OPEN ACCESS Journal of Interdisciplinary Research in Allied Health and Pharmacy
ISSN (Print): 3106-020X (Online): 3106-0218
Journal homepage: https://jirap.ubas.edu.pk

REVIEW ARTICLE

# Impact of Laparoscopic Cystectomy on Ovarian Reserve Markers in Women with Endometriosis: A Systematic Review and Meta-Analysis

Mehnaz Raees [1], Shehzadi Saima Hussain[2], Laila Zeb[3], Syed Abdullah Faisal[4], Syed Muhammad Hamid[5], Shahan Ullah[6]

[1]Lady Reading Hospital, Peshawar, , [2]Peshawar Medical College, Peshawar, [3]Khyber Medical College, Peshawar, [4]Faculty of Pharmaceutical Sciences, University of Biological and Applied Sciences, Lahore

**Correspondence**
Shehzadi Saima Hussain
**Email:** maple9894@yahoo.com

**Co-corresponding author:**
Syed Muhammad Hamid
Email: syedhamid143@hotmail.com

**Conflict of Interest**

All the authors have no conflict of interest

**Reference**
Raees.M., Saima.S., Zeb.L., Faisal. A., Hamid.M., Ullah.S., (2026 Impact of Laparoscopic Cystectomy on Ovarian Reserve Markers in Women with Endometriosis: A Systematic Review and Meta-Analysis, Journal of Interdisciplinary Research in Allied Health Sciences.

**Abstract**
**Background:** Laparoscopic cystectomy is frequently used to treat endometriomas but there is ongoing discussion regarding how it affects the ovarian reserve. The purpose of this meta-analysis was to assess how laparoscopic cystectomy affected ovarian reserve indicators in endometriosis-affected women.
**Methods:** Following PRISMA guidelines, a systematic review and meta-analysis were carried out. We looked through databases like PubMed, Google Scholar, Cochrane Library, and MEDLINE to find pertinent research published between 2000 and 2024. Included were randomized controlled trials and observational studies that compared anti-Müllerian hormone (AMH), follicle-stimulating hormone (FSH), and antral follicle count (AFC) levels before and after laparoscopic cystectomy for endometriomas. Meta-analyses with random effects were conducted.
**Results:** 2,415 patients from 17 studies (12 cohorts and 5 RCTs) were included. AMH levels (mean difference: -1.01 ng/mL, 95 percent CI: -1.30 to -0.73) and AFC (mean difference: -1.01, 95 percent CI: -1.83 to -0.20) were significantly lower following laparoscopic cystectomy when compared to controls. After surgery, FSH levels rose (mean difference: 1.71 mIU/mL, 95 percent CI: -0.01 to 3.42). There was a high degree of heterogeneity among the studies (I2 = 88-97%).
**Conclusion:** According to this meta-analysis, ovarian reserve markers, specifically AMH and AFC, significantly decline after laparoscopic cystectomy for endometriomas. When advising patients about the surgical treatment of endometriomas, clinicians should take these possible consequences into account, particularly for women who hope to become pregnant in the future. To assess the long-term effects on reproductive outcomes, more investigation is required.

**Keywords:** ovarian reserve, laparoscopic cystectomy, endometriosis, infertile women, anti-Müllerian hormone, follicle-stimulating hormone

## Background

Endometriosis is the third most reported reproductive disease after Douglas peritoneum and uterosacral ligament endometriosis (1). It is a prevalent disease that is often misunderstood, impacting about 5 to 15% of women during their reproductive age and 2 to 5% of women after menopause. (2-4). Increasing incidence rates of endometriosis led to high rates of infertility cases, pelvic pain, and reduced quality of life (5). Endometriosis is defined as the development of a cyst with ectopic endometriotic lining within the ovary (6). In other words, this condition is characterized by endometrial-like tissue on the outer side of the uterine cavity within the ovaries, pelvis, or the Douglas pouch & uterosacral ligaments (7), leading to ovarian dysfunction, impaired fertility, dyschezia, lower back pain, dyspareunia, and reduced ovarian reserve that induce long-term effects on reproductive health (8). Due to the enormous complexities associated with endometriosis, the treatment of this disease remained a clinical challenge.

The most common strategies for the management of ovarian endometriosis include Gonadotropin-releasing hormone (GnRH) analogues, ablation of the cyst wall and cystectomy or drainage (9). Among these laparoscopic cystectomy which involves the surgical removal of endometriomas is a frequently successful treatment approach for women with ovarian cysts related to endometriosis. (10, 11). This treatment helps in fertility preservation among infertile women. The clinical outcomes of laparoscopic cystectomy in managing endometriosis include low recurrence rates of endometriomas, and high clinical pregnancy rates as compared to drainage & ablation (12). However, few studies showed that laparoscopic cystectomy with surgical removal of the endometrioma cyst wall can result in a significant

decrease in the ovarian reserve due to the inevitable removal of healthy ovarian tissue (13, 14). While other studies suggested that laparoscopic cystectomy does not substantially reduce ovarian reserve, according to some research postoperative reproductive outcomes may even increase.

The quantity and quality of women's oocytes that are essential for fertility is known as ovarian reserve. Major histological markers that can detect the ovarian reserve include antral follicle count (AFC), serum levels of anti-Müllerian hormone (AMH), and follicle-stimulating hormone (FSH) levels that can provide insight into a woman's reproductive potential (15). This surgical management of endometriosis can lead to low ovarian reserve. Given evidence of both short-term and long-term loss in ovarian reserve, there has been growing concern regarding the impact of laparoscopic cystectomy on ovarian reserve (16). Despite its growing use, the impact of laparoscopic cystectomy on ovarian reserve remains a subject of ongoing debate.

Few cohort studies reported the impacts of laparoscopic cystectomy on ovarian reserve, but no meta-analysis reported the inconsistencies in the available literature regarding to association among laparoscopic cystectomy and ovarian reserve (17-19). It is critical for guiding clinical practice among women with endometriosis who want to preserve fertility after surgery. In order to assess the clinical effects of laparoscopic cystectomy on ovarian reserve in endometriosis patients, we used a meta-analysis approach. Through pooled analysis, the study aimed to measure key markers of ovarian reserve such as AFC, AMH, and FSH levels to assess the overall impact of cystectomy. By balancing the need for efficient disease treatment to maintain fertility and reduce long-term ovarian damage, this meta-analysis aims to offer evidence-based recommendations for doctors managing women with endometriosis and endometriomas.

## Methods

### 2.1 Study Protocol

A recent systematic review and meta-analysis of the clinical results of laparoscopic cystectomy on ovarian reserve in patients with endometriosis was conducted in accordance with the "Reporting Items for Systematic Review and Meta-Analysis (PRISMA)" guidelines (20) (21). Since our study was a meta-analysis of previously published observational and case-control studies, no additional ethical review was required.

### 2.2 Data Sources and Search Strategy

To extract and find relevant studies published between 2000 and 2024, a thorough literature search was carried out using a variety of electronic databases, including PubMed, Google Scholar, the Cochrane Library, and MEDLINE. Using MeSH keywords, the pertinent research articles were extracted such as (“ovarian reserve” OR “viable egg count” OR “ovarian follicle” OR “infertility”) AND (“laparoscopic cystectomy” OR “removal of cyst”) AND (“antral follicle count” OR “AFC” OR “follicular stimulating hormone” OR “FSH” OR “AMH” OR “Anti-Mullerian Hormone”). Additional studies were extracted and identified from reference lists by manually searching previous meta-analyses and reviews.

### 2.3 Eligibility Criteria

Research articles were chosen and screened from electronic databases using the following eligibility requirements. Only research that satisfied the following requirements for inclusion was accepted: (1). Studies that discuss the women population with endometriosis, cysts, and endometrioma 2). Studies analyzing the patient population that underwent laparoscopic cystectomy 3). Studies tracking the changes in serum AMH levels, AFC, and FSH levels markers of ovarian reserve. 4). studies using observational cohort studies, case-control studies, and RCTs 5). The full text of the English-language studies was accessible.

Those studies were excluded: 1). The study population of women suffering from cysts or cystic mass 2). Studies involving other treatment strategies for endometriosis rather than laparoscopic cystectomy 3). Research focusing on outcomes other than the histological indicators of ovarian reserve 4). Additionally, studies based on editorials, comprehensive reviews, narrative reviews, systematic reviews, and meta-analyses were not included. 5). Non-full text papers and studies published in languages other than English were not included.

### 2.4 Study selection

All studies obtained through our online search were imported into Endnote, and duplicates were removed. Two authors independently screened titles and abstracts, excluding irrelevant articles. Full-text screening was then performed on the remaining studies, and the studies meeting our eligibility criteria were finalized.

### 2.5 Data Extraction

A pre-specified table was used to extract the data by two independent reviewers. The information pertaining to demographics, including authors, study year, country, population, sample size, study design, and study follow-up, and primary outcomes of histological markers such as AMH levels, AFC count, and FSH levels were extracted (Table 1). Discrepancies were resolved by consulting a third reviewer.

### 2.6 Quality Assessment

The included RCTs' risk bias was evaluated using the Cochrane risk of bias tool. Six domains were used to

assess the risk bias of the included studies: allocation concealment, participant blinding, selection bias, blinding of outcome assessment, selective reporting, and other biases. Each included study's score or level was divided into three categories: high-risk, unclear, and low-risk (22). For non-randomized studies, the Newcastle-Ottawa Scale (NOS) was used to assess the quality of case-control and cohort studies (23). For included studies low risk was defined as a score of more than 7 moderate risk as a score of between 5-7 and high risk as a score of less than 5. Consensus was used to settle any disputes regarding risk bias assessment.

### 2.7 Statistical Analysis

Review Manager Software (Cochrane Collaboration version 5.4.0) was used for all statistical analysis. (24). Statistical significance was defined as a p-value of less than 0. 05. Random-effects models were used to analyze pooled data for studies that might have heterogeneity. The effect sizes were shown as mean differences for continuous outcomes such as FSH levels, AMH levels, and AFC count. The $I^2$ statistic was used to assess heterogeneity; significant heterogeneity was indicated by $I^2$ values greater than 50 percent.

## Results

### 3.1 Search Results

The study's objectives and title, "Clinical Outcomes of Laparoscopic Cystectomy on Ovarian Reserve in Patients with Endometriosis," guided the selection and screening of research articles in accordance with PRISMA guidelines. Using "MeSH" keywords, 3,930 research articles were retrieved from the aforementioned electronic databases, and 18375 duplicates were eliminated. Following the PRISMA guidelines, only 2202 papers were screened after excluding 977 research articles. Among these, only 1225 articles were assessed for eligibility criteria. Only nine studies met the inclusion criteria and were included in this study, as shown in Figure 1.

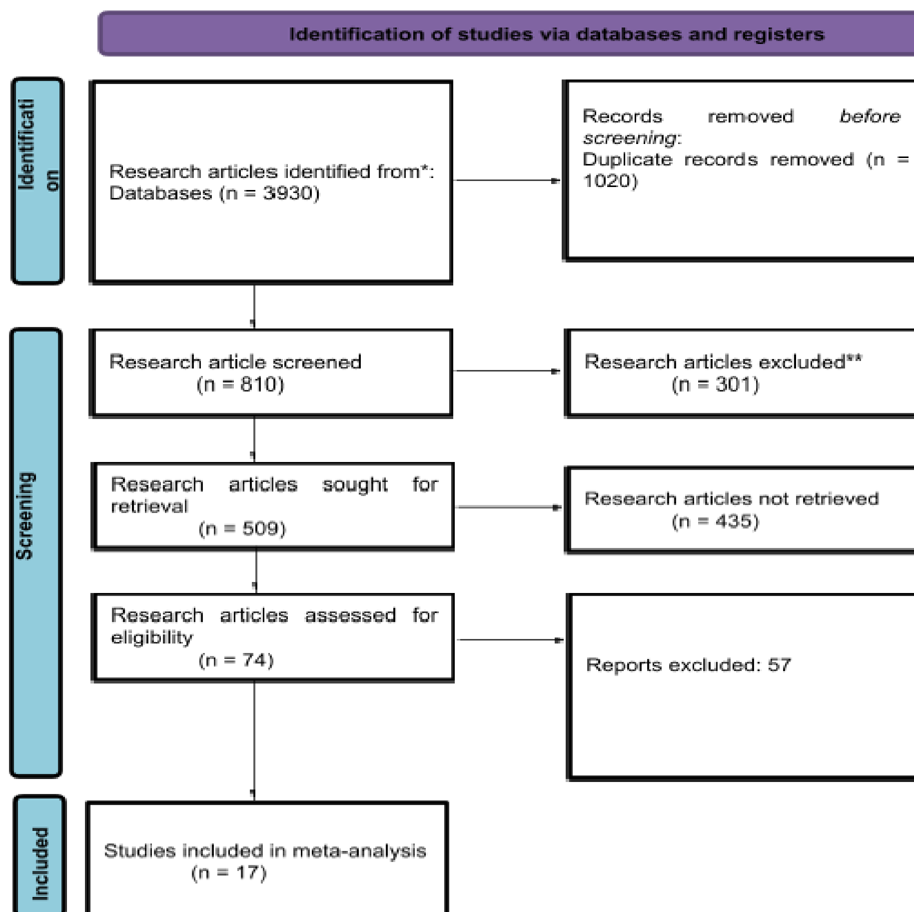


**Figure 1:** ***Screening and selection of included studies by PRISMA Guidelines***

**3.2 Characteristics of Included Studies**

Our study analyzed seventeen research articles (12 prospective cohort studies and 5 RCTs) and 2,415 women with endometriosis patients to use a meta-analysis method to assess the clinical results of laparoscopic cystectomy on ovarian reserve in endometriosis patients. The main characteristics of selected studies for analysis have been presented in Table 1. All included studies were retrospective or prospective observational studies, and randomized clinical trials were published from 2000 to 2024. The sample size was relatively small due to the nature of laparoscopic cystectomy, with study populations ranging from 37 to 409 women with endometriosis. Mean age ranged from 18 to 40 years, and follow-up periods lasted 3 to 12 months.

**Table 1: Characteristics of Included Studies**

| Author, year | Country | Study population with mean age | Study groups | Study design | Study follow up | AMH levels (ng/ml) | AFC | FSH (mIU/mL) | Mean (±SE) ovarian volume (mL) |
|---|---|---|---|---|---|---|---|---|---|
| Tsolakidis et al., 2010 (25) | Greece | 37 women (22–40 years) | T: 10 in laparoscopic cystectomy<br>P: 10 in Three-step procedure | Prospective cohort study | 6 months | T: 3.9–2.9<br>P: 4.5–3.99 | T: 2.4 ± 0.8<br>P: 4.36 ± 0.8 | T: 16.3 ± 3.8<br>P: 11.1 ± 3.8 | T: 11.5 ± 4.8<br>P: 11.0 ± 2.9 |
| Goodman et al., 2016 (26) | Canada | 116 women (18-43 years) | T: 29 in laparoscopic cystectomy<br>P: 29 without laparoscopic cystectomy | Prospective cohort study | 6 months | T: 2.76-3.95<br>P: 2.93 | | | |
| Ding et al., 2015 (27) | China | 72 women (30-40 years) | T: 72 in laparoscopic cystectomy<br>P: 20 in control group | Prospective cohort study | 12 months | T: 2.16<br>P: 2.9 | T: 6.35 ±1.51<br>P: 5.60 ± 1.35 | T: 6.29 ± 1.93<br>P: 5.64 ± 1.32 | |
| Zhang et al., 2016 (28) | China | 207 ovarian endometrioma (18-45 years) | T: 69 in laparoscopic cystectomy<br>P: 69 in control | Prospective cohort study | 12 months | T: 2.0 ± 0.9<br>P: 3.1 ± 1.6 | T: 4.2 ± 1.5<br>P: 6.3 ± 2.0 | T: 9.6 ± 4.0<br>P: 6.5 ± 2.8 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shaltout et al 2019 (29) | Egypt | 200 women (18-35 years) | T: 100 in laparoscopic management<br><br>P: 100 in control | randomized controlled trial | 6 months | T: 4.54<br>P: 5.41 | T: 12.5<br>P: 11.1 | | |
| Mehdizadeh et al., 2016 (30) | Iran | 70 patients (18-40 years) | 70 underwent laparoscopic cystectomy | prospective observational study | 6 months | T: 1.32±0.16<br><br>P: 2.63±0.319 | | | |
| Kostrzewa et al., 2019 (31) | Poland | 70 women (18–40 years) | 35 in laparoscopic cystectomy<br><br>35 in control | prospective randomized, clinical study | 12 months | T: 3.45 ± 3.37<br><br>P: 4.89 ± 3.66 to | | | |
| Sweed et al., 2019 (32) | Egypt | 122 women with endometriosis (18-35 years) | 61 in laparoscopic cystectomy ling | Prospective, randomized clinical trial | 6 months | T: 1.66 ± 1.02<br>P: 2.15 ± 1.48 | T: 3.2 ±1.3<br>P: 5.8 ± 2.7 | | T: 3.1 ± 1.6<br>P: 5.7 ± 2.6 |
| Sarbazi et al., 2021 (33) | Iran | 174 women (18-40 years) | 67 in laparoscopic cystectomy<br>67 in control | cohort study | 6 months | T: 1.76 ± 1.40<br>P: 2.80 ± 1.86 | | | |
| Karadag et al., 2020 (34) | Turkey | 68 women (18 -40 years) | 36 with endometriosis<br><br>32 with dermoid cyst | prospective observational study | 6 months | T: 1.47±0.55<br>P: 2.17±0.56 | T: 2.16±0.94<br>P: 3.40±0.87 | | |
| Candiani et al., 2018 (35) | Italy | 60 patients (18-60 years) | 30 in laparoscopic cystectomy<br><br>30 in laser vaporization | randomized clinical trial | 3 months | T: 1.8 ± 0.8<br>P: 1.9 ± 0.9 | T: 4.1 ± 2.2<br>P: 3.6 ± 1.9 | | |

| Zaitoun et al., 2013 (36) | Egypt | 121 patients (18-40 years) | 61 in laparoscopic cystectomy<br><br>60 in control | prospective randomized study | 18 months | T: 2.5 ± 0.4<br>P: 4.5 ± 0.9 | T: 6.6 ± 2.3<br>P: 6.4 ± 2.5 | T: 10.5 ± 0.3<br>P: 6.7 ± 0.4 | |
|---|---|---|---|---|---|---|---|---|---|
| Salihoğlu et al., 2016 (37) | Turkey | 121 patients | 34 in laparoscopic cystectomy<br><br>33 in control | Prospective case-control study | 6 months | T: 2.61 ± 2.3<br><br>P; 5.7 ± 3.7 | T; 3<br>P; 5 | T: 6.7±3.0<br>P: 6.9±1.9 | |
| El-Aal et al., 2018 (38) | Egypt | 44 women (18-35 years) | 22 in laparoscopic<br>22 in control | Prospective study | 3 months | | T: 5.5<br>P: 9 | T: 5.98<br>P: 6.19 | |
| Chen et al., 2014 (39) | China | 96 women | 40 in laparoscopic<br><br>56 in control | Prospective study | 3 months | T: 1.53 ± 1.37<br>P: 2.20 ± 1.23 | | | |
| Rasoul et al., 2021 (40) | Iraq | 332 women (18- 40 years) | 122 in laparoscopic cystectomy<br><br>200 in control | Prospective cohort study | 3 months | T: 1.69<br>P: 3.33 | | T: 10.34<br>P: 9.64 | |
| Mak et al., 2024 (41) | Taiwan | 409 patients with endometriosis | | Retrospective cohort study | 6 months | T: 0.7 ± 1.6<br>P: 1.5 ± 2.1 | | | |

AMH: anti-Müllerian hormone levels, AFC: antral follicle count.

### 3.3 Quality Assessment

Among twelve prospective cohort studies, four included studies were of low-risk (27, 37, 39, 41), and eight studies were of moderate risk (25, 26, 28, 30, 33, 34, 38, 40), as shown in Table 2. The majority of comparisons revealed low to moderate evidence quality, and the main causes of the decline in confidence were the study's limitations, inconsistencies, indirectness, and imprecision.

Table 2: Quality assessment of included studies by Newcastle-Ottawa Scale

| | **Selection** | | | | **Comparability** | | **Outcome** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Representative of the exposed cohort** | **Selection of external control** | **Ascertainment of exposure** | **Outcome of interest not present** | **Main factor** | **Additional factor** | **Assessment of outcome** | **Sufficient follow-up time** | **Adequacy of follow-up time** | **Total** |
| Tsolakidis et al., 2010 (25) | * | 0 | * | 0 | * | 0 | * | * | * | 6/9 |
| Goodman et al., 2016 (26) | * | * | * | 0 | * | 0 | * | 0 | 0 | 5/9 |
| Ding et al., 2015 (27) | * | * | 0 | * | * | * | * | * | * | 8/9 |
| Zhang et al., 2016 (28) | 0 | * | * | 0 | * | 0 | * | * | * | 5/9 |
| Mehdizadeh et al., 2016 (30) | * | * | 0 | * | * | 0 | * | 0 | 0 | 5/9 |
| Sarbazi et al., 2021 (33) | * | 0 | * | 0 | * | * | * | * | * | 7/9 |
| Karadag et al., 2020 (34) | * | * | * | 0 | * | 0 | * | 0 | 0 | 5/9 |
| Salihoğlu et al., 2016 (37) | * | * | 0 | * | * | * | * | * | * | 8/9 |
| El-Aal et al., 2018 (38) | * | 0 | * | * | 0 | * | * | 0 | * | 6/9 |
| Chen et al., 2014 (39) | * | * | 0 | * | * | * | * | * | * | 8/9 |
| Rasoul et al., 2021 (40) | * | * | * | 0 | * | 0 | * | 0 | 0 | 5/9 |
| Mak et al., 2024 (41) | * | * | * | * | * | * | * | 0 | * | 8/9 |

***= yes, 0= no**

**3.4 Risk Bias Assessment**

The Cochrane risk of bias tool was used to assess the studies, and the findings are presented in Figures 2 and 3. Among 5 included RCTs, one study was low-risk (32), and four studies were of moderate risk (29, 31, 35, 36). All our studies were considered to have minimal risk of bias, indicating a high level of reliability.

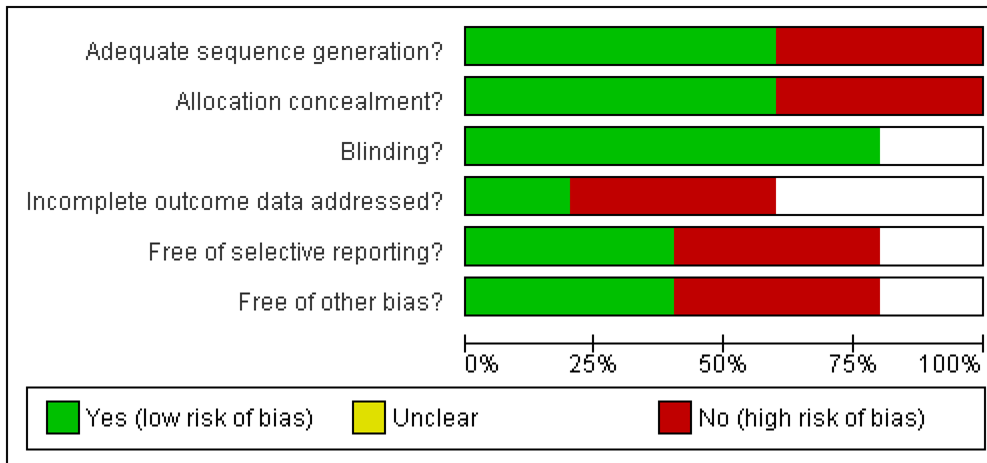


**Figure 2: Risk bias graph of included RCT studies**

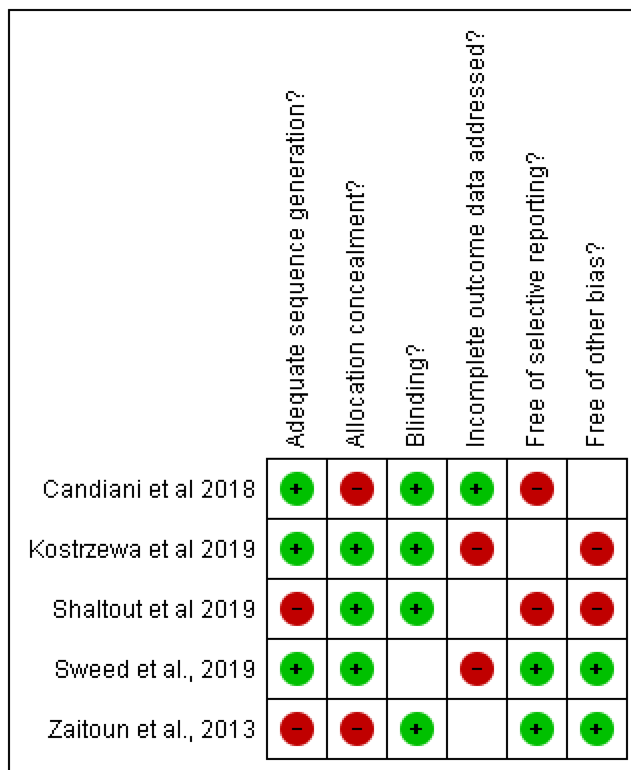


Figure 3: Summary of risk bias graph of included RCT studies

### 3.5 Primary Outcomes

#### 3.5.1 Anti- Müllerian Hormone (AMH) Levels

Among Among 17 included studies, 16 research articles reported change in AMH levels as an outcome of ovarian reserve after the laparoscopic cystectomy compared to placebo. The pooled analysis showed that AMH levels were lower among the laparoscopic cystectomy group as compared to control [-1.01 (95% CI: -1.30 to 0.73), p< 0.00001] and the reported heterogeneity ($I^2$ =88%), as mentioned in Figure 4 and 5.

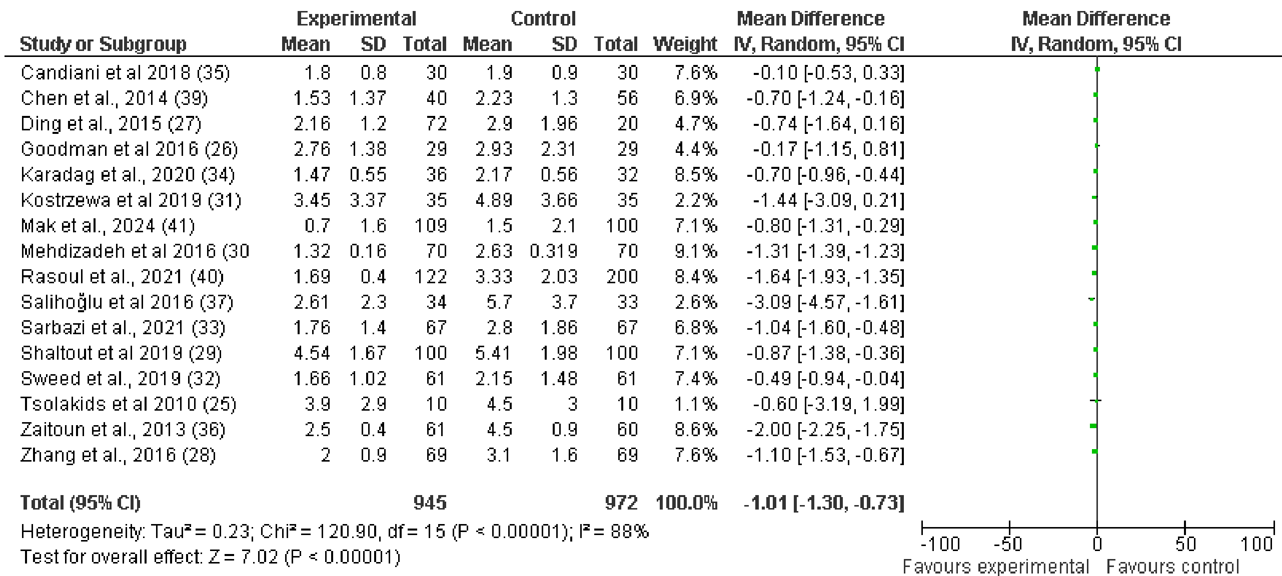


**Figure 4: Forest plot of changes in AMH levels among patients receiving laparoscopic cystectomy compared to control**

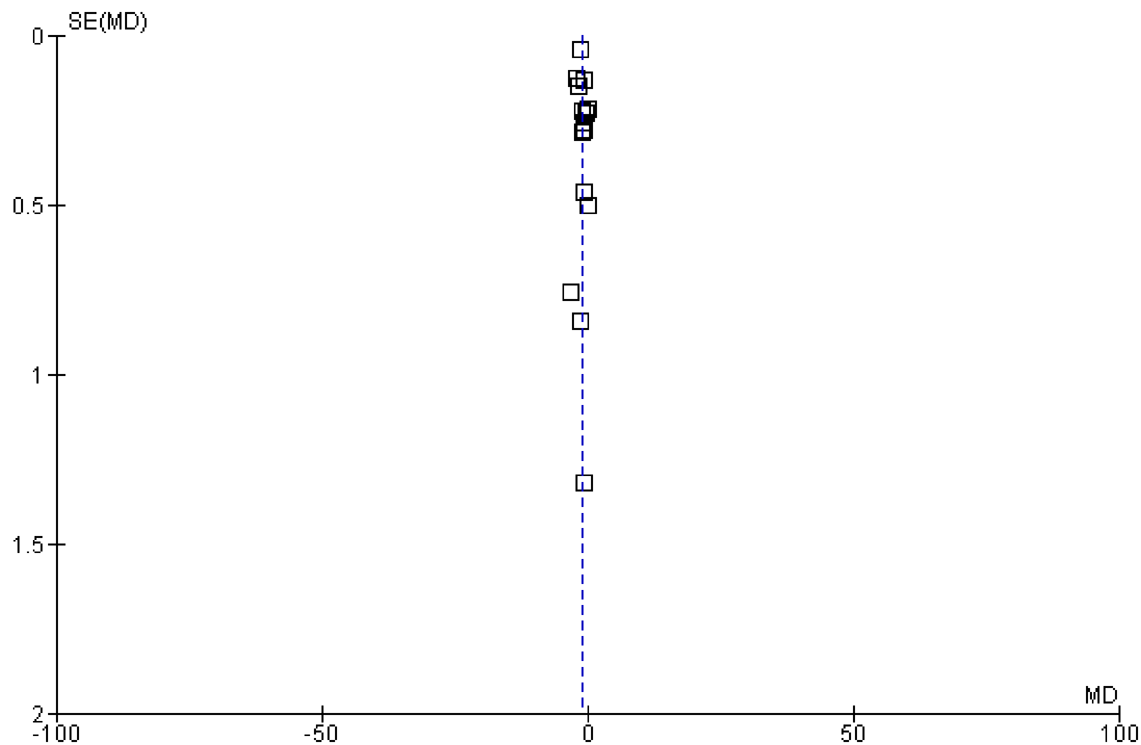


**Figure 5: Funnel plot of changes in AMH levels among patients receiving laparoscopic cystectomy compared to control**

### 3.5.2 Antral Follicle Count (AFC)

Among 17 included studies, 10 research articles reported a change in AFC count as an outcome of ovarian reserve after the laparoscopic cystectomy as compared to placebo. The pooled analysis showed that AFC was lower among the laparoscopic cystectomy group as compared to control [-1.01 (95% CI: -1.83 to -0.20), p< 0.00001] and the reported heterogeneity ($I^2$ =91%), as mentioned in Figure 6 and 7.

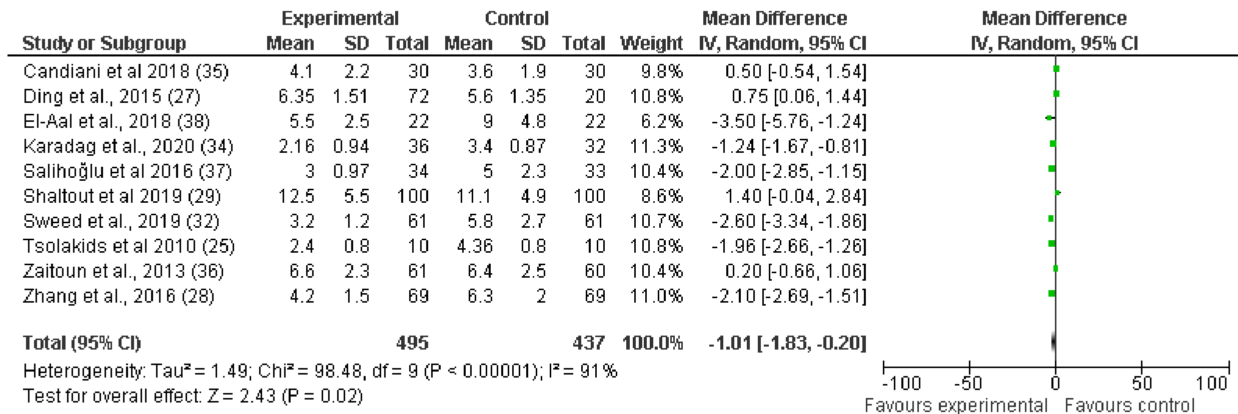


**Figure 6: Forest plot of changes in AFC count among patients receiving laparoscopic cystectomy compared to control**

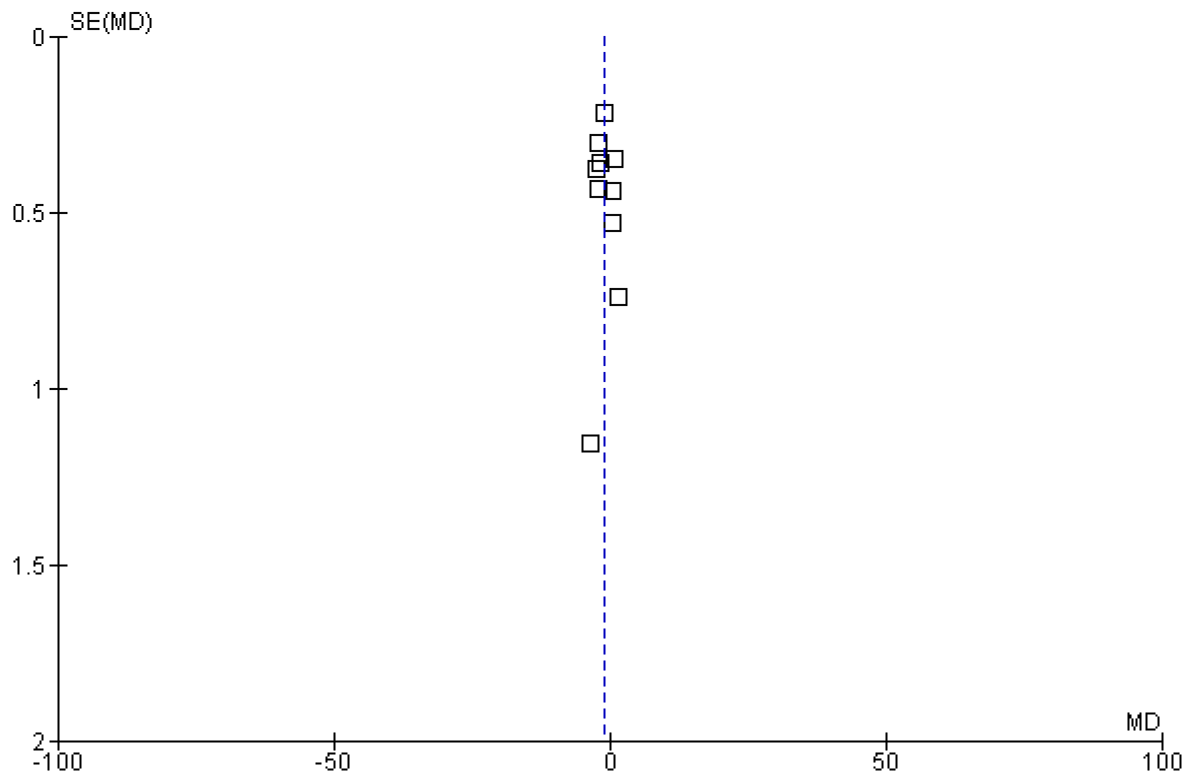


**Figure 7: Funnel plot of changes in AFC count among patients receiving laparoscopic cystectomy compared to control**

### 3.5.3 Follicle Stimulating Hormone (FSH) (mIU/mL)

Among 17 included studies, 7 research articles reported change in FSH levels as an outcome of ovarian reserve after the laparoscopic cystectomy as compared to placebo. According to the pooled analysis, the laparoscopic cystectomy group had higher FSH levels than the control group [1.71 (95% CI: -0.01 to 3.42), p< 0.00001] and heterogeneity reported ($I^2$ =97%), as mentioned in Figure 8 and 9. The results showed that higher levels of FSH were associated with reduced ovarian reserve.

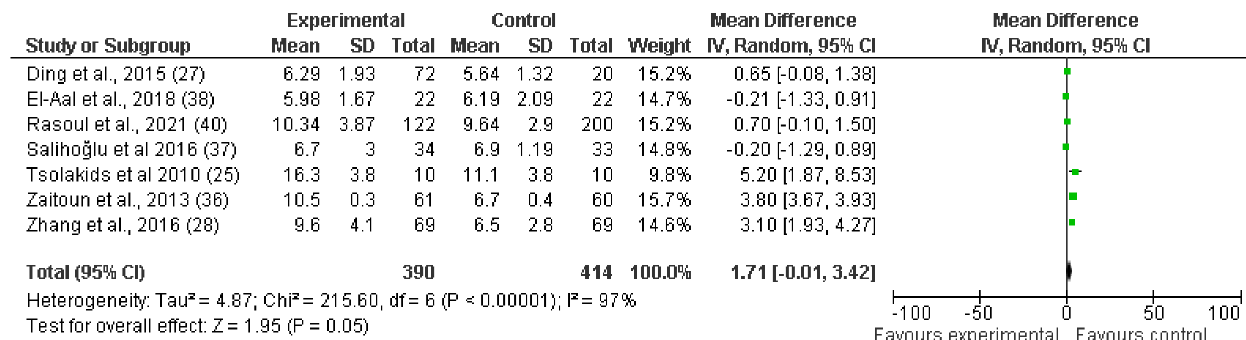


**Figure 8: Forest plot of changes in FSH levels among patients receiving laparoscopic cystectomy compared to control**

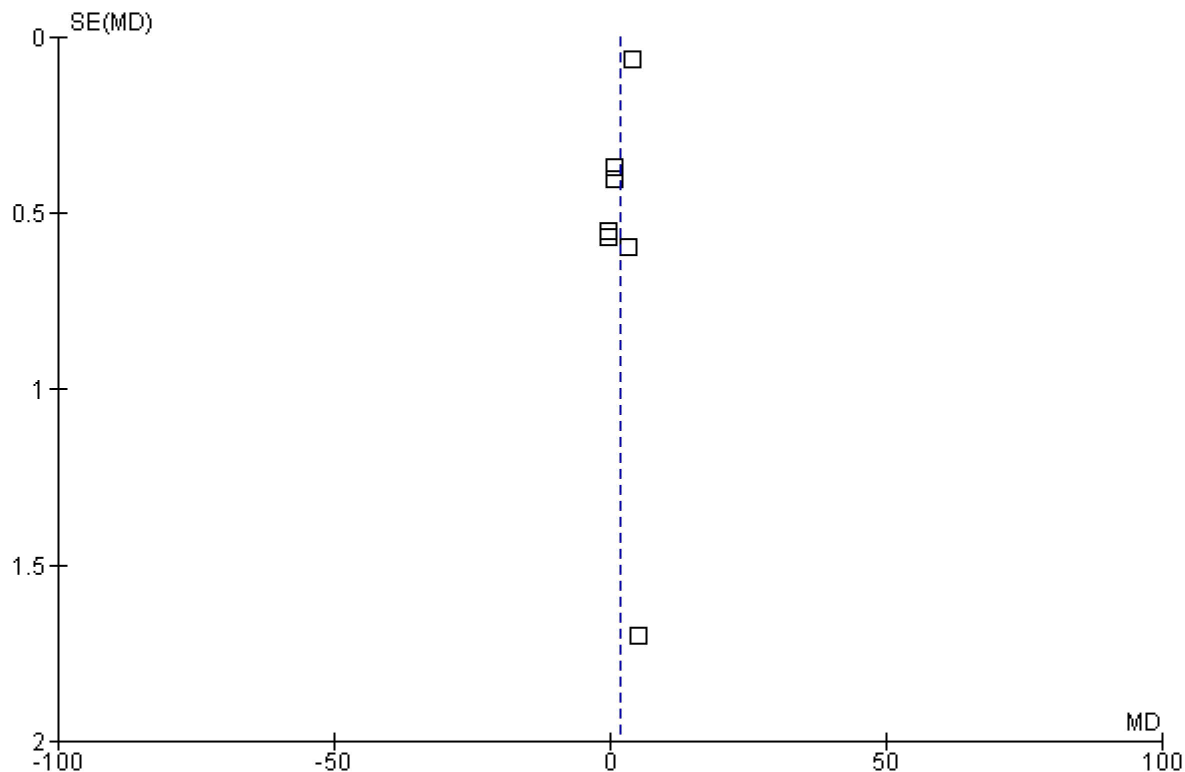


**Figure 9: Funnel plot of changes in FSH levels among patients receiving laparoscopic cystectomy compared to control**

## Discussion

This meta-analysis examines the effects of laparoscopic cystectomy on endometriosis patients' ovarian reserve. The primary outcomes of this study were AFC, AMH, and FSH levels after laparoscopic cystectomy among women with endometriosis compared to control. The included studies had follow-up periods ranging from 3 months to 12 months. The findings of this study reported that AMH levels and AFC count were lower among patients in the group receiving laparoscopic cystectomy. It showed that ovarian reserve was reduced after laparoscopic cystectomy among women with endometriosis patients. The pooled analysis showed that AMH levels [-1.01 (95% CI: -1.30 to 0.73), p< 0.00001] and AFC [-1.01 (95% CI: -1.83 to -0.20), p< 0.00001] were lower among laparoscopic cystectomy group as compared to control. Additionally, the pooled analysis showed that FSH levels were improved [1.71 (95% CI: -0.01 to 3.42), p< 0.00001] among the laparoscopic cystectomy group as compared to the control. The results showed that higher levels of FSH were associated with reduced ovarian reserve. Among twelve prospective cohort studies, four included studies were of low-risk (27, 37, 39, 41), and eight studies were of moderate risk (25, 26, 28, 30, 33, 34, 38, 40), as assessed by NOS. Among 5 included RCTs, one study was low-risk (32), and four studies were of moderate risk, according to the Cochrane risk bias tool (29, 31, 35, 36).

It has been demonstrated that laparoscopic cystectomy, a widely used treatment for ovarian cysts, including endometriomas, has a detrimental effect on ovarian reserve (42). Antral follicle count (AFC) and anti-Müllerian hormone (AMH) levels have been shown in numerous studies to decrease after surgery significantly (43). Both ablation and cystectomy reduce AMH levels, but cystectomy appears to have a greater detrimental effect on ovarian reserve, evidenced by AFC measurements. Both endometrioma and non-endometrioma cases influence ovarian reserve, although the effects of bilateral cystectomy are more noticeable (44). Numerous prospective studies and comprehensive reviews confirm these conclusions. Affected women have lower live birth rates, fewer mature oocytes, and a decreased ovarian response to activation when their ovarian reserve is diminished after endometrioma surgery (45).

Laparoscopic cystectomy among endometriosis women is associated with a series of changes in ovaries including ovarian reserves. Due to the invasive removal of endometriomas, that can impact both the tissue of the ovary and its follicular levels, our results imply that laparoscopic cystectomy is linked to a reduction in ovarian reserve. The idea that ovarian function may be impeded after cystectomy, particularly in cases where the cysts are large or comprise a significant amount of ovarian tissue, is confirmed by the decrease in AFC, which is directly connected with ovarian reserve (14, 46). A rise in FSH levels may result from compensatory pituitary response to reduced ovarian function after surgery. The rise in FSH levels seen in this analysis could be the result of a secondary rise in ovarian stimulation after surgery, or it could be an indicator of a hormonal adjustment following surgery, perhaps brought on by a rise of ovarian dysfunction linked to endometriosis (47). Although FSH increased significantly statistically, the clinical relevance remains uncertain and may not fully offset declines in AMH and AFC (48).

Inside selected studies, quality evaluation was an essential element. Among twelve prospective cohort studies, four were classified as low risk and eight as moderate risk, according to the Newcastle-Ottawa Scale. Five RCTs contain one low-risk, and four moderate-risk studies analyzed using Cochrane's risk-of-bias tool. In some of the studies included here, there was a moderate risk of bias. However, the overall consistency of findings increases the reliability of our conclusions. Yet, heterogeneity across studies, heterogeneity across studies, patient characteristics, and surgical techniques contributed to variability in outcomes.

Given these results, physicians must consider the possible effects of laparoscopic cystectomy on ovarian reserve when advising endometrioma patients, particularly those who wish to maintain their fertility (17, 36). A cystectomy can lower ovarian reserve even though it can temporarily alleviate symptoms and enhance fertility results. Future studies should concentrate on developing methods to reduce ovarian damage during surgery, such as employing more conservative methods for removing endometriomas, smaller incisions, or sophisticated surgical techniques (49). Long-term research assessing ovarian reserve and fertility outcomes following laparoscopic cystectomy is also required to fully comprehend the extent of the procedure's impact on reproductive health.

This meta-analysis has several limitations that should be taken into account. First, the included studies' follow-up periods ranged widely from three to twelve months, which may impact the long-term evaluation of ovarian reserve. Short-term alterations in ovarian reserve markers may not accurately reflect the long-

term reproductive capacity of these patients. Additionally, some of the studies were rated as having a moderate risk of bias, indicating that not all of them were of a high caliber. This may have had an impact on the results, particularly the accuracy and relevance of the conclusions. Furthermore, variations in surgical techniques and patient characteristics, such as the location and size of endometriomas, may have contributed to the heterogeneity between studies.

## CONCLUSION

Overall, this meta-analysis's results demonstrated that endometrioma laparoscopic cystectomy is linked to a decrease in ovarian reserve, as evidenced by low AMH levels and low AFC, which are post-surgery outcomes. While FSH levels did increase noticeably, the overall impact of laparoscopic surgery on ovarian activity would suggest that the surgeons would have to consider any implication of laparoscopic cystectomy and balance the choice not to imply such intervention, especially in a woman who wishes to preserve or enhance fertility. Further long-term studies are required to elucidate effects on fertility outcomes and develop surgical approaches that minimize ovarian damage.

**Reference**

1. Mcleod BS, Retzloff MG. Epidemiology of Endometriosis:: An Assessment of Risk Factors. Clinical obstetrics and gynecology. 2010;53(2):389-96.

2. Moradi Y, Shams-Beyranvand M, Khateri S, Gharahjeh S, Tehrani S, Varse F, et al. A systematic review on the prevalence of endometriosis in women. Indian Journal of Medical Research. 2021;154(3):446-54.

3. Sarria-Santamera A, Orazumbekova B, Terzic M, Issanov A, Chaowen C, Asúnsolo-del-Barco A, editors. Systematic review and meta-analysis of incidence and prevalence of endometriosis. Healthcare; 2020: MDPI.

4. Davari-Tanha F, Askari F, Akrami M, Mohseni M, Ghajarzadeh M. Sleep quality in women with endometriosis. Academic Journal of Surgery. 2014;1(3-4):57-9.

5. Mahmood TA, Templeton A. Prevalence and genesis of endometriosis. Human reproduction. 1991;6(4):544-9.

6. Acién P, Velasco I. Endometriosis: a disease that remains enigmatic. International Scholarly Research Notices. 2013;2013(1):242149.

7. Smolarz B, Szyłło K, Romanowicz H. Endometriosis: epidemiology, classification, pathogenesis, treatment and genetics (review of literature). International journal of molecular sciences. 2021;22(19):10554.

8. Murphy AA. Clinical aspects of endometriosis. Annals of the New York Academy of Sciences. 2002;955(1):1-10.

9. Allaire C, Bedaiwy MA, Yong PJ. Diagnosis and management of endometriosis. Cmaj. 2023;195(10):E363-E71.

10. Lee D, Kim SK, Lee JR, Jee BC. Management of endometriosis-related infertility: Considerations and treatment options. Clinical and experimental reproductive medicine. 2020;47(1):1.

11. Jiang M, Hou W, Yu T. Clinical efficacy of laparoscopic surgery combined with drug therapy for endometriosis: A meta-analysis. Medical Engineering & Physics. 2022;107:103866.

12. Laguerre MD, Arkerson BJ, Robinson MA, Moawad NS. Outcomes of laparoscopic management of chronic pelvic pain and endometriosis. Journal of Obstetrics and Gynaecology. 2022;42(1):146-52.

13. Somigliana E, Berlanda N, Benaglia L, Viganò P, Vercellini P, Fedele L. Surgical excision of endometriomas and ovarian reserve: a systematic review on serum antimüllerian hormone level modifications. Fertility and sterility. 2012;98(6):1531-8.

14. Raffi F, Metwally M, Amer S. The impact of excision of ovarian endometrioma on ovarian reserve: a systematic review and meta-analysis. The Journal of Clinical Endocrinology & Metabolism. 2012;97(9):3146-54.

15. Yang X-h, Ji F, AiLi A, TuerXun H, He Y, Ding Y. Effects of laparoscopic ovarian endometriosis cystectomy combined with postoperative GnRH-a therapy on ovarian reserve, pregnancy, and outcome recurrence. Clin Exp Obstet Gynecol. 2014;41(3):272-5.

16. Alammari R, Lightfoot M, Hur H-C. Impact of cystectomy on ovarian reserve: review of the literature. Journal of Minimally Invasive Gynecology. 2017;24(2):247-57.

17. Ozaki R, Kumakiri J, Tinelli A, Grimbizis GF, Kitade M, Takeda S. Evaluation of factors

predicting diminished ovarian reserve before and after laparoscopic cystectomy for ovarian endometriomas: a prospective cohort study. Journal of ovarian research. 2016;9:1-10.

18. Mansouri G, Safinataj M, Shahesmaeili A, Allahqoli L, Salehiniya H, Alkatout I. Effect of laparoscopic cystectomy on ovarian reserve in patients with ovarian cyst. Frontiers in Endocrinology. 2022;13:964229.

19. Ergun B, Ozsurmeli M, Dundar O, Comba C, Kuru O, Bodur S. Changes in markers of ovarian reserve after laparoscopic ovarian cystectomy. Journal of minimally invasive gynecology. 2015;22(6):997-1003.

20. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Systematic reviews. 2015;4:1-9.

21. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. bmj. 2021;372.

22. Cumpston M, Li T, Page MJ, Chandler J, Welch VA, Higgins JP, et al. Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. The Cochrane database of systematic reviews. 2019;2019(10).

23. Lo CK-L, Mertz D, Loeb M. Newcastle-Ottawa Scale: comparing reviewers' to authors' assessments. BMC medical research methodology. 2014;14:1-5.

24. Deeks JJ, Higgins JP. Statistical algorithms in review manager 5. Statistical methods group of the Cochrane Collaboration. 2010;1(11).

25. Tsolakidis D, Pados G, Vavilis D, Athanatos D, Tsalikis T, Giannakou A, et al. The impact on ovarian reserve after laparoscopic ovarian cystectomy versus three-stage management in patients with endometriomas: a prospective randomized study. Fertility and sterility. 2010;94(1):71-7.

26. Goodman LR, Goldberg JM, Flyckt RL, Gupta M, Harwalker J, Falcone T. Effect of surgery on ovarian reserve in women with endometriomas, endometriosis and controls. American journal of obstetrics and gynecology. 2016;215(5):589. e1-. e6.

27. Ding Y, Yuan Y, Ding J, Chen Y, Zhang X, Hua K. Comprehensive assessment of the impact of laparoscopic ovarian cystectomy on ovarian reserve. Journal of minimally invasive gynecology. 2015;22(7):1252-9.

28. Zhang C-H, Wu L, Li P-Q. Clinical study of the impact on ovarian reserve by different hemostasis methods in laparoscopic cystectomy for ovarian endometrioma. Taiwanese Journal of Obstetrics and Gynecology. 2016;55(4):507-11.

29. Shaltout MF, Elsheikhah A, Maged AM, Elsherbini MM, Zaki SS, Dahab S, et al. A randomized controlled trial of a new technique for laparoscopic management of ovarian endometriosis preventing recurrence and keeping ovarian reserve. Journal of ovarian research. 2019;12:1-8.

30. Mehdizadeh Kashi A, Chaichian S, Ariana S, Fazaeli M, Moradi Y, Rashidi M, et al. The impact of laparoscopic cystectomy on ovarian reserve in patients with unilateral and bilateral endometrioma. International Journal of Gynecology & Obstetrics. 2017;136(2):200-4.

31. Kostrzewa M, Wilczyński JR, Głowacka E, Żyła M, Szyłło K, Stachowiak G. One-year follow-up of ovarian reserve by three methods in women after laparoscopic cystectomy for endometrioma and benign ovarian cysts. International Journal of Gynecology & Obstetrics. 2019;146(3):350-6.

32. Sweed MS, Makled AK, El-Sayed MA, Shawky ME, Abd-Elhady HA, Mansour AM, et al. Ovarian reserve following laparoscopic ovarian cystectomy vs cyst deroofing for endometriomas. Journal of Minimally Invasive Gynecology. 2019;26(5):877-82.

33. Sarbazi F, Akbari E, Karimi A, Nouri B, Ardebili SN. The clinical outcome of laparoscopic surgery for endometriosis on pain, ovarian reserve, and cancer antigen 125 (CA-125): A cohort study. International Journal of Fertility & Sterility. 2021;15(4):275.

34. Karadağ C, Demircan S, Turgut A, Çalışkan E. Effects of laparoscopic cystectomy on ovarian reserve in patients with endometrioma and dermoid cyst. Turkish journal of obstetrics and gynecology. 2020;17(1):15.

35. Candiani M, Ottolina J, Posadzka E, Ferrari S, Castellano L, Tandoi I, et al. Assessment of ovarian

reserve after cystectomy versus 'one-step'laser vaporization in the treatment of ovarian endometrioma: a small randomized clinical trial. Human Reproduction. 2018;33(12):2205-11.

36. Zaitoun MM, Zaitoun MM, El Behery MM. Comparing long term impact on ovarian reserve between laparoscopic ovarian cystectomy and open laprotomy for ovarian endometrioma. Journal of ovarian research. 2013;6:1-6.

37. Salihoğlu KN, Dilbaz B, Cırık DA, Ozelci R, Ozkaya E, Mollamahmutoğlu L. Short-term impact of laparoscopic cystectomy on ovarian reserve tests in bilateral and unilateral endometriotic and nonendometriotic cysts. Journal of minimally invasive gynecology. 2016;23(5):719-25.

38. El-Aal A, Hany M, Mira IM, Samy EM. The impact of laparoscopic ovarian cystectomy on ovarian reserve in cases of endometrioma. The Egyptian Journal of Hospital Medicine. 2018;73(10):7692-8.

39. Chen Y, Pei H, Chang Y, Chen M, Wang H, Xie H, et al. The impact of endometrioma and laparoscopic cystectomy on ovarian reserve and the exploration of related factors assessed by serum anti-Mullerian hormone: a prospective cohort study. Journal of ovarian research. 2014;7:1-8.

40. Rasoul NS, Al Allak MM. A prospective cohort study on laparoscopic cystectomy of endometrioma and its effects on ovarian reserve. J Pak Med Assoc. 2021;71(Suppl 9):S8-s11.

41. Mak K-S, Huang Y-T, Weng CH, Wu K-Y, Lin W-L, Wang C-J. Factors affected the ovarian reserve after laparoscopic cystectomy for ovarian endometriomas. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2024.

42. Iwase A, Hirokawa W, Goto M, Takikawa S, Nagatomo Y, Nakahara T, et al. Serum anti-Müllerian hormone level is a useful marker for evaluating the impact of laparoscopic cystectomy on ovarian reserve. Fertility and sterility. 2010;94(7):2846-9.

43. Primarintan TN. The Relationship Between Laparoscopic Cystectomy and Ovarian Reserve: A Systematic Review and Meta-Analysis. Asian Journal of Health Research. 2024;3(1):69-78.

44. Zhang Y, Zhang S, Zhao Z, Wang C, Xu S, Wang F. Impact of cystectomy versus ablation for endometrioma on ovarian reserve: a systematic review and meta-analysis. Fertility and sterility. 2022;118(6):1172-82.

45. Barátová D, Mekiňová L, Slabá K, Crha I. Surgical treatment of endometriomas and ovarian reserve. Ceska Gynekologie. 2016;81(3):182-5.

46. Tian Z, Zhang Y, Zhang C, Wang Y, Zhu H-L. Antral follicle count is reduced in the presence of endometriosis: a systematic review and meta-analysis. Reproductive biomedicine online. 2021;42(1):237-47.

47. Conforti A, Carbone L, Di Girolamo R, Iorio GG, Guida M, Campitiello MR, et al. Therapeutic management in women with a diminished ovarian reserve: a systematic review and meta-analysis of randomized controlled trials. Fertility and Sterility. 2024.

48. Younis JS, Shapso N, Fleming R, Ben-Shlomo I, Izhaki I. Impact of unilateral versus bilateral ovarian endometriotic cystectomy on ovarian reserve: a systematic review and meta-analysis. Human reproduction update. 2018;25(3):375-91.

49. Vignali M, Mabrouk M, Ciocca E, Alabiso G, Barbasetti di Prun A, Gentilini D, et al. Surgical excision of ovarian endometriomas: Does it truly impair ovarian reserve? Long term anti-Müllerian hormone (AMH) changes after surgery. Journal of Obstetrics and Gynaecology Research. 2015;41(11):1773-8.