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Association Between Endometriosis Severity and Ovarian Reserve in Infertile Women

Alaa Abd El Kareem Noori[1]*, Fatima Hussain Kadhum Alawees[2] and Nadia Abd Niaf [3]

[1]MBChB., DGO., Obstetrics and Gynaecology, Iraqi Ministry of Health, Babil Health Directorate, Alaskandaria General Hospital, Babil, Iraq
[2]MBChB., DGO., Obstetrics and Gynaecology, Iraqi Ministry of Health, Babil Health Directorate, Al-Zahraa Maternity Hospital, Babil, Iraq
[3]MBChB., FICMS., Obstetrics and Gynaecology, Iraqi Ministry of Health, Babil Health Directorate, Alaskandaria General Hospital, Babil, Iraq

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Abstract

Background: *Endometriosis is associated with infertility and may compromise ovarian reserve. However, the relationship between disease severity and ovarian reserve remains incompletely defined.*
Objective: To assess the association between endometriosis severity and preoperative ovarian reserve markers among infertile women.

Methods: *This analytical cross-sectional study included 80 infertile women with laparoscopically confirmed endometriosis at hospitals in Babil, Iraq, between March 2025 and September 2026. Disease severity was classified using the revised American Society for Reproductive Medicine (rASRM) staging system. Serum anti-Müllerian hormone (AMH) was measured before surgery, and antral follicle count (AFC) was assessed using early follicular-phase transvaginal ultrasonography. Demographic characteristics, infertility characteristics, and ovarian reserve markers were compared across stages using one-way analysis of variance and the chi-square test.*

Results: *Participants had a mean age of 31.2 ± 5.7 years. Stage I, II, III, and IV disease occurred in 20%, 33.8%, 30.0%, and 16.3%, respectively. Age, body mass index, infertility duration, and infertility type did not differ significantly across stages (all $p>0.05$). Mean AMH concentrations across stages I–IV were 3.1 ± 1.3, 2.6 ± 1.2, 1.8 ± 1.0, and 1.2 ± 0.8 ng/mL, respectively ($p<0.001$). Corresponding total AFC values were 14.2 ± 5.3, 12.5 ± 5.1, 9.1 ± 4.6, and 7.2 ± 3.2 ($p<0.001$). Right and left ovarian AFC also differed significantly across stages (both $p<0.001$).*

Conclusion: *Higher rASRM stage was associated with lower preoperative AMH and AFC. These findings support individualised ovarian reserve assessment and fertility counselling, particularly in advanced endometriosis. Longitudinal studies are needed to clarify causality and reproductive implications.*

***Corresponding author**: Alaa Abd El Kareem Noori, MBChB., DGO., Obstetrics and Gynaecology, Iraqi Ministry of Health, Babil Health Directorate, Alaskandaria General Hospital, Babil, Iraq.

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Introduction

Endometriosis is a chronic, oestrogen-dependent inflammatory disorder characterised by the presence of endometrium-like tissue outside the uterine cavity. It predominantly affects women of reproductive age and is strongly associated with pelvic pain and infertility. Infertility is one of its most clinically important consequences, arising through several interacting mechanisms, including pelvic adhesions and distorted tubo-ovarian anatomy, chronic inflammation, altered folliculogenesis, impaired oocyte quality and disturbances in endometrial receptivity [1]. Current European Society of Human Reproduction and Embryology (ESHRE) guidance therefore recognises infertility as a major component of endometriosis management and recommends consideration of ovarian reserve when treatment decisions are made [2].

Ovarian reserve refers to the remaining functional follicular pool within the ovaries and is an important determinant of reproductive potential, particularly among women undergoing infertility assessment or assisted reproductive treatment. Serum anti-Müllerian hormone (AMH) concentration and ultrasonographic antral follicle count (AFC) are the most commonly used markers for its clinical assessment. AMH is produced by granulosa cells of pre-antral and small antral follicles and provides a relatively cycle-independent estimate of the follicular pool [3]. Recent systematic evidence suggests that women with endometriosis may demonstrate lower AMH levels and AFC than women without the disease, although the magnitude of this association varies according to disease phenotype, ovarian involvement, previous treatment and study population [4].

The relationship between endometriosis and diminished ovarian reserve is likely multifactorial. Ovarian endometriomas may directly affect surrounding ovarian tissue through chronic inflammation, oxidative stress, fibrosis and alterations in the local follicular environment. These mechanisms may contribute to follicular loss and impaired ovarian function. However, the independent effect of an endometrioma itself remains controversial, as recent critical appraisal has found that evidence for a direct reduction in ovarian reserve before surgery is inconsistent. In contrast, considerably stronger evidence demonstrates that surgical treatment of ovarian endometriomas, particularly cystectomy, can reduce ovarian reserve through inadvertent removal of healthy ovarian cortex, vascular injury and damage related to haemostasis [5,6].

An important unresolved question is whether deterioration in ovarian reserve is related to the severity of endometriosis. More advanced disease may be associated with extensive pelvic inflammation, adhesions, ovarian involvement and bilateral endometriomas, potentially exposing ovarian tissue to greater cumulative damage. ESHRE identifies women with severe disease, particularly bilateral ovarian endometriomas, as a group at increased risk of reduced AMH and premature ovarian insufficiency. Furthermore, the adverse effect of endometrioma surgery appears greater in bilateral than unilateral disease, highlighting the importance of disease extent when evaluating reproductive potential [2, 7]. Nevertheless, the relationship between conventional endometriosis stage and ovarian reserve remains incompletely defined, therefore, the present study aims to investigate the association between endometriosis severity and ovarian reserve among infertile women.

Methods

This was an analytical cross-sectional study conducted in the Babil city hospitals, Iraq. The study was conducted between 1st of March 2025 and 1st of september 2026. It assessed the association between endometriosis severity and ovarian reserve in infertile women.The study included women aged between 18 and 45 years who underwent laparoscopy for a clinical indication and

were screened consecutively. Infertility was defined as failure to achieve pregnancy after at least 12 months of regular unprotected intercourse [8].

Women were included if endometriosis was documented at laparoscopy, a revised American Society for Reproductive Medicine (rASRM) stage was recorded, and serum anti-Müllerian hormone (AMH) had been measured before surgery.Women with previous ovarian surgery, chemotherapy or pelvic radiotherapy, or polycystic ovary syndrome were excluded as these conditions affect ovarian reserve. Data were collected using a structured form and the participants' clinical records. Recorded variables included age, body mass index, type and duration of infertility, reproductive history, previous fertility treatment, hormonal medication, and other identified causes of infertility.

Endometriosis severity was determined from the laparoscopic findings using the rASRM classification. Participants were classified as stage I (minimal), stage II (mild), stage III (moderate), or stage IV (severe) [9]. The presence and laterality of ovarian endometriomas were also recorded.

Serum AMH was measured before laparoscopy. Antral follicle count (AFC) was assessed by transvaginal ultrasonography during the early follicular phase. Follicles in each ovary were counted separately, and the counts were summed to obtain the total AFC. Any difficulty counting follicles because of an endometrioma was documented. AMH and AFC were used as measures of ovarian reserve [10]. Data were analysed using SPSS version 24. Continuous variables were summarised as mean ± standard deviation, and categorical variables as number and percentage. Differences in continuous variables across the four rASRM stages were assessed using one-way analysis of variance (ANOVA); the distribution of infertility type was compared using the chi-square test. A two-sided p-value < 0.05 was considered statistically significant.

Results

The study included 80 women with endometriosis; 16 (20%) had stage I, 27 (33.8%) stage II, 24 (30.0%) stage III, and 13 (16.3%) stage IV. Age, BMI, duration of infertility, and type of infertility did not differ significantly across stages (p-value > 0.05) (Table 1).

Table 1: Baseline Demographic and Infertility Characteristics of Women by rASRM Endometriosis Stage (N=80)

Variables	Stage 1 (n=16)	Stage 2 (n=27)	Stage 3 (n=24)	Stage 4 (n=13)	Total	p-value
Age (years),Mean ± SD	29.1±5.2	30.8±5.5	31.9±5.9	33.3±6.0	31.2±5.7	0.220
BMI (kg/m2),Mean ± SD	26.5±4.5	27.0±4.6	27.5±4.7	28.0±4.9	27.2±4.6	0.827
Duration of infertility (years), Mean ± SD	3.6±2.1	4.0±2.2	4.5±2.5	5.2±2.7	4.3±2.4	0.282
Primary infertility	10 (62.5)	16 (59.3)	12 (50.0)	6 (46.2)	44 (55.0)	0.749
Secondary infertility	6 (37.5)	11 (40.7)	12 (50.0)	7 (53.8)	36 (45.0)	

Mean preoperative AMH and total AFC decreased across successive stages. Mean AMH was 3.1 ± 1.3 ng/mL in stage I and 1.2 ± 0.8 ng/mL in stage IV (p-value <0.001). Mean total AFC was 14.2 ± 5.3 and 7.2 ± 3.2, respectively (p-value <0.001). Right and left ovarian AFC also differed significantly across stages (Table 2).

Table 2: Preoperative Ovarian Reserve Markers by rASRM Endometriosis Stage (N=80)

Variables	Stage 1 (n=16)	Stage 2 (n=27)	Stage 3 (n=24)	Stage 4 (n=13)	p-value
Preoperative AMH (ng/ml)	3.1±1.3	2.6±1.2	1.8±1.0	1.2±0.8	<0.001
Total AFC	14.2±5.3	12.5±5.1	9.1±4.6	7.2±3.2	<0.001

Right ovarian AFC	7.0±3.1	6.0±3.0	4.5±2.4	3.5±2.1	<0.001
Left ovarian AFC	7.2±2.9	6.5±2.7	4.6±2.6	3.7±2.4	<0.001

Discussion

The association between endometriosis severity and ovarian reserve has important implications for fertility counselling and treatment planning. In this study, increasing rASRM stage was associated with progressively lower preoperative anti-Müllerian hormone (AMH) and antral follicle count (AFC), suggesting greater impairment of ovarian reserve in advanced disease.

Age, BMI, infertility duration, and infertility type did not differ significantly across stages. However, nonsignificant differences do not establish equivalence, and the numerically higher age in stage IV could partly influence ovarian reserve measurements.

Mean AMH decreased from 3.1 ± 1.3 ng/mL in stage I to 1.2 ± 0.8 ng/mL in stage IV ($p<0.001$). Similarly, Shebl et al. (2009) reported mean AMH concentrations of 3.28 ± 1.93 ng/mL in stage I–II disease and 2.38 ± 1.83 ng/mL in stage III–IV disease [11]. Their early-stage group had concentrations comparable to controls, whereas advanced disease was associated with significantly lower AMH. Differences in absolute concentrations may reflect patient selection, age, disease phenotype, and assay methods.

More recently, Valenti et al. (2026) found that stage III–IV endometriosis was associated with 40.1% lower AMH than no endometriosis, after adjustment for potential confounders [12]. Ovarian endometriomas showed the strongest association, supporting the importance of ovarian involvement when interpreting stage-related differences. However, our study compared stages rather than women with and without endometriosis, limiting direct quantitative comparison.

Consistent evidence comes from Farland et al. (2024), who studied 1,961 premenopausal women and found 29.6% lower adjusted AMH among those with laparoscopically confirmed endometriosis [13]. Their participants were older than our cohort, and disease stage was unavailable, but the findings support an association beyond fertility-clinic populations. Muzii et al. (2018) additionally reported lower AMH in women with unoperated endometriomas, with a pooled mean difference of −0.84 ng/mL, indicating that reduced reserve may precede surgery [14].

Total AFC decreased from 14.2 ± 5.3 in stage I to 7.2 ± 3.2 in stage IV ($p<0.001$). Kasapoglu et al. (2018) similarly documented declining AFC during six-month follow-up of women with endometriomas [15]. Conversely, Lessans et al. (2024) found comparable AMH and AFC in women with isolated superficial endometriosis and controls [16]. This suggests that reduced reserve is not uniform across endometriosis phenotypes and may be particularly associated with ovarian involvement and advanced disease.

Interpretation is limited by the small stage-specific groups, absence of unaffected controls, and unavailable details regarding endometrioma characteristics, previous ovarian surgery, and hormonal treatment. Between-stage comparisons cannot establish progressive loss within individuals or predict pregnancy outcomes. Nevertheless, concordant reductions in AMH and AFC support individualised ovarian reserve assessment and fertility counselling, particularly in advanced disease.

Conclusions and Recommendations

Higher rASRM endometriosis stage was associated with lower preoperative AMH and AFC, suggesting reduced ovarian reserve in women with advanced disease. These findings support incorporating ovarian reserve assessment into individualised fertility counselling and treatment planning, particularly before ovarian surgery. Decisions should consider age, reproductive goals, previous treatment, and ovarian involvement rather than disease

stage alone. Larger prospective studies with detailed endometrioma characteristics and reproductive follow-up are recommended to clarify this association and determine its implications for treatment response and pregnancy outcomes.

Ethical considerations: Ethical approval was obtained from the relevant body. Written informed consent was obtained from all participants before enrolment. Participation was voluntary, and participants could withdraw at any time without affecting their clinical care. Confidentiality was maintained by anonymising study data and restricting access to authorised researchers. The study was conducted in accordance with the Declaration of Helsinki.

Conflicts of interest: The authors declare no conflicts of interest.

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