ progestogen) mitigates bone density reduction and hypoestrogenic symptoms while preserving analgesic efficacy [19,20]. For example, a randomized trial of linzagolix at 200 mg with add-back reported a significant response rate for dysmenorrhea (72.9% vs 23.5% for placebo) and bone loss <1% under add-back regimens, illustrating the potential of GnRH antagonists for short- and medium-term therapeutic strategies [17,20]. Relugolix combination therapy (with estradiol and norethisterone) showed sustained pain reduction for up to two years in phase 3 trials with acceptable safety under add-back therapy [18,21]. Long-term elagolix data indicate that add-back therapy significantly improves tolerability and limits negative skeletal effects, enabling longer treatment durations than typical short courses [19]. Safety considerations require monitoring of bone mineral density and hypoestrogenic symptoms, as well as contraindications in women planning pregnancy [7,20].

Combination Therapies and Sequential Strategies

In clinical practice, combined or sequential use of different drug classes is increasingly employed to optimize analgesia, minimize adverse effects, and tailor therapy to reproductive plans. Sequential administration of short-term intensive GnRH antagonist courses (for rapid symptom control and disease activity reduction) followed by long-term maintenance with progestins or COCs is a common clinical strategy, supported by evidence that maintenance therapy reduces recurrence rates and sustains quality-of-life improvements [16,21]. Add-back therapy is an integral component of long-term GnRH antagonist management, maintaining analgesic efficacy while limiting bone loss and hypoestrogenic effects [20]. The choice of combination or sequential regimens depends on endometriosis phenotype (nodular, superficial, peritoneal vs ovarian), inflammatory status, prior treatment responses, and patient preference; network meta-analyses and comparative studies suggest that adaptive, personalized algorithms achieve the best long-term clinical outcomes with minimized adverse effects [16,17]. Sequential strategies commonly transition from short-term intensive suppression (e.g., GnRH antagonists) to long-term maintenance with progestins or COCs [16,21]. Network analyses indicate that such personalized treatment algorithms optimize pain control while minimizing side effects [16], with add-back therapy being crucial for sustaining efficacy in the long-term treatment horizon [20]. Treatment selection should be guided by endometriosis phenotype, prior therapeutic response, and reproductive planning [16,17].

Postoperative Therapy and Recurrence Prevention

Role of Surgical Intervention: Excision vs. Ablation

Postoperative management of endometriosis should integrate careful evaluation of the surgical technique with planning appropriate medical therapy aimed at minimizing recurrence risk, controlling pain, and, where relevant, supporting reproductive outcomes. Evidence from meta-analyses regarding the choice of surgical technique is inconclusive: some analyses demonstrate superiority of radical excision over ablation in reducing dysmenorrhea and certain pain domains in short- and medium-term follow-up (notably greater pain score reduction in the excision group in select studies) [22]. However, systematic reviews with meta-analyses aggregating recent studies emphasize that differences between excision and ablation largely depend on lesion location and depth, surgeon experience, and technique employed, resulting in heterogeneity of outcomes and no universal superiority of one method [23,24]. Regarding recurrence risk, complete removal of larger and deep lesions (excision) may be associated with lower rates of clinical lesion and ovarian endometrioma recurrence in some cohorts, but this benefit must be balanced against the potential impact on ovarian reserve in endometrioma surgery, requiring individualized operative planning [22,24].

Importance of Postoperative Hormonal Therapy in Recurrence Prevention

The role of postoperative hormonal therapy is well established in reducing recurrence rates and alleviating pain: meta-analyses covering various postoperative hormonal regimens after conservative surgery have shown significant reductions in clinical and imaging-confirmed recurrence compared with observation or placebo [1,25,26]. Choice of agent—from oral or systemic progestogens to levonorgestrel-releasing intrauterine systems (LNG-IUS), or short courses of GnRH agonists/antagonists—determines the profile of benefits and adverse effects. Meta-analyses demonstrate that LNG-IUS and dienogest effectively reduce recurrence and pain scores (VAS), with network analyses showing strong therapeutic effects when combined with conservative laparoscopy [12,25,26,27]. Timing and duration of therapy are crucial: long-term maintenance (≥ 6 –12 months or longer) is associated with lower recurrence rates than no therapy, although the optimal duration should be tailored to the patient's reproductive plans and risk profile [1,28].

Factors Influencing Recurrence Risk

Recurrence risk is influenced by both non-modifiable and modifiable factors. Meta-analyses identify younger age and higher rASRM scores as associated with increased recurrence risk, as well as prior surgeries, larger endometriomas, elevated CA-125 levels, and severe dysmenorrhea as predictive factors [29]. The type of surgery (excision vs. ablation) as a risk determinant is complex: some analyses suggest lower recurrence after excision in specific subgroups (e.g., endometriomas), but results are heterogeneous, and additional factors such as completeness of resection or residual microscopic foci strongly modify the effect [25,29,30]. Long-term cohort analyses indicate that cumulative recurrence rates increase over time, with a substantial proportion occurring within several years, highlighting the need for maintenance strategies and regular monitoring [30].

Postoperative Pain Prevention

Meta-analytic evidence indicates that combining optimal surgical technique with postoperative medical therapy reduces pain severity and improves quality of life. Systematic reviews and network analyses report significant reductions in VAS scores for patients receiving postoperative hormonal therapy compared with observation, with differences depending on drug class and follow-up duration [16,31]. Network comparisons suggest that GnRH agonist + estroprogestogen combinations or long-term progestogen regimens are most effective for short-term dysmenorrhea reduction, while LNG-IUS and dienogest demonstrate strong long-term outcomes and recurrence prevention [28,31]. Consideration of tolerability and impact on ovarian reserve is essential, particularly for patients undergoing aggressive resection; benefits in pain relief and recurrence prevention must be weighed against potential reproductive consequences.

Impact on Fertility and Pregnancy Outcomes after Surgery and Postoperative Therapy

The effect of surgical intervention and postoperative therapy on fertility and pregnancy outcomes has been analyzed in numerous meta-analyses with mixed results. Comparisons of conservative laparoscopy versus no intervention show improved natural pregnancy rates in specific subgroups (particularly mild-to-moderate disease), though this effect diminishes with advanced disease, patient age, and repeated surgeries [12,27,32]. Regarding postoperative hormonal therapy, evidence suggests that routine long-term suppression immediately after surgery should not be applied indiscriminately in women seeking prompt conception, as delaying attempts may reduce short-term pregnancy likelihood. In selected patients with pain and recurrence risk, short courses of GnRH agonists (e.g., three-month cycles) may enhance conception rates depending on individual profiles, necessitating case-by-case decision-making [26,33]. Consequently, individualized counseling on reproductive planning is recommended, with consideration of short-term adjuvant therapy where benefits outweigh delays in conception, and collaboration with reproductive centers when assisted reproductive technology may be indicated postoperatively.

Non-Pharmacological Interventions and a Holistic Treatment Approach Psychology and Quality of Life – Impact of Endometriosis

Endometriosis is associated with a substantial, multidimensional psychological burden. Meta-analytic evidence demonstrates increased prevalence of anxiety and depressive symptoms, as well as significant reductions in quality of life compared with the general population. Severity of psychological distress correlates with pain intensity, sexual dysfunction, and chronicity of symptoms, supporting routine mental health assessment and incorporation of psychological interventions into patient care [5]. Syntheses of randomized and quasi-randomized trials indicate that targeted psychological interventions—including cognitive-behavioral therapy (CBT) for pain, acceptance and commitment therapy (ACT), and mindfulness-based programs—provide measurable benefits: they reduce subjective pain intensity, improve quality-of-life metrics, and decrease depressive and anxiety symptoms in short- and medium-term follow-up. Effectiveness varies depending on therapy intensity, therapist expertise, and integration with medical or surgical treatment. Meta-analyses further show that comprehensive psychological programs enhance adherence to pharmacotherapy and patient satisfaction, indirectly improving clinical and functional outcomes. In practice, this necessitates parallel planning of psychological care alongside pharmacotherapy and rehabilitation [6,34].

Acupuncture and Complementary Therapies

Systematic reviews and meta-analyses of randomized trials suggest that acupuncture and related interventions may moderately improve endometriosis-associated pelvic pain and quality-of-life measures. Some studies report reductions in CA-125 levels following acupuncture, although evidence is less consistent. Heterogeneity in trial protocols—including selection of points, moxibustion techniques, treatment frequency, and sham controls—as well as variable methodological quality limits the strength of conclusions. Nonetheless, aggregate and network meta-analyses indicate moderate superiority of acupuncture over no intervention or standard care in VAS-measured pain reduction across multiple cohorts [35,36,37]. Comparative network analyses suggest that combined modalities (e.g., acupuncture plus moxibustion) may outperform certain monotherapies, though larger, rigorously blinded RCTs with longer follow-up are needed to differentiate true clinical effects from placebo and establish optimal protocols [36,37].

Physiotherapy, Physical Activity, and Movement as Supportive Strategies

Recent systematic reviews and meta-analyses evaluating exercise programs, aerobic training, core stabilization exercises, and targeted pelvic floor therapy indicate that physical activity and supervised rehabilitation confer benefits in pain reduction, quality of life, and pelvic function (including decreased pelvic floor muscle tension). Effects are most pronounced in well-defined, short-term supervised programs, though limitations exist due to small sample sizes, intervention heterogeneity, and brief follow-up periods, supporting recommendations for standardized rehabilitation protocols and larger, long-term RCTs [38,39]. Pelvic floor physiotherapy—including muscle relaxation and neuromodulation techniques, manual therapy, and movement education—should be considered first-line in patients with musculoskeletal pain components or bladder/bowel dysfunction, and combining individualized and group exercise programs enhances patient self-management capabilities [39,40].

Proposed Multimodal Treatment Model

Based on evidence from meta-analyses and comprehensive systematic reviews, a proposed multimodal treatment model integrates precise phenotyping of endometriosis, personalized surgical/medical intervention, concurrent implementation of psychological pain-management programs, and rehabilitation strategies (pelvic floor physiotherapy, exercise programs), with optional complementary therapies (e.g., acupuncture) for symptomatic support when the patient is interested. Syntheses and descriptions of interdisciplinary care models indicate that coordination by a multidisciplinary team (gynecologist, pelvic floor physiotherapist, psychologist/psychiatrist, pain specialist, and fertility specialist if needed) results in greater pain reduction, improved functional outcomes, and higher patient satisfaction compared with single-discipline approaches. Literature also emphasizes the heterogeneity of interdisciplinary programs and the need for standardized processes, patient involvement in service design, and long-term cost-effectiveness evaluation [40,41,42]. In practice, a multimodal model should be flexible and individualized: identifying dominant pain mechanisms (somatic vs. neuropathic vs. central), early addressing of psychological comorbidities, structured rehabilitation planning, and synchronization with patient reproductive goals enhance intervention efficacy and allow rational allocation of therapeutic resources [34,41].

Endometriosis and Assisted Reproductive Technologies (ART)

Impact of Endometriosis on In Vitro Fertilization Outcomes (IVF/ICSI)

Endometriosis exerts a complex, multidimensional impact on fertility, encompassing both anatomical alterations that hinder physiologic gamete transport and inflammatory microenvironments within the ovaries and peritoneal cavity, potential compromise of oocyte/embryo quality, and diminished ovarian reserve in the presence of endometriomas and/or prior ovarian surgery. Mechanistically, inflammation, oxidative stress, and local immune dysregulation predominate, impairing implantation and pregnancy progression, which contributes to observed differences in selected ART efficacy parameters. Pooled analyses show reduced implantation rates in patients with endometriosis, while live birth rates (LBR) do not demonstrate consistent, significant reductions compared with reference populations, suggesting partial compensation through ART procedures and clinical strategies [9,43–45]. Registry data and large cohort studies indicate that deep infiltrating endometriosis (DIE) and/or ovarian lesions visible on ultrasound (endometriomas, DIE) are associated with lower cumulative live birth rates after the first IVF/ICSI cycle, independent of oocyte yield, highlighting lesion location and type as key prognostic factors. Specific effects—such as reduced oocyte retrieval and higher gonadotropin requirements—are documented in meta-analyses and conceptual studies, particularly in the presence of endometriomas [9,44,45].

Pre- and Post-Operative Strategies for ART Candidates

Therapeutic strategy for patients planning ART should be individualized, considering age, ovarian reserve (preferably assessed via AMH), lesion location and size, pain symptoms, and prior surgeries. Consensus guidelines recommend that routine removal of endometriomas prior to IVF should not be standard but considered for specific indications: improved access to follicles during oocyte retrieval, pain management, or suspicion of concomitant pathology [46]. Cystectomy removes diseased tissue but carries significant risk of reduced ovarian reserve; meta-analytic data demonstrate substantial AMH decline, especially after bilateral interventions [47]. Moreover, meta-analyses show that cystectomy does not routinely improve IVF outcomes (e.g., LBR) across the population and reduces oocyte yield, thus surgical intervention should primarily address symptom control or technical obstacles to oocyte retrieval [48]. Evidence emphasizes that surgical technique matters: tissue-sparing methods and coagulation-minimizing approaches (e.g., laser or plasma instead of wide strip excision) may better preserve ovarian parenchyma and reserve, though current data are mainly from observational studies with short-term follow-up, warranting confirmation in RCTs and long-term studies [49].

Regarding sequence, “surgery first” versus “IVF first” strategies have been extensively analyzed. A systematic review and meta-analysis including 22 studies (~3,997 patients) showed no significant advantage of routine surgery before IVF for LBR, while highlighting a negative impact on ovarian reserve (decreased AMH and lower oocyte yield), supporting the absence of universal evidence favoring “surgery first” across the population [50]. Consensus guidelines recommend individualization for ART candidates, noting that routine endometrioma removal before IVF should not be standard, but may be considered in clear clinical indications (e.g., improved follicle access, severe pain, or suspicion of coexisting pathology) [46]. Narrative reviews and clinical syntheses indicate surgical benefit is more likely in selected subgroups—patients with dominant pain linked to specific lesion locations, younger women with preserved reserve, and those without prior surgery [49]. In cases of markedly reduced ovarian reserve or bilateral endometriomas, “IVF first” is often preferred, as prior surgery may further reduce AMH and stimulation response. Meta-analytic syntheses across multiple studies confirm that pre-ART surgery does not routinely improve LBR, and some high-quality analyses suggest worse outcomes post-surgery, underscoring the need for patient counseling regarding risks and benefits before ART [48,51].

Pharmacological Therapy in the Context of Fertility

Pharmacotherapy around ART requires balancing disease control with preservation of reproductive potential. Pre-cycle suppression protocols using ultralong GnRH agonists (3–6 months) have shown benefits in selected patients with severe disease in multiple meta-analyses and systematic reviews, although evidence is heterogeneous and inconclusive. For instance, a large systematic review and meta-analysis of 70 studies reported reduced implantation rates and oocyte yield in patients with endometriosis but no consistent impact on LBR overall, emphasizing interpretation in the context of disease phenotype and treatment plan [43]. Consensus guidelines recommend individualized decision-making and allow consideration of ultralong down-regulation for patients with extensive, painful endometriosis, provided delay in conception is acceptable [46].

Meta-analytic data (19 studies) evaluating surgical and pre-ART management strategies highlight no routine advantage of surgery prior to IVF for LBR; after excluding high-risk-of-bias studies, results even suggested decreased LBR post-surgery, supporting selective surgical qualification [51]. Regarding progestogens, a systematic review of five studies (568 patients) indicated that dienogest pretreatment yields comparable outcomes to no pretreatment for most endpoints, with some signal for improved clinical pregnancy and LBR in certain subgroups (especially fresh embryo transfers). Comparisons with prolonged GnRH suppression are heterogeneous, and dienogest may reduce the number of developing follicles, relevant for stimulation protocol planning and choice of fresh versus frozen transfer [44,51,52]. Finally, pharmacotherapy between surgery and ART (e.g., short GnRH agonist or progestogen courses) can be clinically justified to limit disease activity and alleviate symptoms before stimulation. Systematic reviews and meta-analyses, however, indicate limited and heterogeneous evidence for direct LBR improvement, which should be considered in patient counseling and multidisciplinary treatment planning [46,51,52].

Discussion

The evidence synthesized in this review highlights endometriosis as a heterogeneous condition requiring individualized and interdisciplinary management. Surgical excision provides effective and durable symptom relief, yet its potential impact on ovarian reserve- especially in bilateral endometriomas- necessitates careful patient selection based on pain severity, lesion phenotype, and reproductive plans. Pharmacological treatments, including progestins, combined hormonal contraceptives, and GnRH analogues or antagonists, remain central to pain control and postoperative suppression. However, medication alone does not fully address the chronic and multifactorial nature of endometriosis-related pain. Recent systematic reviews confirm that psychological interventions, pelvic floor physiotherapy, and structured exercise programs contribute meaningfully to improved pain coping, quality of life, and functional capacity, underscoring the importance of integrating non-pharmacological strategies into routine care. In fertility management, endometriosis may reduce implantation rates and ovarian response, yet cumulative live birth rates after IVF/ICSI are generally comparable to controls, indicating that ART can offset many disease-related impairments. Meta-analytic data do not support routine pre-IVF surgery for endometriomas, as cystectomy may reduce ovarian reserve without improving live birth outcomes. Pharmacological pretreatments, including ultralong GnRH agonists or dienogest, may benefit select subgroups but lack consistent evidence for broad application. Collectively, the findings emphasize that optimal outcomes depend on individualized care pathways integrating surgical, medical, psychosocial, and fertility-focused strategies.

Conclusions

This review demonstrates that effective endometriosis management requires a personalized, multimodal approach combining tailored surgical decisions, evidence-based hormonal therapy, and comprehensive non-pharmacological support. Surgery offers symptom relief but must be balanced against the risk to ovarian reserve. Medical therapies remain foundational for pain control and recurrence prevention, while psychological and physiotherapeutic interventions enhance overall quality of life. In fertility care, ART outcomes are generally favorable, and routine pre-IVF surgery is not recommended.

Future research should focus on identifying patient-specific predictors of treatment response, refining fertility-preserving surgical techniques, and evaluating long-term outcomes of integrated, multidisciplinary care models. Further high-quality trials are needed to clarify the role of emerging medical therapies and to optimize individualized treatment algorithms for diverse endometriosis phenotypes.

Funding Statement: The article did not receive any funding.

Conflict of Interest Statement: No conflicts of interest to declare.

REFERENCES

1. Zakhari, A., Delpero, E., McKeown, S., Tomlinson, G., Bougie, O., & Murji, A. (2021). Endometriosis recurrence following post-operative hormonal suppression: a systematic review and meta-analysis. *Human reproduction update*, 27(1), 96–107. <https://doi.org/10.1093/humupd/dmaa033>
2. Liu, Y., Gong, H., Gou, J., Liu, X., & Li, Z. (2021). Dienogest as a Maintenance Treatment for Endometriosis Following Surgery: A Systematic Review and Meta-Analysis. *Frontiers in medicine*, 8, 652505. <https://doi.org/10.3389/fmed.2021.652505>
3. Wu, H., Liu, J. J., Ye, S. T., Liu, J., & Li, N. (2024). Efficacy and safety of dienogest in the treatment of deep infiltrating endometriosis: A meta-analysis. *European journal of obstetrics, gynecology, and reproductive biology*, 297, 40–49. <https://doi.org/10.1016/j.ejogrb.2024.03.032>
4. Xin, L., Ma, Y., Ye, M., Chen, L., Liu, F., & Hou, Q. (2023). Efficacy and safety of oral gonadotropin-releasing hormone antagonists in moderate-to-severe endometriosis-associated pain: a systematic review and network meta-analysis. *Archives of gynecology and obstetrics*, 308(4), 1047–1056. <https://doi.org/10.1007/s00404-022-06862-0>
5. Delanerolle, G., Ramakrishnan, R., Hapangama, D., Zeng, Y., Shetty, A., Elneil, S., Chong, S., Hirsch, M., Oyewole, M., Phiri, P., Elliot, K., Kothari, T., Rogers, B., Sandle, N., Haque, N., Pluchino, N., Silem, M., O'Hara, R., Hull, M. L., Majumder, K., ... Raymont, V. (2021). A systematic review and meta-analysis of the Endometriosis and Mental-Health Sequelae; The ELEMI Project. *Women's health (London, England)*, 17, 17455065211019717. <https://doi.org/10.1177/17455065211019717>
6. Del Pino-Sedeño, T., Cabrera-Maroto, M., Abrante-Luis, A., González-Hernández, Y., & Ortiz Herrera, M. C. (2024). Effectiveness of psychological interventions in endometriosis: a systematic review with meta-analysis. *Frontiers in psychology*, 15, 1457842. <https://doi.org/10.3389/fpsyg.2024.1457842>
7. Wang, J. Y., Zhang, Y., & Ding, J. (2025). Oral Gonadotropin-Releasing Hormone Antagonists in the Treatment of Endometriosis: Advances in Research. *Journal of clinical medicine research*, 17(6), 299–308. <https://doi.org/10.14740/jocmr6236>
8. Somigliana, E., Li Piani, L., Paffoni, A., Salmeri, N., Orsi, M., Benaglia, L., Vercellini, P., & Vigano', P. (2023). Endometriosis and IVF treatment outcomes: unpacking the process. *Reproductive biology and endocrinology : RB&E*, 21(1), 107. <https://doi.org/10.1186/s12958-023-01157-8>
9. Mappa, I., Page, Z. P., Di Mascio, D., Patelli, C., D'Antonio, F., Giancotti, A., Gebbia, F., Mariani, G., Cozzolino, M., Muzii, L., & Rizzo, G. (2024). The Effect of Endometriosis on In Vitro Fertilization Outcomes: A Systematic Review and Meta-Analysis. *Healthcare (Basel, Switzerland)*, 12(23), 2435. <https://doi.org/10.3390/healthcare12232435>
10. Qing, X., He, L., Ma, Y., Zhang, Y., & Zheng, W. (2024). Systematic review and meta-analysis on the effect of adjuvant gonadotropin-releasing hormone agonist (GnRH-a) on pregnancy outcomes in women with endometriosis following conservative surgery. *BMC pregnancy and childbirth*, 24(1), 237. <https://doi.org/10.1186/s12884-024-06430-1>
11. Mitchell, J. B., Chetty, S., & Kathrada, F. (2022). Progestins in the symptomatic management of endometriosis: a meta-analysis on their effectiveness and safety. *BMC women's health*, 22(1), 526. <https://doi.org/10.1186/s12905-022-02122-0>
12. Muzii, L., Di Tucci, C., Galati, G., Carbone, F., Palaia, I., Bogani, G., Perniola, G., Tomao, F., Kontopantelis, E., & Di Donato, V. (2023). The Efficacy of Dienogest in Reducing Disease and Pain Recurrence After Endometriosis Surgery: a Systematic Review and Meta-Analysis. *Reproductive sciences (Thousand Oaks, Calif.)*, 30(11), 3135–3143. <https://doi.org/10.1007/s43032-023-01266-0>
13. Piacenti, I., Tius, V., Viscardi, M. F., Biasioli, A., Arcieri, M., Restaino, S., Muzii, L., Vizzielli, G., & Porpora, M. G. (2025). Dienogest vs. combined oral contraceptive: A systematic review and meta-analysis of efficacy and side effects to inform evidence-based guidelines. *Acta obstetrica et gynecologica Scandinavica*, 104(8), 1424–1432. <https://doi.org/10.1111/aogs.15145>
14. Brown, J., Crawford, T. J., Datta, S., & Prentice, A. (2018). Oral contraceptives for pain associated with endometriosis. *The Cochrane database of systematic reviews*, 5(5), CD001019. <https://doi.org/10.1002/14651858.CD001019.pub3>
15. Cooper, K. G., Bhattacharya, S., Daniels, J. P., Horne, A. W., Clark, T. J., Saridogan, E., Cheed, V., Pirie, D., Melyda, M., Monahan, M., Roberts, T. E., Cox, E., Stubbs, C., Middleton, L. J., & PRE-EMPT Collaborative Group (2024). Long acting progestogens versus combined oral contraceptive pill for preventing recurrence of endometriosis related pain: the PRE-EMPT pragmatic, parallel group, open label, randomised controlled trial. *BMJ (Clinical research ed.)*, 385, e079006. <https://doi.org/10.1136/bmj-2023-079006>
16. Csirz, Á., Kovács, D. P., Szabó, A., Szabó, B., Jankó, Á., Hegyi, P., Nyirády, P., Ács, N., & Valent, S. (2024). Comparative Analysis of Medical Interventions to Alleviate Endometriosis-Related Pain: A Systematic Review and Network Meta-Analysis. *Journal of clinical medicine*, 13(22), 6932. <https://doi.org/10.3390/jcm13226932>
17. Donnez, J., Becker, C., Taylor, H., Carmona Herrera, F., Donnez, O., Horne, A., Paszkowski, M., Petraglia, F., Renner, S. P., Patel, A., Boolell, M., Bestel, E., & Dolmans, M. M. (2024). Linzagolix therapy versus a placebo in patients with endometriosis-associated pain: a prospective, randomized, double-blind, Phase 3 study (EDELWEISS 3). *Human reproduction (Oxford, England)*, 39(6), 1208–1221. <https://doi.org/10.1093/humrep/deae076>

18. Giudice, L. C., As-Sanie, S., Arjona Ferreira, J. C., Becker, C. M., Abrao, M. S., Lessey, B. A., Brown, E., Dynowski, K., Wilk, K., Li, Y., Mathur, V., Warsi, Q. A., Wagman, R. B., & Johnson, N. P. (2022). Once daily oral relugolix combination therapy versus placebo in patients with endometriosis-associated pain: two replicate phase 3, randomised, double-blind, studies (SPIRIT 1 and 2). *Lancet (London, England)*, 399(10343), 2267–2279. [https://doi.org/10.1016/S0140-6736\(22\)00622-5](https://doi.org/10.1016/S0140-6736(22)00622-5)
19. Miller, C. E., Kim, J. H., Kroll, R., Simon, J. A., Soliman, A. M., Thomas, J. W., Xu, Y., Ng, J., & Snabes, M. C. (2024). Efficacy, tolerability, and bone density outcomes of elagolix with add-back therapy for endometriosis-associated pain: twelve months of an ongoing randomized phase 3 trial. *American journal of obstetrics and gynecology*, 231(6), 630.e1–630.e13. <https://doi.org/10.1016/j.ajog.2024.06.040>
20. Donnez, J., Petraglia, F., Taylor, H., Becker, C., Becker, S., Carmona Herrera, F., Paszkowski, M., Bestel, E., Hori, S., & Dolmans, M. M. (2025). Two-year follow-up study (PRIMROSE 3) to assess bone mineral density in subjects with uterine fibroids completing the PRIMROSE 1 and PRIMROSE 2 linzagolix trials. *Human reproduction open*, 2025(3), hoaf025. <https://doi.org/10.1093/hropen/hoaf025>
21. Becker, C. M., Johnson, N. P., As-Sanie, S., Arjona Ferreira, J. C., Abrao, M. S., Wilk, K., Imm, S. J., Mathur, V., Perry, J. S., Wagman, R. B., & Giudice, L. C. (2024). Two-year efficacy and safety of relugolix combination therapy in women with endometriosis-associated pain: SPIRIT open-label extension study. *Human reproduction (Oxford, England)*, 39(3), 526–537. <https://doi.org/10.1093/humrep/dead263>
22. Pundir, J., Omanwa, K., Kovoov, E., Pundir, V., Lancaster, G., & Barton-Smith, P. (2017). Laparoscopic Excision Versus Ablation for Endometriosis-associated Pain: An Updated Systematic Review and Meta-analysis. *Journal of minimally invasive gynecology*, 24(5), 747–756. <https://doi.org/10.1016/j.jmig.2017.04.008>
23. Burks, C., Lee, M., DeSarno, M., Findley, J., & Flyckt, R. (2021). Excision versus Ablation for Management of Minimal to Mild Endometriosis: A Systematic Review and Meta-analysis. *Journal of minimally invasive gynecology*, 28(3), 587–597. <https://doi.org/10.1016/j.jmig.2020.11.028>
24. Hashemi, M., Rouholamin, S., Ghahiri, A., & Momeni Alkami, F. (2023). Comparison of laparoscopic ablation versus excision for superficial endometriosis-associated pain. *American Journal of Clinical and Experimental Obstetrics & Gynecology*, 9(1), 1-7. <https://e-century.us/files/ajceog/9/1/ajceog0148677.pdf>
25. Wattanayingcharoenchai, R., Rattanasiri, S., Charakorn, C., Attia, J., & Thakkestian, A. (2021). Postoperative hormonal treatment for prevention of endometrioma recurrence after ovarian cystectomy: a systematic review and network meta-analysis. *BJOG : an international journal of obstetrics and gynaecology*, 128(1), 25–35. <https://doi.org/10.1111/1471-0528.16366>
26. Xiong, Y., Huang, W., Wang, C., Ma, W., Jin, S., Lin, J., Deng, X., Peng, Y., Huang, Y., Du, X., & Han, X. (2025). Effectiveness and Safety of Postoperative Medical Treatments Following Fertility-Preserving Surgery for Endometriosis: A Network Meta-Analysis. *BJOG : an international journal of obstetrics and gynaecology*, 10.1111/1471-0528.70016. Advance online publication. <https://doi.org/10.1111/1471-0528.70016>
27. Skhirtladze, D., Kristesashvili, J., & Charekishvili, R. (2024). Efficacy of postsurgical medical therapy for infertile patients with deep endometriosis. *Ginekologia polska*, 10.5603/gpl.99414. Advance online publication. <https://doi.org/10.5603/gpl.99414>
28. Chen, I., Veth, V. B., Choudhry, A. J., Murji, A., Zakhari, A., Black, A. Y., Agarpao, C., & Maas, J. W. (2020). Pre- and postsurgical medical therapy for endometriosis surgery. *The Cochrane database of systematic reviews*, 11(11), CD003678. <https://doi.org/10.1002/14651858.CD003678.pub3>
29. Jiang, D., Zhang, X., Shi, J., Tao, D., & Nie, X. (2021). Risk factors for ovarian endometrioma recurrence following surgical excision: a systematic review and meta-analysis. *Archives of gynecology and obstetrics*, 304(3), 589–598. <https://doi.org/10.1007/s00404-021-06129-0>
30. Veth, V. B., Keukens, A., Reijs, A., Bongers, M. Y., Mijatovic, V., Coppus, S. F. P. J., & Maas, J. W. M. (2024). Recurrence after surgery for endometrioma: a systematic review and meta-analyses. *Fertility and sterility*, 122(6), 1079–1093. <https://doi.org/10.1016/j.fertnstert.2024.07.033>
31. Keukens, A., Veth, V. B., Regis, M., Mijatovic, V., Bongers, M. Y., Coppus, S. F. P. J., & Maas, J. W. M. (2024). The effect of surgery or medication on pain and quality of life in women with endometrioma. A systematic review and meta-analysis. *European journal of obstetrics, gynecology, and reproductive biology*, 293, 95–105. <https://doi.org/10.1016/j.ejogrb.2023.12.012>
32. Hodgson, R. M., Lee, H. L., Wang, R., Mol, B. W., & Johnson, N. (2020). Interventions for endometriosis-related infertility: a systematic review and network meta-analysis. *Fertility and sterility*, 113(2), 374–382.e2. <https://doi.org/10.1016/j.fertnstert.2019.09.031>
33. Richard, E., Morin, J., Murji, A., Lemyre, M., Laberge, P. Y., & Maheux-Lacroix, S. (2022). Effect of Postoperative Hormonal Suppression on Fertility in Patients With Endometriosis After Conservative Surgery: A Systematic Review and Meta-analysis. *Obstetrics and gynecology*, 139(6), 1169–1179. <https://doi.org/10.1097/AOG.0000000000004811>
34. Desai, J., Strong, S., & Ball, E. (2024). Holistic approaches to living well with endometriosis. *F1000Research*, 13, 359. <https://doi.org/10.12688/f1000research.142586.2>

35. Giese, N., Kwon, K. K., & Armour, M. (2023). Acupuncture for endometriosis: A systematic review and meta-analysis. *Integrative medicine research*, 12(4), 101003. <https://doi.org/10.1016/j.imr.2023.101003>
36. Li, H., Wang, X., Wang, Y., Gao, Y., Zheng, X., Zhang, X., Li, X., Zheng, X., Fan, X., Zuo, G., & She, Y. (2024). Acupuncture and Related Therapies for Endometriosis: A Network Meta-Analysis of Randomized Controlled Trials. *Journal of pain research*, 17, 3197–3216. <https://doi.org/10.2147/JPR.S488343>
37. Chen, C., Li, X., Lu, S., Yang, J., & Liu, Y. (2024). Acupuncture for clinical improvement of endometriosis-related pain: a systematic review and meta-analysis. *Archives of gynecology and obstetrics*, 310(4), 2101–2114. <https://doi.org/10.1007/s00404-024-07675-z>
38. Xie, M., Qing, X., Huang, H., Zhang, L., Tu, Q., Guo, H., & Zhang, J. (2025). The effectiveness and safety of physical activity and exercise on women with endometriosis: A systematic review and meta-analysis. *PloS one*, 20(2), e0317820. <https://doi.org/10.1371/journal.pone.0317820>
39. Can, G., Amorim das Virgens, I. P., Fehér, B., Orbán, E. P., Fehérvári, P., Bánhid, F., Hegyi, P., Mayer, Á. A., & Ács, N. (2025). Physiotherapy for endometriosis-associated pelvic pain: A systematic review and meta-analysis. *Pain medicine (Malden, Mass.)*, pna083. Advance online publication. <https://doi.org/10.1093/pm/pna083>
40. Mick, I., Freger, S. M., van Keizerswaard, J., Gholiof, M., & Leonardi, M. (2024). Comprehensive endometriosis care: a modern multimodal approach for the treatment of pelvic pain and endometriosis. *Therapeutic advances in reproductive health*, 18, 26334941241277759. <https://doi.org/10.1177/26334941241277759>
41. Fang, Q. Y., Campbell, N., Mooney, S. S., Holdsworth-Carson, S. J., & Tyson, K. (2024). Evidence for the role of multidisciplinary team care in people with pelvic pain and endometriosis: A systematic review. *The Australian & New Zealand journal of obstetrics & gynaecology*, 64(3), 181–192. <https://doi.org/10.1111/ajo.13755>
42. McReynolds, D., Shiraz, R., Tangey, M. A., Egerton, T., & Frawley, H. (2025). Effectiveness of Multidisciplinary Treatment Compared to Single Discipline Treatment of Female Chronic Pelvic Pain: A Systematic Review and Meta-Analyses. *BJOG : an international journal of obstetrics and gynaecology*, 132(12), 1716–1733. <https://doi.org/10.1111/1471-0528.18322>
43. Qu, H., Du, Y., Yu, Y., Wang, M., Han, T., & Yan, L. (2022). The effect of endometriosis on IVF/ICSI and perinatal outcome: A systematic review and meta-analysis. *Journal of gynecology obstetrics and human reproduction*, 51(9), 102446. <https://doi.org/10.1016/j.jogoh.2022.102446>
44. Latif, S., Khanjani, S., & Saridogan, E. (2024). Endometriosis and In Vitro Fertilization. *Medicina (Kaunas, Lithuania)*, 60(8), 1358. <https://doi.org/10.3390/medicina60081358>
45. Alson, S., Henic, E., Jokubkiene, L., & Sladkevicius, P. (2024). Endometriosis diagnosed by ultrasound is associated with lower live birth rates in women undergoing their first in vitro fertilization/intracytoplasmic sperm injection treatment. *Fertility and sterility*, 121(5), 832–841. <https://doi.org/10.1016/j.fertnstert.2024.01.023>
46. Becker, C. M., Bokor, A., Heikinheimo, O., Horne, A., Jansen, F., Kiesel, L., King, K., Kvaskoff, M., Nap, A., Petersen, K., Saridogan, E., Tomassetti, C., van Hanegem, N., Vulliemoz, N., Vermeulen, N., & ESHRE Endometriosis Guideline Group (2022). ESHRE guideline: endometriosis. *Human reproduction open*, 2022(2), hoac009. <https://doi.org/10.1093/hropen/hoac009>
47. Younis, J. S., & Taylor, H. S. (2024). The impact of ovarian endometrioma and endometriotic cystectomy on anti-Müllerian hormone, and antral follicle count: a contemporary critical appraisal of systematic reviews. *Frontiers in endocrinology*, 15, 1397279. <https://doi.org/10.3389/fendo.2024.1397279>
48. Wu, C. Q., Albert, A., Alfaraj, S., Taskin, O., Alkusayer, G. M., Havelock, J., Yong, P., Allaire, C., & Bedaiwy, M. A. (2019). Live Birth Rate after Surgical and Expectant Management of Endometriomas after In Vitro Fertilization: A Systematic Review, Meta-Analysis, and Critical Appraisal of Current Guidelines and Previous Meta-Analyses. *Journal of minimally invasive gynecology*, 26(2), 299–311.e3. <https://doi.org/10.1016/j.jmig.2018.08.029>
49. Colombi, I., Ginetti, A., Cannoni, A., Cimino, G., d'Abate, C., Schettini, G., Giorgi, M., Raimondo, D., Martire, F. G., Lazzeri, L., Zupi, E., & Centini, G. (2024). Combine Surgery and In Vitro Fertilization (IVF) in Endometriosis-Related Infertility: When and Why. *Journal of clinical medicine*, 13(23), 7349. <https://doi.org/10.3390/jcm13237349>
50. Riemma, G. (2025). Surgery prior to IVF/ICSI versus up-front IVF/ICSI for the treatment of infertility associated with ovarian and deep infiltrating endometriosis: A systematic review and meta-analysis. *Reproductive BioMedicine Online*, Article 105178. <https://doi.org/10.1016/j.rbmo.2025.105178>
51. Bourdon, M., Peigné, M., Maignien, C., de Villardi de Montlaur, D., Solignac, C., Darné, B., Languille, S., Bendifallah, S., & Santulli, P. (2024). Impact of Endometriosis Surgery on In Vitro Fertilization/Intracytoplasmic Sperm Injection Outcomes: a Systematic Review and Meta-analysis. *Reproductive sciences (Thousand Oaks, Calif.)*, 31(6), 1431–1455. <https://doi.org/10.1007/s43032-023-01421-7>
52. Shao, W., Li, Y., & Wang, Y. (2023). Impact of dienogest pretreatment on IVF-ET outcomes in patients with endometriosis: a systematic review and meta-analysis. *Journal of ovarian research*, 16(1), 166. <https://doi.org/10.1186/s13048-023-01245-8>