

Association of Serum Anti-Müllerian Hormone Level with Size of Ovarian Endometrioma

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ABSTRACT

Background: Ovarian endometriomas (“chocolate cysts”) are cysts filled with hemosiderin associated with pelvic pain, dysmenorrhea, dyspareunia, and infertility, and they can diminish ovarian reserve through compression, inflammation, and oxidative stress. While anti-Müllerian hormone (AMH) indicates ovarian reserve, its association with the size of endometriomas remains uncertain. This research analyzes AMH levels in women with large (≥ 5 cm) versus small (< 5 cm) endometriomas and explores their relationship. **Methods & Materials:** This cross-sectional study at Bangabandhu Sheikh Mujib Medical University, Dhaka (Oct 2022–Sep 2023), included 80 women (18–40 years) with ovarian endometriomas, divided into ≥ 5 cm ($n=40$) and < 5 cm ($n=40$) groups. Data were collected, AMH measured by electrochemiluminescence immunoassay, and analyzed using t-test, chi-square, Pearson’s correlation, and odds ratio ($p < 0.05$). **Results:** The mean age was similar between groups (24.75 ± 5.38 vs 26.20 ± 5.51 years; $p=0.238$), with no significant socio-demographic or reproductive differences. Overweight was more common in the large endometrioma group, while normal BMI predominated in the small group. Dysmenorrhea was the most frequent symptom, and most cysts were unilateral. Mean serum AMH was significantly lower in women with large endometriomas (2.05 ± 1.75 vs 2.83 ± 1.72 ng/mL; $p=0.047$), showing a negative correlation with cyst size ($r = -0.253$; $p=0.024$). Low AMH (< 3.19 ng/mL) was associated with a 3.1-fold increased risk of large endometriomas. **Conclusion:** Serum AMH levels decline with increasing ovarian endometrioma size, suggesting that larger endometriomas are associated with reduced ovarian reserve. Monitoring AMH may guide clinical management and fertility preservation strategies in affected women.

Keywords: Ovarian endometrioma, Anti-Müllerian hormone, AMH, Ovarian reserve, Endometriosis, Cyst size.

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INTRODUCTION

Endometriomas are cystic lesions of the ovaries that arise from endometrial glands and stroma located outside the uterine cavity [1]. These cysts are commonly referred to as “chocolate cysts” because they contain thick, dark brown, hemosiderin-rich fluid that results from repeated cyclic hemorrhage within the cyst cavity [2]. On ultrasonographic examination, ovarian endometriomas usually appear as round, homogeneous, hypoechoic cystic masses with diffuse low-level internal echoes and minimal vascularization [3]. The cyst wall frequently adheres to adjacent pelvic structures such as the ovarian fossa, uterus, or uterosacral ligaments, and large cysts may coexist with other functional ovarian cysts [4]. Ovarian endometriomas are present in approximately 17–44% of women diagnosed with endometriosis [5]. Endometriosis is a chronic estrogen-dependent inflammatory disease

characterized by the presence of endometrial-like tissue outside the uterine cavity and affects around 10–15% of women of reproductive age [6].

The most common clinical manifestations include dysmenorrhea, chronic pelvic pain, dyspareunia, and infertility, which significantly affect the quality of life and reproductive health of affected women [7]. Several hypotheses have been proposed to explain the pathogenesis of ovarian endometriomas. The most widely accepted mechanism is the theory of retrograde menstruation, which suggests that viable endometrial cells reflux through the fallopian tubes during menstruation and implant on the ovarian surface [8]. Another possible mechanism is coelomic metaplasia, where epithelial cells of the peritoneum or ovarian cortex transform into endometrial-like tissue and contribute to the development of endometriotic cysts [9]. Ovarian reserve refers to a woman’s reproductive potential in terms of the

quantity and quality of ovarian follicles and oocytes. The presence of endometriomas may impair ovarian reserve through several mechanisms, including compression of surrounding ovarian tissue, chronic inflammation, oxidative stress, and fibrosis within the ovarian microenvironment [9].

Surgical removal of endometriomas is often indicated in women presenting with pelvic pain, infertility, or suspicion of malignancy. However, surgical treatment may itself negatively affect ovarian reserve because removal of the cyst wall may inadvertently excise healthy ovarian tissue containing primordial follicles [10]. Therefore, careful evaluation of ovarian reserve is essential when planning the management of patients with ovarian endometriomas, especially those who wish to preserve their fertility. Anti-Müllerian hormone (AMH) is a glycoprotein produced by granulosa cells of pre-antral and small antral follicles and is widely considered a reliable biomarker of ovarian

reserve. AMH levels remain relatively stable throughout the menstrual cycle and correlate well with the number of antral follicles present in the ovaries [11]. The relationship between the size of ovarian endometriomas and ovarian reserve remains controversial. Some studies suggest that larger cysts may exert greater pressure on surrounding ovarian tissue and contribute to more significant follicular loss, whereas other studies have reported no clear association between endometrioma size and serum AMH levels. Therefore, further investigation is needed to determine whether serum AMH levels correlate with the size of ovarian endometriomas and to better understand their impact on ovarian reserve.

METHODS & MATERIALS

This cross-sectional comparative study was conducted in the Department of Obstetrics and Gynecology and the Department of Reproductive Endocrinology and Infertility at Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbagh, Dhaka, from October 2022 to September 2023. The study population consisted of women aged 18–40 years diagnosed with ovarian endometrioma by transabdominal or transvaginal ultrasonography who attended the outpatient or inpatient departments with complaints of pelvic pain and/or infertility. Using purposive (non-random) sampling, a total of 80 participants fulfilling the inclusion criteria were enrolled and divided into two groups according to endometrioma size: Group A (n=40) with large endometrioma (≥5 cm) and Group B (n=40) with small endometrioma (<5 cm). The sample size was calculated using the formula for comparison of two means based on previous data ($\mu_1=4$, $\mu_0=3$, $\sigma_1=1.5$, $\sigma_0=1.5$) with 5% level of significance and 80% power, yielding 35 participants per group; after adding a 10% non-response rate the required sample size became 39 per group, and finally 40 participants were included in each group during the one-year data collection period. Women aged 18–40 years with dysmenorrhea, deep

dyspareunia, pelvic pain, and/or infertility and ultrasound evidence of endometrioma were included, while pregnant women, patients with previous endometrioma surgery, polycystic ovarian syndrome, premature ovarian failure, endocrine disorders, recent malignancy, vitamin D deficiency, or recent hormonal therapy were excluded. Data on socio-demographic and clinical variables including age, marital status, education, occupation, age at menarche, parity, body mass index, endometrioma localization, and serum anti-Müllerian hormone (AMH) level were collected using a semi-structured questionnaire. Endometrioma size was measured in centimeters as the mean of three perpendicular ultrasonographic measurements of the cyst, and bilateral cysts were recorded as the sum of both sizes. Three milliliters of venous blood were collected aseptically from each participant at any phase of the menstrual cycle, and serum was separated by centrifugation at 3000 rpm for 10 minutes and stored at -20 °C until analysis. Serum AMH levels were measured in the Department of Biochemistry and Molecular Biology, BSMMU using an electrochemiluminescence immunoassay (ECLIA) method with an automated Beckman Coulter analyzer, and a cutoff value of 3.19 ng/mL was used to define low AMH levels. Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to summarize variables, while the unpaired t-test compared continuous variables and the chi-square test compared categorical variables. Pearson’s correlation coefficient was applied to assess the association between serum AMH level and endometrioma size, and odds ratios with 95% confidence intervals were calculated to determine the strength of association; a p-value <0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Review Board (IRB) of BSMMU, Shahbag, Dhaka, Bangladesh.

RESULTS

Table I shows total of 80 patients were included in the study, with 40 in Group A and 40 in Group B. In Group A, the most frequent age group was 21–30 years 19 (47.5%), followed by 18–20 years 12 (30.0%) and 31–40 years 9 (22.5%). Similarly, in Group B the majority were 21–30 years 22 (55.0%), followed by 31–40 years 11 (27.5%) and 18–20 years 7 (17.5%). The mean age was 24.75 ± 5.38 years in Group A and 26.20 ± 5.51 years in Group B, with no statistically significant difference between the groups (p=0.238). Regarding educational status, in Group A the most frequent category was up to SSC/equivalent 17 (42.5%), followed by illiterate 12 (30.0%) and higher secondary and above 11 (27.5%). In Group B, the majority also had education up to SSC/equivalent 21 (52.5%), followed by illiterate 10 (25.0%) and higher secondary and above 9 (22.5%), with no statistically significant difference between the groups (p=0.669). Considering occupation, most patients in both groups were housewives, accounting for 25 (62.5%) in Group A and 26 (65.0%) in Group B. This was followed by garments workers 7 (17.5%), students 4 (10.0%) and service holders 4 (10.0%) in Group A, whereas in Group B students 6 (15.0%), service holders 5 (12.5%) and garments workers 3 (7.5%) were observed. The difference between the groups was not statistically significant (p=0.572). In terms of monthly family income, the majority of patients in both groups belonged to the lower middle-class income group (>8,585–33,637 Tk.), comprising 28 (70.0%) in Group A and 31 (77.5%) in Group B, followed by the lower-class group (≤8,585 Tk.) 9 (22.5%) and 5 (12.5%), and the upper middle-class group (>33,637–104,391 Tk.) 3 (7.5%) and 4 (10.0%) in Group A and Group B respectively. No statistically significant difference was observed between the groups (p=0.407).

Table I
Comparison of socio-demographic variables between the groups (n=80).

Variables	Group A(n=40)	Group B (n=40)	p-value
	n (%)	n (%)	
Age (years)			
18–20	12 (30.0)	7 (17.5)	0.420 ^a
21–30	19 (47.5)	22 (55.0)	
31–40	9 (22.5)	11 (27.5)	
Mean ± SD	24.75 ± 5.38	26.20 ± 5.51	0.238 ^b
Education			
Illiterate	12 (30.0)	10 (25.0)	0.669 ^a
Up to SSC/Equivalent	17 (42.5)	21 (52.5)	
Higher secondary & above	11 (27.5)	9 (22.5)	
Occupation			0.572 ^c

Housewife	25 (62.5)	26 (65.0)
Student	4 (10.0)	6 (15.0)
Garments worker	7 (17.5)	3 (7.5)
Service holder	4 (10.0)	5 (12.5)
Monthly family income (BDT)		
Lower class ($\leq$ 8,585 Tk.)	9 (22.5)	5 (12.5)
Lower middle class (>8,585 – 33,637 Tk.)	28 (70.0)	31 (77.5)
Upper middle class (>33,637 – 104,391 Tk.)	3 (7.5)	4 (10.0)

0.407^c

Chi square test was done to measure the level of significance; Unpaired t-test was done to measure the level of significance; Fisher's exact test was done to measure the level of significance Figure within parentheses indicates in percentage.

Table II presents in Group A, the most frequent age at menarche was ≥ 12 years 34 (85.0%), followed by <12 years 6 (15.0%). Similarly, in Group B the majority of patients also had age at menarche ≥ 12 years 38 (95.0%), while <12 years was

observed in 2 (5.0%) patients. There was no statistically significant difference between the groups ($p=0.263$). Regarding parity, the majority of patients in both groups were nulliparous, accounting for 29 (72.5%) in Group A and 30 (75.0%) in

Group B, followed by parous patients 11 (27.5%) and 10 (25.0%) respectively. The difference between the groups was not statistically significant ($p=0.799$).

Table II

Comparison of age at menarche and parity between the groups ($n=80$).

Variables	Group A (n=40) n (%)	Group B (n=40) n (%)	p-value
Age at menarche			
<12 years	6 (15.0)	2 (5.0)	0.263 ^c
≥12 years	34 (85.0)	38 (95.0)	
Parity			
Nulliparous	29 (72.5)	30 (75.0)	0.799 ^a
Parous	11 (27.5)	10 (25.0)	

Chi square test was done to measure the level of significance. Fisher's exact test was done to measure the level of significance Figure within parentheses indicates in percentage.

Table III shows in Group A, the most frequent BMI category was overweight (25.0–29.9 kg/m²) 22 (55.0%), followed by normal (18.5–24.9 kg/m²) 16 (40.0%) and obese (≥ 30 kg/m²) 2 (5.0%). In Group B,

the majority of patients had normal BMI (18.5–24.9 kg/m²) 22 (55.0%), followed by overweight (25.0–29.9 kg/m²) 17 (42.5%) and obese (≥ 30 kg/m²) 1 (2.5%). The mean BMI was 26.04 ± 2.64 kg/m² in Group A

and 25.15 ± 3.25 kg/m² in Group B. No statistically significant difference was observed between the groups ($p=0.181$ for mean BMI and $p=0.436$ for BMI categories).

Table III

Comparison of BMI between the groups ($n=80$).

BMI (kg/m ²)	Group		p value
	Group A ($n=40$) n (%)	Group B ($n=40$) n (%)	
Normal (18.5–24.9)	16 (40.0)	22 (55.0)	0.436 ^c
Overweight (25.0–29.9)	22 (55.0)	17 (42.5)	
Obese (≥ 30)	2 (5.0)	1 (2.5)	
Mean $\pm$ SD	26.04 ± 2.64	25.15 ± 3.25	0.181 ^b

Unpaired t-test was done to measure the level of significance. Fisher's Exact test was done to measure the level of significance. Figure within parentheses indicates in percentage.

Table IV shows dysmenorrhea was the most common, observed in 39 (97.5%) patients in Group A and 36 (90.0%) in Group B. Reproductive issues were reported in 27 (67.5%) of Group A and 31 (77.5%) of Group B. Pelvic pain was present in 18 (45.0%) of Group A and 10 (25.0%) of Group B, while dyspareunia

was the least frequent, reported in 6 (15.0%) and 5 (12.5%) of patients in Groups A and B, respectively. No statistically significant differences were observed between the groups for any of the presenting symptoms ($p>0.05$). Regarding cyst laterality on TVS, the majority of patients in both groups had unilateral cysts,

accounting for 34 (85.0%) in Group A and 35 (87.5%) in Group B, whereas bilateral cysts were found in 6 (15.0%) and 4 (10.0%) of patients in Groups A and B, respectively, with no statistically significant difference between the groups ($p=0.499$).

Table IV
Comparison of presenting symptoms and cyst laterality on TVS finding between the groups (n=80).

Variables	Group A (n=40) n (%)	Group B (n=40) n (%)	p-value
Presenting symptoms			
Dysmenorrhea	39 (97.5)	36 (90.0)	0.359 ^c
Dyspareunia	6 (15.0)	5 (12.5)	0.745 ^a
Pelvic pain	18 (45.0)	10 (25.0)	0.061 ^a
Reproductive issues	27 (67.5)	31 (77.5)	0.317 ^a
Laterality			
Unilateral	34 (85.0)	35 (87.5)	0.499 ^a
Bilateral	6 (15.0)	4 (10.0)	

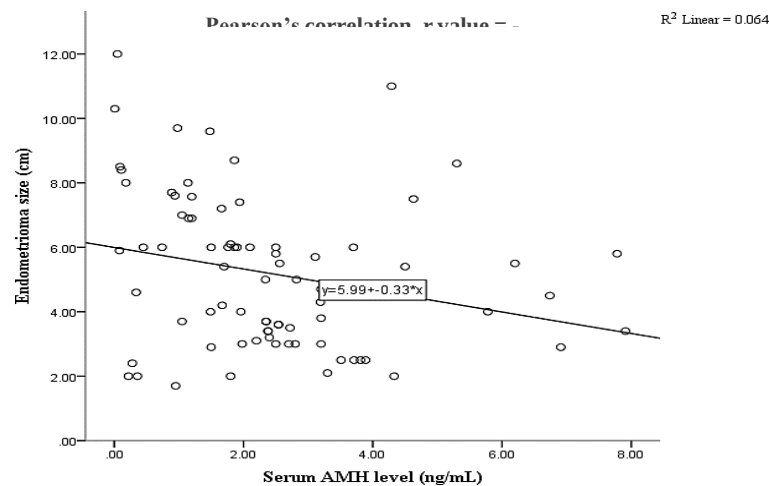
Chi square test was done to measure the level of significance. Fisher's exact test was done to measure the level of significance. Figure within parentheses indicates in percentage. *Multiple responses in presenting symptoms.

Table V presents the mean serum AMH and 2.83 ± 1.72 ng/mL in Group B. levels compared to Group A, and this level was 2.05 ± 1.75 ng/mL in Group A. Patients in Group B had higher AMH difference was statistically significant (p=0.047) .

Table V
Comparison of mean (±SD) serum Anti-Mullerian Hormone (AMH) levels between the groups (n=80).

Serum AMH (ng/mL)	Group		p-value
	Group A (n=30)	Group B (n=40)	
Mean ± SD	2.05 ± 1.75	2.83 ± 1.72	0.047 ^b

Unpaired t-test was done to measure the level of significance



R2 = percentage of variability of endometrioma due to decline of serum AMH levels and vice versa, r = Pearson's correlation coefficient.

Figure 1: Scatterplot diagram showing the correlation between serum AMH and size of ovarian endometrioma (n=80).

A negative correlation was observed between serum AMH levels and ovarian endometrioma size (r = -0.253; p = 0.024), suggesting that as endometrioma size increases, AMH levels tend to decrease. The R2 value of 0.064 indicates that approximately 6.4% of the variability in

ovarian endometrioma size can be attributed to changes in serum AMH levels (Figure 1). Table-VI shows a significant difference in AMH levels was observed between Group A and Group B (p = 0.026). Patients with

low AMH levels had 3.1 times higher risk of developing endometrioma sized ≥5cm compared to those with AMH levels ≥3.19 (Odds Ratio = 3.143; 95% CI = 1.120 – 8.822).

Table VI
Odds ratios (OR) and 95% confidence intervals (CI) for endometrioma size according to anti-müllerian hormone levels in pregnancy (n=80).

S. AMH level (ng/mL)	Groups		p-value*	Odds Ratio (95% CI)
	Group A (n=40)	Group B (n=40)		
<3.19	33 (82.5)	24 (60.0)		3.143
≥3.19	7 (17.5)	16 (40.0)	0.026	(1.120-8.822)

*Chi-square test was done to measure the level of significance. Figure within parenthesis indicates in percentage.CI = Confidence Interval.

DISCUSSION

The serum anti-müllerian hormone (AMH) level in women with endometrioma often has lower values, which is due to chronic inflammatory processes and the presence of increased reactive oxygen species in the ovarian environment [12]. The size of an endometrioma is important because larger endometriomas can have a greater impact on ovarian function, potentially causing increased pain, deformation of ovarian tissue, and fertility problems [13]. In the present study, a total number of 80 symptomatic ovarian endometrioma patients were included purposively, and women with large-sized endometrioma (≥5 cm) were enrolled in Group A (n=40) and the others with small-sized endometrioma (<5 cm) were included in Group B (n=40). In this study, the majority of patients (56.3%) fell within the 21–30 years age group, with Group B having a slightly higher mean age compared to Group A (26.20±5.51 vs. 24.75±5.38 years; p=0.238). A higher percentage of women in Group A (42.5%) had an educational background up to the secondary school certificate or equivalent level in comparison to Group B (52.5%). The majority of women in both groups were housewives (Group A: 62.5% vs. Group B: 65.0%). Additionally, a significant proportion of patients in both Group A (70.0%) and Group B (77.5%) belonged to the lower-middle-class social status category. Statistical analysis revealed no significant differences between Group A and Group B in terms of their socio-demographic characteristics (p > 0.05) [14]. A similar study showed that the mean patient age was 31 (20–35) years in the endometrioma group and 30 (21–35) years in the non-endometrioma group [15]. Most of the patients in both Group A and Group B had their menarche at an age of ≥12 years (85.0% vs. 95.0%, respectively). Additionally, nulliparous women accounted for 72.5% of those with larger endometriomas and 75.0% of those with endometrioma sized <5 cm in both groups. In comparison of the Body Mass Index between Group A and Group B, the mean (±SD) BMI was slightly higher among the Group A women (26.04±2.64 kg/m²) than the Group B women (25.15±3.25 kg/m²)

with the majority (55.0%) of Group A distributed in the overweight category compared to 42.5% of Group B. Obesity was observed in 5.0% of Group A women compared to only 2.5% of Group B participants. These differences were not statistically significant (p>0.05) [16]. In this study comparing two groups of women with endometriomas, there were no statistically significant differences in the prevalence of common presenting symptoms, including dysmenorrhea, dyspareunia, and reproductive issues, although most of the women presented with dysmenorrhea (Group A: 97.5% vs. Group B: 90.0%) [17]. In the current study, the laterality of endometriomas, whether unilateral (Group A: 85.0% vs. Group B: 87.5%) or bilateral (Group A: 15.0% vs. Group B: 10.0%), also did not significantly differ between the two groups, indicating relatively similar clinical presentations [18]. In Group A, the mean AMH levels (2.05±1.75 ng/mL) were significantly lower than in Group B (2.83±1.72 ng/mL) with a p-value of 0.047. Additionally, a significant negative correlation (r = -0.253; p = 0.024) was observed between serum AMH levels and ovarian endometrioma size, indicating that larger endometriomas were associated with lower AMH levels. Furthermore, patients with low AMH levels (<3.19 ng/mL) had a 3.1 times higher risk of developing endometriomas sized ≥5 cm compared to those with AMH levels ≥3.19 (Odds Ratio = 3.143; 95% CI = 1.120–8.822) [19]. A study on preoperative serum AMH levels in women with endometrioma carried out retrospectively showed a correlation between serum AMH levels and endometrioma cyst size, with 97 women divided into two groups (endometrioma cyst mass and non-endometrioma ovarian cyst mass) [20]. A meta-analysis also reported that larger endometrioma masses cause greater damage to ovarian reserves, leading to a decrease in serum AMH levels [21]. Endometrioma cysts are known to contain various components, including cellular damage-mediating factors, proteolytic enzymes, inflammatory molecules, reactive oxygen species (ROS), and iron, which can induce alterations in neighboring cells and may initiate

tumorigenesis [22,23]. Karadağ et al. documented a significant correlation of serum AMH level with the size of unilateral endometrioma (R = -0.372, p = 0.008), suggesting that increased endometrioma size is related to decreased AMH levels [24]. In contrast, Marcellin et al. reported that AMH concentrations were not significantly different between two groups (3.7±2.8 ng/mL vs. 4.1±3.3 ng/mL) and that log10 AMH positively correlated with log10 OMA cyst volume in a regression model (R² = 0.23; coefficient = 0.05; 95% CI, 0.007–0.10) [25]. In light of these findings, it is evident that there is an association between serum AMH levels and larger ovarian endometriomas.

CONCLUSION

The study results show that serum AMH level declines with the increasing size of ovarian endometrioma. This finding suggests that monitoring of AMH levels could provide valuable insights for clinicians in managing endometriosis-related ovarian pathologies and making informed treatment decisions. Therefore, those who developed large endometrioma (≥5cm) were associated with low serum AMH level.

LIMITATIONS

This study has several limitations. First, it was conducted in a single tertiary hospital, which may not represent the wider population. Second, the sample size was relatively small, limiting the statistical power of the findings. Third, the study period was short, restricting long-term observation and follow-up. Finally, participants were selected using a non-random (purposive) sampling method, which may introduce selection bias. Therefore, the findings of this study cannot be generalized to the entire population.

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