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Predictive Role of Anti-Mullerian Hormone in Spontaneous Miscarriage among Iraqi Pregnant Women

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Annotation: Background: Early pregnancy loss, particularly during the first trimester, is a common reproductive complication with multifactorial causes. Anti-Müllerian Hormone (AMH), a marker of ovarian reserve, has recently been investigated for its potential role in predicting pregnancy outcomes. This study aims to evaluate the predictive role of serum AMH levels in first-trimester miscarriage among pregnant women in Iraq.

Methods: This study was involving 129 pregnant women aged 20 to 40 years at ≤12 weeks of gestation. The case group included 79 women who experienced spontaneous miscarriage, while the control group consisted of 50 women with ongoing viable pregnancies, matched for age and gestational age. Serum AMH levels were measured and compared between the two groups. Maternal age and body mass index (BMI) were also assessed.

Results: There was no significant difference in maternal age between the groups ($p = 0.7316$). However, BMI was significantly higher in the miscarriage group compared to the control group (p = 0.024). Serum AMH levels were significantly lower in the miscarriage group (1.653 ± 1.12 ng/mL) compared to the control group (2.682 ± 1.40 ng/mL), with a p-value < 0.05.

Conclusion: Lower serum AMH levels are significantly associated with early pregnancy loss and may serve as a useful biomarker for identifying women at increased risk of miscarriage. Incorporating AMH testing into early pregnancy evaluation may improve reproductive care and risk stratification, particularly in resource-limited settings such as Iraq.

Keywords: AMH, miscarriage, early pregnancy loss, ovarian reserve, Iraq.

Introduction

Miscarriage, or spontaneous pregnancy loss before 20 weeks of gestation, is the most frequent early pregnancy complication, happening in 10–20% of clinically recognized pregnancies (Sapra et al., 2017). About 80% of these losses occur during the first trimester, with chromosomal abnormalities responsible for about 50–70% of cases (THARAPEL et al., 1985). Unlike induced abortion, spontaneous miscarriage is a natural process and can be categorized into several clinical types, including: threatened miscarriage (vaginal bleeding with intact cervix), inevitable miscarriage (bleeding with cervical dilatation), incomplete miscarriage (partial expulsion of products of conception), complete miscarriage (expulsion of all products of conception), and missed miscarriage (retention of dead embryo or fetus) (Nepyivoda & Ryvak, 2020).

Risk of spontaneous miscarriage increases with rising maternal age, from about 10% in women aged 20-24 years to over 50% in women older than 45 years (Du Fossé et al., 2020). Some other established risk factors include previous miscarriage, certain maternal medical conditions (e.g., diabetes and thyroid disease), congenital uterine abnormalities, and lifestyle factors like smoking and consumption of large amounts of caffeine (McNestry et al., 2023). Despite these established connections, in the majority of cases, spontaneous miscarriage's pathophysiology remains unexplained, particularly those unassociated with chromosomal abnormalities (Colley et al., 2019). Miscarriage in Iraqi culture also carries very serious social and psychological consequences, typically reinforced by motherhood and fertility beliefs. Women who undergo miscarriage will likely suffer from emotional distress, such as grief, guilt, and social pressure, emphasizing the need for integrated psychosocial support in miscarriage management (Abed et al., 2019). Because of these challenges, research like the current one, assessing the prognostic utility of AMH for early pregnancy loss, can enhance knowledge, enable earlier risk identification, and support the development of specific, evidence-based interventions within Iraq's health system.

Anti-Müllerian Hormone (AMH), a glycoprotein secreted by preantral and small antral follicle granulosa cells, is a well-established marker of ovarian reserve (La Marca & Volpe, 2006). Its circulating level has a close correlation with the primordial follicle number and is a good estimator of a woman's reproductive potential regardless of menstrual cycle fluctuation (Mihm et al., 2011).

Clinically, AMH is utilized routinely to assess ovarian responsiveness in ART, whereby decreased levels (<1.1 ng/mL) reflect diminished ovarian reserve (DOR), and elevated levels (>3.5 ng/mL) are commonly associated with polycystic ovary syndrome (PCOS) (de Carvalho et al., 2008).

Besides fertility assessment, growing research interest has also investigated the possibility of AMH to predict early pregnancy outcomes (Cedars, 2022). While AMH's function in follicular development is known, it may also affect oocyte quality and endometrial receptivity through some of its receptors that are present in reproductive tissues (Buratini et al., 2022). Some studies have posited that reduced levels of AMH would be associated with higher risk for first-trimester pregnancy loss by virtue of compromised oocyte viability or dysregulated embryo-endometrium interaction (it, 2020). But this correlation has been questioned as other research has found that no significant correlation exists after adjustment for maternal age. The study aimed to evaluate the predictive role of serum anti-Müllerian hormone (AMH) levels in early pregnancy loss among women with confirmed first-trimester pregnancies.

Materials and Methods

This study was conducted at the Department of Obstetrics and Gynecology, Al Sadiq Hospital (Samawah city, Iraq), between April 2024 and March 2025. All procedures were conducted in accordance with the Declaration of Helsinki. Consent forms were obtained from all participants, and detailed information was recorded.

A total of 129 women aged 20 to 45 years with clinically confirmed intrauterine pregnancies at ≤12 weeks of gestation were recruited. All participants underwent transvaginal or transabdominal ultrasonography to confirm the presence of an intrauterine gestational sac.

Participants were divided into two groups when the first group as control group (n = 50) including women with ongoing, viable pregnancies at the time of recruitment. Controls were matched to cases based on maternal age and gestational age at the time of blood sample collection. Whereas second group as miscarriage group (n = 79) including women who experienced a spontaneous miscarriage during the first trimester.

The inclusion criteria of participants including Age between 20 and 45 years, confirmed intrauterine pregnancy by ultrasound, gestational age ≤12 weeks and No history of chronic medical illness or hormonal therapy. Where as exclusion criteria of participants if they had any of the following: Polycystic ovary syndrome (PCOS), known endocrine disorders (e.g., thyroid dysfunction, diabetes mellitus), use of ovulation induction agents or assisted reproductive technology (e.g., IVF) and congenital or acquired uterine abnormalities (e.g., fibroids, septate uterus) (Abed et al., 2022).

Blood Sample Collection and AMH Measurement

Venous blood samples (approximately 5 mL) were collected from all participants at the time of enrollment, prior to miscarriage (in case group) or during routine first-trimester prenatal evaluation (in control group). Serum was separated by centrifugation and stored at −20°C until analysis (Abed et al., 2023).

Serum AMH concentrations were measured using a commercially available enzyme-linked immunosorbent assay (ELISA) kit [Rochi, Switzerland], following the manufacturer’s instructions. All samples were assayed in duplicate to ensure accuracy. The intra-assay and inter-assay coefficients of variation were below 10% (Bungum et al., 2018).

Statistical Analysis

Data were analyzed using GarphPad Prism software (Version 8). Descriptive statistics were reported as mean ± standard deviation (SD) for continuous variables and as frequency and percentage for categorical variables. Comparisons between groups were made using the independent samples t-test with p value ≤ 0.05 (Ali et al., 2024).

Results and Discussion

A total of 129 pregnant women were enrolled in the study, including 79 women who experienced

Groups	N	Mean ± SD	Range of age	Significantly different? (P < 0.05)	95% confidence interval
According to Age (Years)					
Control Group	50	30.16 ± 6.87	20- 38	NS (0.7316)	-2.621 to 1.845
Miscarriage Group	79	29.77 ± 5.18	20-40		
According to BMI (kg/m²)					
Control Group	50	24.90 ± 4.36	18-32	S** (0.024)	0.6799 to 3.596
Miscarriage Group	79	27.04 ± 3.88	18-33		
According to AMH (ng/mL)					
Control Group	50	2.682 ± 1.40	0.2 – 5.8	S**** (< 0.05)	-1.471 to -0.5869
Miscarriage Group	79	1.653 ± 1.12	0.1 – 4.3		

a first-trimester miscarriage (case group) and 50 women with ongoing pregnancies (control group). The statistical results of groups in Table 1 according to age, BMI and AMH.

Table 1: Statistical results of groups according to age, BMI and AMH variable. P. value ≤ 0.05.

*AMH: Anti-mullerian hormone, NS: Non-significant, S: Significant

The mean age in the miscarriage group was 29.77 ± 5.18 years (range: 20–40), while the control group had a mean age of 30.16 ± 6.87 years (range: 20–38). There was no statistically significant difference in age between the two groups (p = 0.7316, 95% CI: −2.621 to 1.845) as in Figure 1.

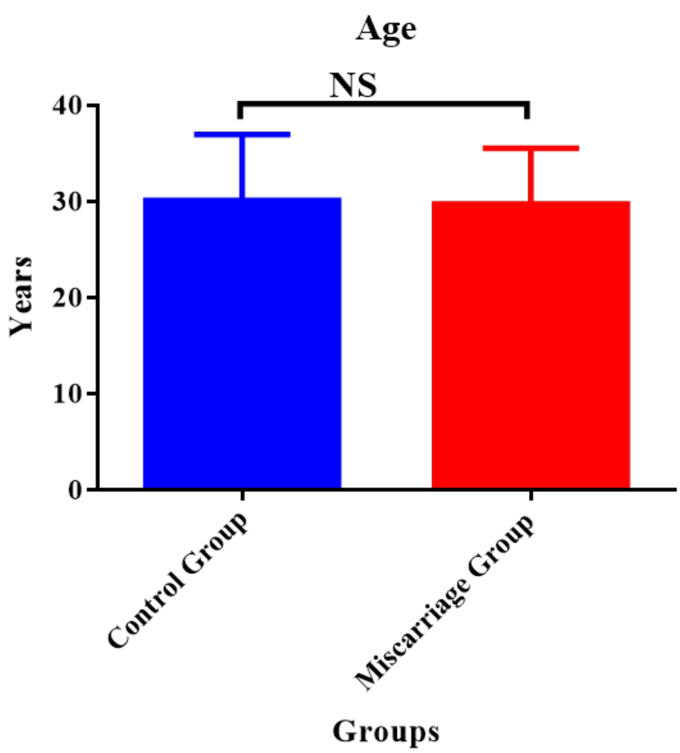

Figure 1: Comparison between groups according to age (years).

This suggests that our study population, maternal age was not a distinguishing factor for early pregnancy loss. This finding contrasts with several large-scale epidemiological studies that have demonstrated a strong association between advanced maternal age and increased risk of miscarriage, particularly beyond the age of 35 (Quenby et al., 2021). However, our study focused on a relatively young cohort (ages 20–40), and the limited representation of women at higher maternal ages may have reduced the ability to detect an age-related effect.

Furthermore, since both groups were matched for age and gestational age, any potential age-related confounding was minimized by design. This reinforces the notion that other biological markers, such as serum AMH levels, may provide additional predictive value beyond maternal age alone, particularly in younger women (Subramanian et al., 2022). It is important to consider that the role of age in miscarriage is multifactorial and may interact with factors such as oocyte quality, chromosomal abnormalities, and hormonal environment (Dean et al., 2018). Therefore, while age remains an important consideration in reproductive outcomes, it was not independently associated with early pregnancy loss in our sample.

Our study found a statistically significant association between higher body mass index (BMI) and early pregnancy loss. Women in the miscarriage group had a higher mean BMI (27.04 kg/m²) compared to those in the control group (24.90 kg/m²), with a p-value of 0.024. This suggests that elevated BMI may be an independent risk factor for first-trimester miscarriage as in Figure 2.

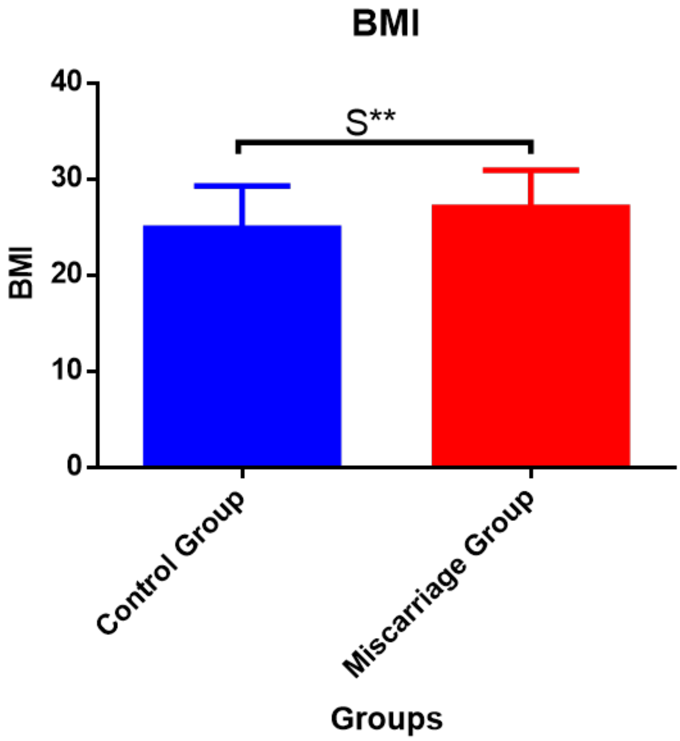

Figure 2: Comparison between groups according to BMI

These results are consistent with existing literature that links overweight and obesity to adverse reproductive outcomes, including miscarriage. Increased adiposity is known to affect oocyte quality, endometrial receptivity, and early placental development, potentially through mechanisms involving insulin resistance, inflammation, and altered hormone levels (Gonzalez et al., 2022; Yang et al., 2022). Furthermore, obesity is associated with higher levels of leptin and lower levels of adiponectin, which can impair implantation and early embryonic development (Dos Santos et al., 2015). Although the BMI difference observed in our study was modest, it may reflect a clinically relevant threshold effect, especially in populations with generally lower BMI averages. Importantly, the average BMI in both groups fell within the normal to overweight range (18–33), indicating that even mild increases in BMI may contribute to miscarriage risk.

he mean serum AMH level in the miscarriage group was 1.653 ± 1.12 ng/mL, which was significantly lower than that of the control group (2.682 ± 1.40 ng/mL). This difference was statistically significant ($p < 0.05$), with a 95% confidence interval of −1.471 to −0.5869. The range of AMH values was 0.1–4.3 ng/mL in the miscarriage group and 0.2–5.8 ng/mL in the control group as in Figure 3.

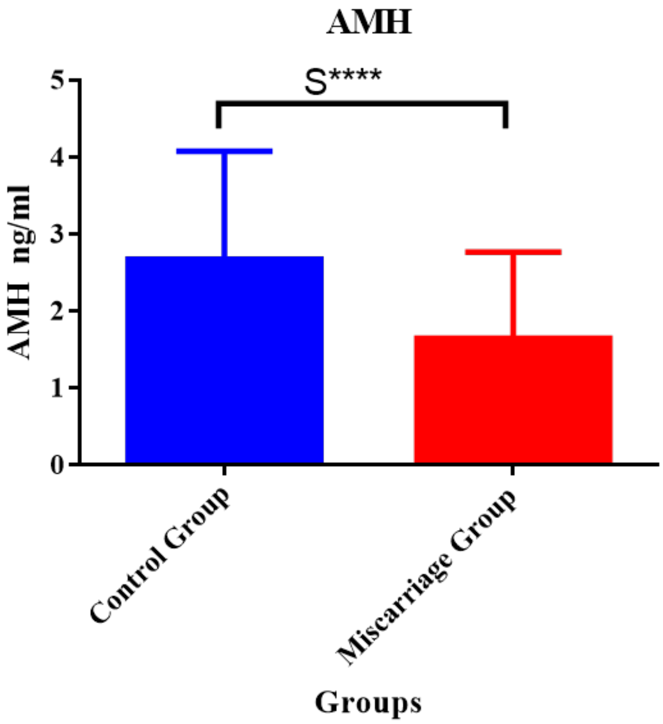

Figure 3: Comparison between groups according to AMH.

AMH is a well-established marker of ovarian reserve, produced by granulosa cells of preantral and small antral follicles (Monniaux et al., 2014). While its traditional role lies in fertility assessment, recent studies have suggested that AMH may also have predictive value for pregnancy outcomes, including miscarriage (Busnelli et al., 2021). The lower AMH levels in the miscarriage group in our study may reflect compromised ovarian reserve or reduced oocyte quality, both of which are associated with chromosomal abnormalities and failed early embryonic development (Chinè et al., 2023).

The results of this study are consistent with prior research that links diminished ovarian reserve to adverse reproductive outcomes, even among women who conceive spontaneously (Levi et al., 2001). Notably, the significant difference in AMH persisted despite no significant difference in maternal age between the groups, suggesting that AMH may serve as a more sensitive biomarker for early pregnancy viability than age alone. Although the AMH ranges in both groups overlapped, the group means and confidence interval analysis support the utility of AMH as a predictive marker. Clinically, this could aid in early risk stratification of pregnancies, especially among women with borderline ovarian reserve or a history of miscarriage. However, interpretation of AMH should be done cautiously, as levels can be influenced by factors such as assay variability, BMI, and ethnicity. In addition, while lower AMH may indicate increased miscarriage risk, it is not an absolute determinant of pregnancy failure (Cornille et al., 2022).

Conclusion

This study demonstrates a significant association between lower serum Anti-Müllerian Hormone (AMH) levels and first-trimester miscarriage among Iraqi women. While maternal age showed no significant difference between groups, women who experienced early pregnancy loss had significantly higher body mass index (BMI) and lower AMH levels compared to those with ongoing pregnancies. These findings suggest that AMH may serve as a valuable biomarker for assessing the risk of early pregnancy loss, independent of age.

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