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Research Article

The Correlation Between Low AMH and Study Variables of Age, Number of Eggs, Maturation Rate and Top-Quality Embryos

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Abstract

This study examines the impact of low Anti-Müllerian Hormone (AMH) levels (< 1 ng/mL) on fertility outcomes in assisted reproductive technologies (ART). AMH, a key biomarker of ovarian reserve, is more reliable than other hormonal indicators due to its stability. Women with low AMH often experience diminished ovarian reserve (DOR), leading to reduced ovarian response, lower oocyte yield, and decreased pregnancy success rates. The study analyzes correlations between AMH levels, fertilization rates, and pregnancy outcomes to provide evidence-based recommendations for clinical practice in ART. A study of 71 women (ages 23 - 48, mean 35.7) with low AMH undergoing ART analyzed variables including egg count, fertilization, and embryo quality. The average number of eggs retrieved was 4.21, with a fertilization rate of 70%. AMH levels ranged from 0.05 to 0.99 ng/mL (mean 0.55). AMH is a key marker of ovarian reserve, moderately correlating with egg count and weakly with mature eggs. However, it lacks strong ties to fertilization or embryo quality. Future research should explore additional biomarkers for better fertility prediction.

Keywords: AMH; Assisted Reproductive Techniques; Egg Counts; Fertilization R

Introduction

Anti-Müllerian hormone (AMH) is a glycoprotein hormone produced by granulosa cells in ovarian follicles. It plays a crucial role in the regulation of folliculogenesis and serves as a reliable biomarker for ovarian reserve, reflecting the remaining quantity of eggs within the ovaries. AMH levels have gained significant attention in reproductive medicine due to their predictive value in assessing ovarian function and fertility potential [1].

The clinical relevance of AMH has been well-documented in numerous studies. It is considered a superior marker for ovarian reserve compared to other hormonal indicators such as follicle-stimulating hormone (FSH) and estradiol (E2) due to its cycle-independent stability and minimal variability. AMH measurement has become integral to the evaluation of patients undergoing fertility treatments, including *in vitro* fertilization (IVF) and intrauterine insemination (IUI) [2].

Low AMH levels, often defined as less than 1 ng/mL, are indicative of a reduced ovarian reserve. Women with low AMH are frequently diagnosed with diminished ovarian reserve (DOR), which is associated with poorer response to ovarian stimulation and lower oocyte yield during ART cycles. The diminished quantity and quality of oocytes in these women pose significant challenges, often leading to lower fertilization rates, suboptimal embryo quality, and reduced pregnancy success rates [3].

The primary objective of this study is to evaluate the success rates of fertilization and pregnancy in women with AMH levels below 1 ng/mL undergoing ART. By examining a comprehensive dataset, the study seeks to identify key factors influencing treatment outcomes and to provide evidence-based recommendations for clinical practice. Specific objectives include: Assessing the correlation between AMH levels and ovarian response to stimulation. Analyzing fertilization rates in relation to AMH levels. Evaluating pregnancy success rates in women with low AMH. Identifying potential predictors of successful ART outcomes in this patient population.

Several studies have explored the role of AMH in predicting ART outcomes. A meta-analysis demonstrated that AMH is a strong predictor of poor ovarian response, with low levels being associated with higher cycle cancellation rates and lower live birth rates. Similarly, further research confirmed the prognostic value of AMH in identifying women at risk for poor response to ovarian stimulation [4].

Research by Nelson., *et al.* (2009) highlighted the relationship between AMH levels and oocyte quality, showing that lower AMH concentrations were linked to a higher incidence of chromosomal abnormalities in embryos. Furthermore, a study by Sunkara., *et al.* (2011) revealed that AMH levels could predict the likelihood of achieving a clinical pregnancy, with lower levels correlating with reduced success rates [5].

This retrospective study aims to explore the impact of low AMH levels (< 1 ng/mL) on fertilization and pregnancy success rates, providing insights into the challenges and outcomes associated with assisted reproductive technologies (ART) in women with diminished ovarian reserve (DOR) [6].

Methods

This retrospective study analyzed data from women undergoing assisted reproductive technology (ART) treatments at British-Syrian IVF Centre, ALRasheed Hospital, Damascus between [1/1/2022] and [1/1/2024]. The primary focus was on women with serum AMH levels less than 1 ng/mL, which is indicative of diminished ovarian reserve (DOR). Ethical approval for the study was obtained from the Ethical Committee of ministry of health, ensuring that all patient data were handled in compliance with ethical standards and patient confidentiality [7,8].

The study included women aged 23 - 48 years who underwent ART procedures, specifically intracytoplasmic sperm injection (ICSI). Inclusion criteria were based on having a recorded AMH level below 1 ng/mL prior to the initiation of the ART cycle. Exclusion criteria included women with a history of ovarian surgery, chemotherapy, or any other conditions known to significantly affect ovarian reserve independently of age or AMH levels [9,10].

Data were extracted from electronic medical records, focusing on key variables such as age, number of oocytes retrieved, oocytes mature, fertilization rates, embryo quality, and grad 4 embryo i.e. top quality embryos [11,12].

Ovarian stimulation protocols varied among patients and were tailored based on individual ovarian reserve markers and response to previous treatments. Common protocols included the GnRH antagonist protocol. The choice of protocol, as well as the total dose of gonadotropins, was recorded for each patient [3,13].

Primary outcomes measured were the number of oocytes retrieved, fertilization rate (defined as the number of oocytes fertilized per total number of mature oocytes), and embryo quality (graded according to the Gardner and Schoolcraft grading system) [14,15]. To avoid repetition Secondary outcomes included the total dose of gonadotropins required and the incidence of ovarian hyperstimulation syndrome (OHSS) [16,17], whoever the secondary outcome not mentioned in this study as will be in different more advanced study in process at the centre.

Statistical processing used:

Statistical analysis was performed using SPSS version [25] for data analysis:

1. **Descriptive statistics:** To know the arithmetic mean and standard deviation of the quantitative variables included in the tests in addition to the percentages and frequencies of the qualitative variables [18].
2. **Normal distribution test:** By Kolmogorov-Smirnov test when the sample size is greater than 50, in order to find out the most appropriate tests for the study [19].
3. **Correlation study:** By spearman's test to study the strength and destination of the relationship between the variables of the study [20].

Results

71 women between the ages of 23 and 48 with an average age of 35.7 years with low AMH ovarian reserve in assisted reproductive therapies were evaluated. Variables such as the number of eggs, mature eggs, fertilized eggs, embryos and embryo quality were examined. In descriptive statistics it was shown: The number of eggs in the study sample ranged between 1 and 12 eggs with an average of 4.21 eggs, and the number of mature eggs ranged between 0 and 10 eggs with an average of 2.90, and the number of fertilized eggs ranged between 1 and 7 eggs with an average of 2.30, the number of embryos ranged from 1 to 5 embryos with an average of 1.89, the number of embryos of quality 4/4 (top quality) ranged between 0 and 4 embryos with an average of 1.13, the number of embryos of quality 3/4 ranged between 0 and 4 embryos with an average of 0.73, and the number of embryos of quality II ranged between 0 and 1 Fetal with an average of 0.01.

Fertilization rates ranged from 0% to 100% with an average of 70%, AMH values ranged between 0.05 and 0.99 with an average of 0.55.

Study variables	N	Mean	Std. Deviation	Median	Minimum	Maximum
Age	71	35.70	6.00	35	23	48
Number of eggs	71	4.21	2.50	4	1	12
Number of mature eggs	71	2.90	2.15	2	0	10
Number of fertilized	71	2.30	1.68	2	1	7
Number of embryos	71	1.89	1.05	2	1	5
Grad 4 embryo	71	1.13	0.98	1	0	4
Grad 3 embryo	71	0.73	0.89	1	0	4
Grad 2 embryo	71	0.01	0.12	0	0	1
Percentage of Fertilization	71	0.70	0.28	0.75	0	1
AMH	71	0.55	0.25	0.6	0.05	0.99

Table 1: *Description of study variables.*

Normality of data

The variants were subjected to the Kolmogorov-Smirnov test to investigate their distribution, and all of them were not distributed normally except for age and the following table shows the test result.

Study variables	Statistic	df	P-value
Age	0.089	71	0.200*
Number of eggs	0.139	71	0.002
Number of mature eggs	0.212	71	<0.001
Number of fertilized	0.274	71	<0.001
Number of embryos	0.28	71	<0.001
Grad 4 embryo	0.241	71	<0.001
Percentage of fertilization	0.197	71	<0.001
AMH	0.114	71	0.024
* Significant at the 0.05 level.			

Table 2: *Normal distribution test results.*

Study of the correlation between AMH and study variables:

The following table shows the results of the study of the association between the AMH in women and the study variables.

Age	-0.235*	1						
Number of egg	0.335*	-0.342*	1					
Number of mature eggs	0.261*	-0.338*	0.802*	1				
Number of fertilized	0.232	-0.238*	0.666*	0.848*	1			
Number of embryos	0.144	-0.227	0.551*	0.764*	0.907*	1		
Grad 4 embryo	-0.056	-0.119	0.306*	0.568*	0.646*	0.651*	1	
Percentage of Fertilization	0.018	-0.022	-0.181	0.380*	0.334*	0.381*	0.402	1
*. Correlation is significant at the 0.05 level. Spearman's rho								

Table 3: *Correlation matrix between AMH and study variables.*

The results showed a real relationship between AMH and each of (age, number of eggs, number of mature eggs and TQE: top quality embryos) (Table 1-3).

The inverse relationship was weak between age and AMH reached (-0.235), which means that as the woman gets older, the levels of AMH decrease, While the relationship between the number of eggs and AMH hormone was a medium direct of (0.335), which means that the increase in AMH levels.

The relationship between the number of mature eggs and AMH is directly weak (0.261) and means that increasing AMH levels leads to an increase in the number of mature eggs.

There are no statistically significant correlations were found between AMH and each of the following: number of fertilized eggs, number of embryos, number of embryos of the fourth quality (TQE), and percentage of pollination (p > 0.05).

Discussion

The results of this study corroborate existing literature indicating that low AMH levels are a significant predictor of poor ovarian response in ART. Women with AMH levels below 1 ng/mL consistently showed reduced oocyte yield, lower fertilization rates, and diminished embryo quality, which are critical factors influencing ART success. The clinical pregnancy rates, though reduced, underscore the potential for successful outcomes even in patients with diminished ovarian reserve (DOR) [7,21]. The lower oocyte yield and fertilization rates suggest that AMH serves as a reliable biomarker for ovarian reserve, directly influencing the quantity and quality of oocytes retrieved.

The inverse relationship between AMH and age aligns with previous findings that ovarian reserve decreases with age, reflected by the decline in AMH levels [11,22].

The lack of significant correlation between AMH and other fertility outcomes (e.g. fertilized eggs, embryos) suggests that while AMH is a useful marker for ovarian reserve, it might not predict the quality of the eggs or fertilization success directly [23,24].

The study confirms that Anti-Müllerian Hormone (AMH) is an important marker for assessing ovarian reserve. The weak inverse relationship between AMH and age (-0.235) highlights that, as women age, their ovarian reserve diminishes. This finding is consistent with other studies showing that AMH levels decrease naturally as a woman progresses through her reproductive years, especially after age 35. This decline is reflective of a reduction in the number of viable eggs available for fertilization [25,26].

The moderate positive correlation (0.335) between AMH and the number of eggs retrieved supports the idea that higher AMH levels are indicative of a greater number of eggs that can be collected during assisted reproductive procedures. This correlation reinforces the clinical value of AMH in predicting how well a woman may respond to ovarian stimulation, making it a key marker for tailoring fertility treatments [27,28].

The weak positive correlation (0.261) between AMH and the number of mature eggs suggests that AMH also has a role in predicting the maturity of eggs retrieved, but this relationship is not as strong as with the total number of eggs. This indicates that while AMH is a useful tool for estimating egg quantity, it may not be as reliable for assessing egg quality, which is crucial for successful fertilization and pregnancy outcomes [29,30].

The absence of significant correlations between AMH and the number of fertilized eggs, total embryos, and embryo quality (grade 4 and grade 3 embryos) implies that AMH alone is not a sufficient predictor of fertilization success or embryo quality [27,29]. This is an important distinction for clinical practice, as it shows that while AMH can estimate ovarian reserve, it does not directly predict the developmental potential of the eggs retrieved or the likelihood of achieving a successful pregnancy.

The non-significant relationships between AMH and embryo quality (grades 4 and 3) reinforce that egg quality may be influenced by other factors such as age, lifestyle, or underlying health conditions that are not directly reflected by AMH levels.

The lack of correlation with fertilization rates also suggests that factors such as sperm quality, laboratory techniques, and timing may have a stronger influence on fertilization outcomes than AMH levels alone.

These findings underscore the role of AMH as a valuable tool for predicting ovarian reserve and the number of eggs that can be retrieved during fertility treatments. However, the lack of correlation with key outcomes such as fertilization success and embryo quality indicate that AMH should be used in conjunction with other assessments, such as ultrasound follicle counts, hormone levels, and patient history, to create a more comprehensive fertility profile.

For patients undergoing assisted reproductive therapies, AMH levels can help set realistic expectations regarding the number of eggs they may retrieve but should not be relied upon as the sole indicator of treatment success [31,32]. Physicians should communicate to patients that while AMH levels provide insight into egg quantity, the quality of the eggs retrieved and their fertilization potential is influenced by multiple variables, many of which cannot be predicted by AMH alone.

AMH should be utilized alongside other diagnostic tools, such as follicle-stimulating hormone (FSH), estradiol levels, and antral follicle count (AFC), to provide a more comprehensive evaluation of a woman's fertility potential [33,34]. Moreover, understanding the implications of low AMH levels on assisted reproductive technology (ART) outcomes is essential for enhancing patient counseling, optimizing treatment strategies, and improving overall success rates. This highlights the importance of individualized stimulation protocols and greater support during fertility treatment.

Conclusion

Anti-Müllerian hormone (AMH) serves as a valuable marker for assessing ovarian reserve, showing a moderate correlation with the number of retrieved eggs and a weaker correlation with the number of mature eggs. However, AMH does not exhibit a strong association with critical fertility outcomes, such as fertilization rates or embryo quality. This suggests that future research should focus on identifying additional biomarkers or combinations of markers to better predict not only ovarian reserve but also egg quality and embryo development.

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