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Original article

Association between Thyroid Stimulating Hormone and Ovarian Reserve in Euthyroid Infertile Women in Misurata, Libya

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Abstract
Infertility is one of the most common problems in gynecology with medical, economic, and psychological implications. Thyroid dysfunction was identified as one of the contributing factors to infertility in women. Normal thyroid function is essential for the maintenance of hormonal regulation and optimal reproductive health. The ovarian reserve (OR), defined as the number of oocytes remaining in the ovaries representing a woman's reproductive capacity, is also a critical aspect of a woman's reproductive potential. The aim of this study is to investigate the association between thyroid-stimulating hormone (TSH) levels and ovarian reserve (OR) markers in euthyroid infertile women attending the Misurata National Center for Diagnosis and Treatment of Infertility in Misurata, Libya. This retrospective study included 174 women under the age of 40, excluding those with thyroid abnormalities or other significant health conditions, such as polycystic ovarian syndrome, endometriosis, hyperprolactinemia, and a history of ovarian surgery. Hormonal parameters such as Anti-Müllerian hormone (AMH), TSH, follicle-stimulating hormone (FSH), and estradiol were assessed. Pearson correlation analysis and linear regression were performed to explore relationships between TSH and OR markers. Results revealed a mean age of 30.54±5.07 years, mean serum TSH of 1.89±0.86 mIU/L, and a mean AMH of2.01±1.88 ng/mL. Pearson correlation analysis indicated no significant linear relationship between TSH levels and either of the studied OR markers (AMH: r = 0.002, FSH: r = 0.025, and estradiol: r = -0.009) (p > 0.05). Furthermore, participants' categorization based on TSH levels (<2.5 vs. ≥2.5 mIU/L) demonstrated no statistically significant differences in AMH, FSH, or estradiol levels. On the other hand, a statistically significant negative correlation (r = -0.23, p = 0.003) was found between age and AMH levels, indicating that OR declines with advancing age. In conclusion, this study suggests that TSH levels are not predictive of OR in euthyroid infertile females, as no association was observed between TSH levels and OR markers. In contrast, age was distinguished as a key factor influencing the AMH levels. These findings suggest that TSH evaluation in euthyroid females may have limited value when assessing OR, whereas age should be considered as a critical factor in patient counseling and planning reproductive treatment strategies. Further research is required to clarify the relationship between TSH and OR markers among women with intact thyroid function
Keywords. Anti-Müllerian Hormone, Follicle-stimulating Hormone, Infertility, Ovarian Reserve, Thyroid-stimulating Hormone.

Introduction

Infertility is one of the most common problems in gynecology with medical, economic, and psychological implications. According to the World Health Organization (WHO), infertility is defined as the inability to achieve pregnancy after one year of regular, unprotected intercourse [1]. According to the WHO 2023 reports, 1 in 6 adults in the world experience infertility attributed to various factors [2]. Thyroid dysfunction is one of the contributing factors to infertility in women [3,4]. The significance of thyroid hormones (TH) in the female reproductive system has been well established, particularly with the discovery of thyroid-stimulating hormone (TSH) and TH receptors (TR-α1 and TR-β1) on the surface of oocyte and ovarian cells [4]. These play essential roles in folliculogenesis, fertilization, embryogenesis, implantation, and the maintenance of pregnancy [5]. Due to the distribution of TSH receptors in ovarian granulosa cells and uterine endometrium normal TSH levels, particularly levels less than 2.5 mIU/L, were presented with better pregnancy outcomes in women seeking assisted reproductive treatment [6,7] and elevated serum TSH has been associated with lower rates of clinical pregnancy in females at reproductive age [8] Moreover, oocytes have surface receptors for THs, which have been found to influence the actions of FSH and luteinizing hormone (LH) through steroid biosynthesis. Consequently, thyroid conditions such as hypothyroidism and subclinical hypothyroidism (SH) can disrupt menstrual regularity and ovarian state [9]. Additionally, thyroid autoimmunity (TAI) has also been associated with infertility and early pregnancy loss; however, the exact mechanisms of this effect are not clear [9,10]. Therefore, normal thyroid function is essential for supporting reproductive health.

In the same regard, one of the most important aspects of a woman's reproductive potential is the ovarian reserve (OR). OR is the number of oocytes remaining in the ovary representing a woman's reproductive capacity [11]. OR testing can also provide valuable information about the time to menopause, and other conditions and symptoms related to estrogen disequilibrium [12]. Each woman has an inherited number of ovarian follicles, which gradually decrease with age, resulting in poor reproductive outcomes [13]. Women with diminished ovarian reserve (DOR), defined by a reduced reproductive potential with an inadequate response to ovarian stimulation, are more likely to face challenges such as decreased fertility, early menopause, higher miscarriage rates, and suboptimal responses to ovarian stimulation during assisted

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reproductive treatments [14]. These conditions can severely alter the reproductive health of these women, emphasizing the importance of OR evaluation as a part of routine infertility assessment and exploring factors that may contribute to DOR.

Clinical estimation of OR is based on specific markers, including hormone levels and ultrasound measurements; low levels of anti-Müllerian hormone (AMH), a reduced antral follicular count (AFC), and elevated levels of FSH represent low OR. AMH, which is a glycoprotein secreted by granulosa cells of pre-antral and early antral follicles, serves as a reliable marker for assessing OR. Studies have shown that AMH concentrations correlate strongly with oocyte yield after ovarian stimulation, thus it is suitable for predicting bad, good, and even excessive ovarian stimulation during IVF preparation [10,14,15]. Although AMH levels naturally decline with age, recent reports have shown a global rise in the prevalence of DOR. although its precise causes remain poorly understood, many factors can contribute to DOR, such as initial ovarian reserve, certain conditions such as endometriosis, endocrine disorders, ovarian surgeries, and medications as chemotherapeutics [13, 16].

Like other reproductive aspects in women, OR has been found to be affected by thyroid dysfunction. According to several studies, thyroid abnormalities are associated with lower OR, as THs regulate reproductive hormones and support follicular development. Thyroid conditions such as hypothyroidism, SH, and TAI have been associated with low OR markers [9,17, 18]. A number of studies have presented hypothyroidism as one of the most common medical conditions associated with primary ovarian failure and lower serum AMH levels. In one study conducted in the Misurata National Center for Diagnosis and Treatment of Infertility, Libya, hypothyroidism has been presented as one of the most common medical conditions (31.1% of the cases) associated with primary ovarian failure among infertile women less than 40 years old, indicating a strong relationship between thyroid dysfunction and OR [19]. Consistent findings were reported by Eman M Abbas *et al.* from the College of Medicine, University of Baghdad, in a study involving 88 Iraqi women of reproductive age [20]. Likewise, higher normal fT4 concentrations were associated with better OR markers, and lower fT4 concentrations correlated with reduced AMH levels in one big study that involved 4,933 infertile women undergoing assisted reproductive technology (ART) in China [21]. Similarly, infertile women with low AMH had significantly higher TSH levels in comparison to those with normal AMH levels in two different studies conducted in Nepal and Tehran, Iran involved 80 and 134 infertile women, respectively [22,23]. These studies suggest a connection between normal thyroid function and maintaining a good OR in women of reproductive age.

Although the link between OR and thyroid dysfunction has been extensively investigated by numerous researchers, as previously stated, fewer studies have explored the correlation between TSH levels and OR markers in women without prior thyroid disorder. One retrospective analysis has illustrated the association between TSH and AMH in 1,396 infertile females aged between 20 and 45 years. Furthermore, using a second-degree polynomial regression, the researchers identified TSH = 2.88 mIU/L as an inflection point, where AMH levels were highest. [24] These findings align with the results of another study that involved 225 euthyroid infertile women, which showed that those with TSH <3.0 µIU/mL had significantly higher AMH levels compared to those with TSH ≥3.0 µIU/mL ($p = 0.03$), which supports the potential benefit of thyroxine supplementation for women with TSH ≥3.0 µIU/mL [9]. On the contrary, different results have been observed by some other researchers; for example, no significant correlation was found between AMH and thyroid function in two different studies in Turkey and China. They involved 198 and 496 infertile women at childbearing age, respectively [25,26].

Due to the limited number of studies on the relationship between TSH and OR markers in euthyroid infertile women and the inconsistent findings across existing studies' results, further investigations in this area should be conducted in order to clarify this association. The evidence suggesting that high-normal levels of TSH were linked to adverse effects on ovarian stimulation and poor pregnancy outcomes in infertile women raises the possibility that comparable serum TSH levels may be associated with lower AMH concentrations, implying that an association between TSH and OR markers may exist even in women with intact thyroid function. Therefore, an association between TSH serum levels and OR markers in euthyroid infertile women of reproductive age at the Misurata National Center for Diagnosis and Treatment of Infertility was hypothesized. Additionally, age may differentially influence hormonal profiles in women and was therefore anticipated to be an important determinant of major hormone levels. Accordingly, the aim of this study was to examine the relationship between TSH levels and OR markers in euthyroid infertile women of reproductive age seeking treatment at the Misurata National Center for the diagnosis and treatment of infertility.

Methods

Study population and design

This retrospective study was conducted at the Misurata National Center for Diagnosis and Treatment of Infertility, Libya, after ethical clearance was obtained from the research and ethics review committee of the faculty of pharmacy, Misurata University. The permission to collect data was obtained after official letters were approved by the head of the Misurata National Center for Diagnosis and Treatment of Infertility. Medical records of infertile women who attended the center for the first time between January 2024 and January 2025 were reviewed. Revision included age, anthropometric indices, clinical conditions, medication, and

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surgery history. Only 174 subjects met the eligibility criteria for the study. Women under the age of 40 with complete infertility-related data were considered acceptable for inclusion. Exclusion criteria included hypothyroidism or any diagnosed thyroid condition, diabetes mellitus, endometriosis, PCOS, hyperprolactinemia, history of any ovarian surgery, and recent use of ovulation-stimulating medication. Women with a BMI greater than 30 or on L-thyroxine medication were also excluded. Data collected from medical files included patients' age, BMI, and laboratory values for AMH, TSH, FSH, and Estradiol.

Statistical analysis

Data was entered and analyzed using the software Statistical Package for Social Sciences (SPSS) version 27.0. Pearson's correlation and simple linear regression model were employed to assess the relationship between TSH and OR markers, as well as age and OR markers. Participants were categorized based on their TSH levels into two groups: (<2.5 and ≥2.5) mIU/L to determine whether TSH values equal or above 2.5 mIU/L would have any negative impact on AMH level, as speculated. The Mann-Whitney U test was used to determine the statistical significance of the difference between the two groups. Moreover, data were divided into 4 distinct groups based on age: 18-25, 26-30, 31-35, and 36-39 years to investigate changes in hormonal profiles as women age. The Kruskal-Wallis test was utilized to determine the statistical significance of the difference between the 4 groups. A p-value ≤ 0.05 was considered significant.

Results

General characteristics

The analysis of the hormonal profile, as shown in (Table1) revealed notable variability within the studied population. The mean serum TSH was 1.89±0.86 mlU/L, with values ranging from 0.461 to 4.24 mlU/L, and the AMH mean value was 2.01± 1.88 ng/mL, with a broad range (0.01-12.4) ng/mL suggesting the presence of individuals with very low OR, as well as others with relatively high reserve which could be due to differences in age or reproductive health status. Similarly, the estradiol mean was 60.55±69.28 pg/mL with a range (2.5-584.95) pg/mL, while the calculated median value was 51.75 pg/mL. FSH levels, on the other hand, show less variability compared to the other reproductive hormones, with a mean value of 8.62±3.39mIU/L, ranging from 2.59 to 24.88.

Table 1. Demographics and hormonal profile results of participants

Characteristics	**Number of cases**	**Mean± SD**	**Maximum**	**Minimum**
Age	174	30.54±5.07 years	39	18
BMI	174	24.78±3.47 Kg/m²	30	16.1
TSH	174	1.89±0.86 mIU/L	4.24	0.461
AMH	174	2.01±1.88 ng/mL	12.4	0.01
FSH	167	8.62±3.39mIU/L	24.88	2.59
Estradiol (E2)	166	60.85±69.37pg/mL	584.95	2.5

Correlation Studies

Investigating the relationship between serum TSH levels and markers of OR

The results for the relationship investigation between serum TSH levels and markers of OR are shown in (Figure 1). Opposite to what was expected, the Pearson correlation analysis (r) shows that TSH does not exhibit a linear relationship with either of the OR markers. R values for AMH, FSH, and estradiol are close to zero; r = 0.002, 0.025, and -0.009, respectively, and all corresponding p-values are above 0.05, indicating no statistically significant association as illustrated in (Figure 1).

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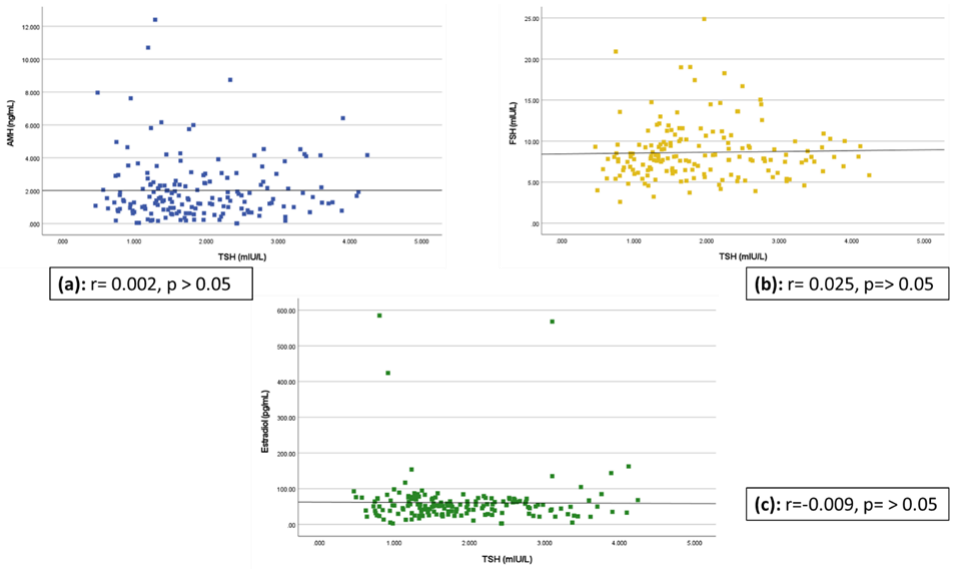

Figure 1. Relationship between TSH levels and OR markers. (a) AMH, (b) FSH, and (c) estradiol

Furthermore, to determine whether TSH values below or equal to 2.5 mIU/L would have an impact on AMH level, as speculated, patients were categorized into two groups based on their serum TSH level, as shown in (Table 2). The Mann-Whitney U test was used to determine the statistical significance of the difference between the two groups.

Table 2. Comparison of OR parameters across TSH groups.

Statistics	TSH<2.5 mIU/L	TSH ≥ 2.5 mIU/L	p-value
Number/percent	134/77	40/23	-
AMH (Mean± SD) CV%	(1.99± 1.98) 99.5%	(2.1± 1.49) 70.95%	-
AMH Median (IQR)	1.45(1.46)	1.65 (2.16)	> 0.05
FSH mIU/L Median (IQR)	8.09 (3.56)	7.75 (2.84)	> 0.05
Estradiol pg/mL Median (IQR)	51.6 (36.77)	54.95 (35.7)	> 0.05

This comparative analysis revealed no statistically significant difference between the two groups in terms of any of the studied hormones. The mean and median AMH in women with a TSH level≥ 2.5 were slightly higher than those of the other group; however, as stated, this difference was found statistically insignificant. Similarly, results of the other OR markers were comparable in both groups, where the median of FSH was 8.09 mIU/L in the first group compared to 7.75 mIU/L in the second group, while the median value for estradiol was 51.6 pg/mL in the low TSH group and 54.95 pg/mL in the second group, without a statistically significant difference. Thus, it appears that classifying participants by TSH level did not show statistically significant differences in the reproductive hormones within the studied sample. The comparison of AMH levels across the groups is visualized in the boxplot in (Figure 2), where the lower TSH group showed a lower median value, with a relatively narrower interquartile range (IQR). Moreover, several outliers were observed in the first group compared to the other group, where no extreme values were observed.

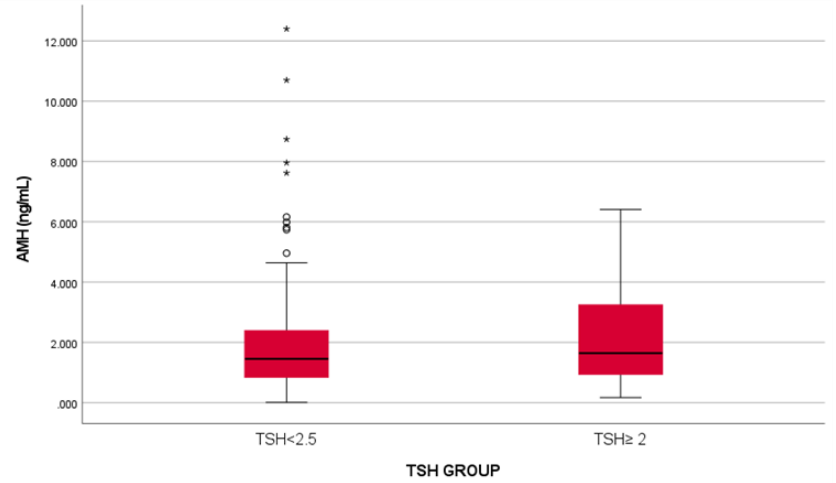

Figure 2. Boxplot representation of AMH levels across TSH groups (<2.5 vs ≥2.5 mIU/L)

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2. Investigating the association between age, OR markers, and TSH

Correlations between age and the OR markers, as well as between age and TSH, were analyzed; results are presented in (Table 3).

Table 3. Pearson correlation analysis of age vs AMH, FSH, Estradiol, and TSH levels

Correlated Variables	Pearson Correlation (r)	p-value
Age vs. AMH (ng/mL)	-0.23	0.003 (<0.05)
Age vs. FSH (mIU/mL)	0.037	> 0.05
Age vs. Estradiol (pg/mL)	0.181	0.02 (<0.05)
Age vs. TSH (mIU/L)	-0.096	> 0.05

The correlation analysis confirms the expected and well-documented effect of age on AMH. There is a statistically significant negative correlation between age and AMH level indicated by the negative r (-0.23) and the low p-value (< 0.003). (Figure 3) shows a linear regression line fitted to data having a negative slope, which further confirms the negative correlation between age and AMH levels. However, the low coefficient of determination (R^2 =0.051) indicates considerable variability in the data, meaning that age alone explains about 5 % of the variance in AMH levels in the studied cohort. Moreover, Weak positive correlations were observed between age and FSH and estradiol, r = 0.37 and 0.18, respectively; however, only estradiol shows statistical significance. Regarding TSH levels, no significant correlation was found between age and TSH (r = -0.096, p > 0.05).

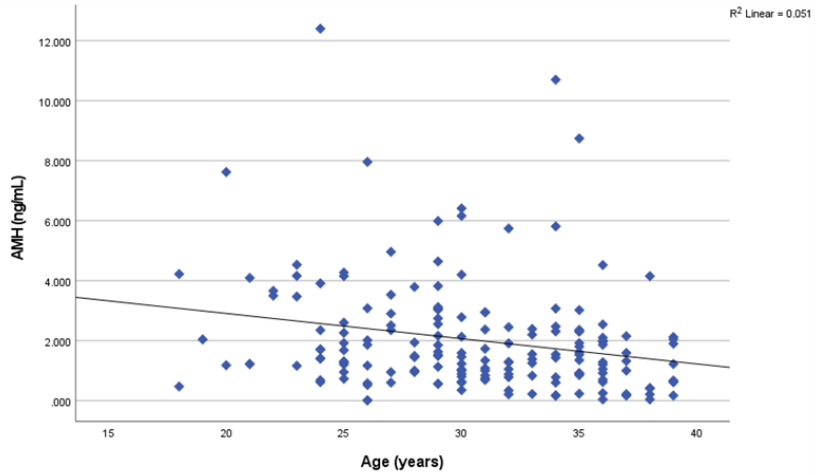

Figure 3. Scatterplot presentation of the linear relationship between age and AMH

3. Investigating age-related variations in hormonal profiles

To further understand age-related variations in hormonal profiles, the sample was divided into four categories based on age, and variations in hormonal profiles within the groups were studied (Table4). The Kruskal-Wallis test was utilized to determine the statistical significance of the difference between the 4 groups. (Figure 4) illustrates the age distribution of participants, with the largest share of participants falling within the middle adulthood (26-30) and (31-35) years, while the youngest and the oldest groups each accounted for 19.5%.

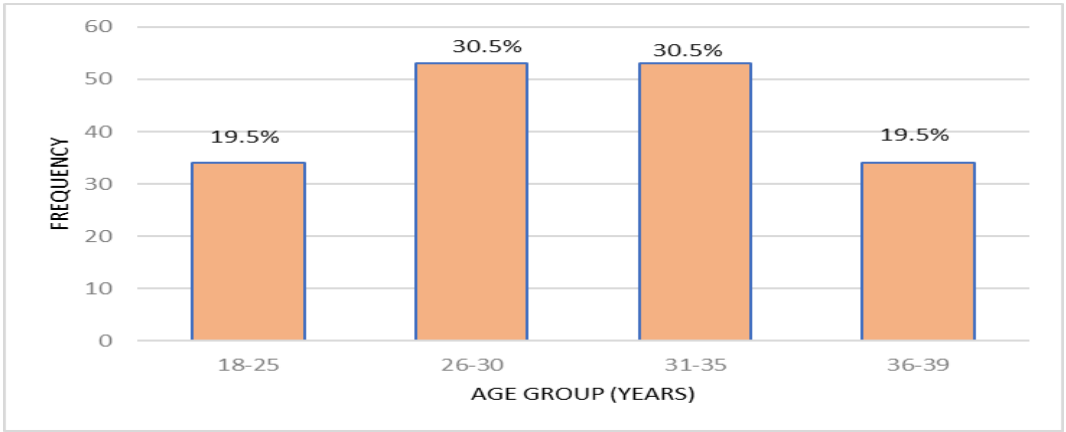

Figure 4. Age distribution of participants

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Table 2. Hormonal characteristics across age groups

Age (years)	18-25	26-30	31-35	36-39	p-value
AMH median (IQR)	1.85 (2.62)	1.63 (2.08)	1.38(1.46)	1.025 (1.53)	0.008 (<0.05)
FSH median (IQR)	8.13 (2.23)	7.615 (3.87)	8.08 (3.12)	7.71 (4.3)	> 0.05
Estradiol median (IQR)	51.04 (26.14)	52.05 (37.21)	48.04 (35.65)	54.73 (41.66)	> 0.05
TSH median (IQR)	1.68 (1.46)	1.55 (1.09)	1.78 (1.07)	1.74 (1.35)	> 0.05

The highest median value was observed in the youngest age group (18–25), and the lowest was in the oldest, with a p-value less than 0.05. This clearly demonstrates that AMH levels significantly decline with age, aligning with expected ovarian aging patterns and supporting the role of AMH as an OR marker. In regard to the other hormones, variations in FSH, Estradiol, and TSH levels were found statistically insignificant as all p-values were > 0.05, suggesting that medians remain relatively stable across these distinct age groups. which is clinically expected as critical hormonal changes usually occur later in the reproductive lifespan.

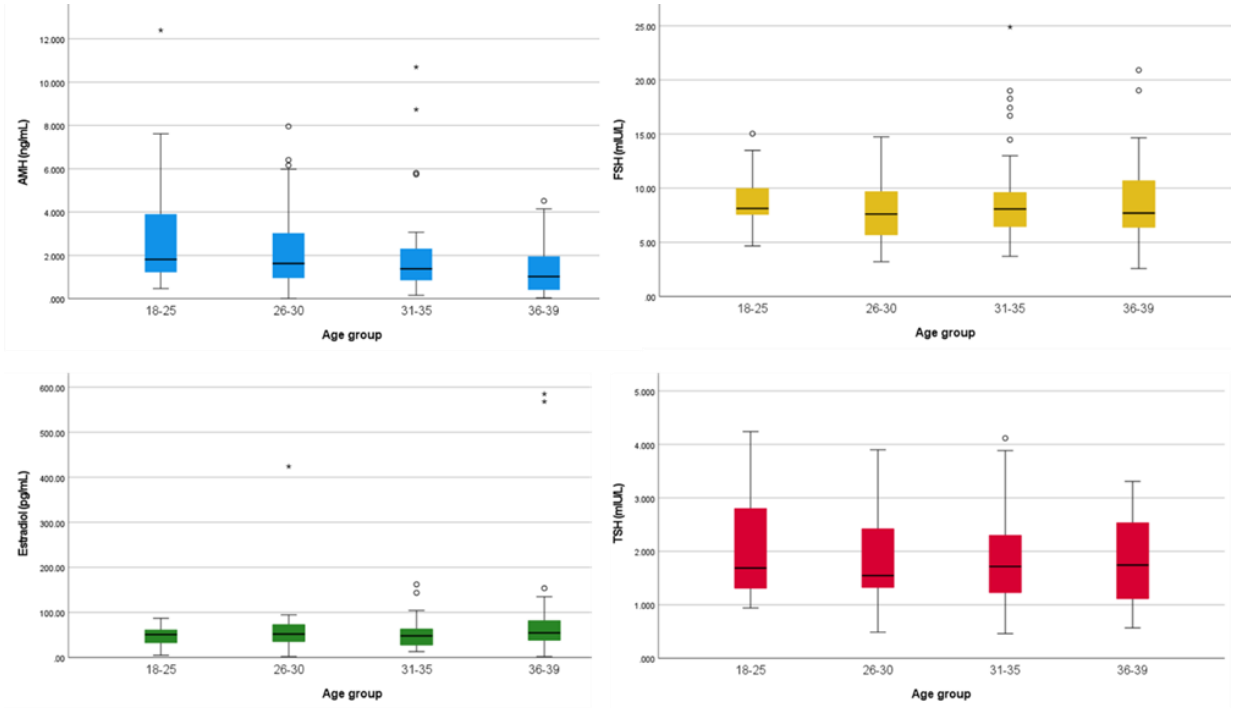

Figure 4. Boxplots representation of hormonal profiles among the reproductive age groups

(Figure 4) features box and whiskers representation of hormonal profiles among the reproductive age groups, with distinct colors assigned to each hormone. The AMH boxplots, depicted in blue, show a notable decline in levels from the youngest age group (18-25) to the oldest (36-39) as previously stated. Although the FSH profile, represented as yellow boxplots, maintains relatively stable levels across the age groups, a slight increase is observed in the oldest group, which suggests a potential diminished ovarian function. Estradiol, shown in green, displays comparable levels across all age groups, with few outliers in the oldest group indicating some fluctuation of ovarian activity. Lastly, the red boxes represent TSH hormonal levels, which exhibit a slight upward trend with age, particularly pronounced in the oldest age group; however, median and IQR are considered comparable in all groups. Overall, the decline in AMH with age is the most pronounced variation among all studied hormones across the different age cohorts.

Discussion

Although correlation results and categorization according to TSH cut off (2.5 mIU/L) did not support our hypothesis that high-normal TSH levels would be associated with lower AMH concentrations, they were similar to the findings of other retrospective studies with comparable sample size. For example, the study conducted by Wu J *et al.* (2021), r value (0.03) with p value (0.50), there was a very weak and non-significant correlation between the two variables [26]. Similarly, Demirci T *et al.* (2020) reported no correlation between AMH and TSH ($r \approx 0$, $p > 0.05$), which means that minor changes in thyroid function did not affect AMH [25]. On the other hand, studies with large sample sizes and prospective designs showed opposite results. One example is the case–control study comparing infertile women to fertile controls that found a negative correlation between AMH and TSH; the correlation coefficient was -0.361 with a p value of 0.036, indicating a statistically significant negative correlation [27]. Additionally, the study by Muge Halici *et al.* (2023), which included a total of 1,396 women aged 20–45 years, reported similar findings [24]. The discrepancy between results is likely attributable to differences in sample size, study design, and age distribution.

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The statistically significant negative correlation between age and AMH indicates that as women in this sample get older, their OR decline, which is consistent with the physiological aging of the ovaries. The strength of the correlation is not strong, possibly due to the age of the tested sample, as all participants are less than 40 years old and therefore expected to retain relatively good reproductive function. This interpretation is supported by the nonsignificant weak positive correlation observed between age and FSH levels. Moreover, the significant weak positive correlation between estradiol and age may reflect the reported physiological fluctuations or compensatory activation of the hypothalamic-pituitary-ovarian axis as a response to OR decline even in women under the age of 40 [28].

No significant correlation was observed between TSH and age in our sample, which might be due to the younger age range of subjects, as age-related decline in thyroid function becomes more pronounced at later ages. These findings align with [26], whereas [24] reported a significant variation with age ($p = 0.038$) in a slightly different population (age 20-45). Importantly, all studies demonstrate a decline in AMH with age, making it a crucial determinant of women's reproductive capacity in euthyroid infertile women under 40 years, whereas TSH level may be of limited value in this context. A major limitation of our study was the retrospective design and the lack of some important measurements, such as AFC and TAI analysis. Future research with larger samples and a prospective design is strongly recommended in order to clarify the relationship between AMH and TSH among euthyroid infertile women.

Conclusion

The study concluded that TSH levels are not predictive of OR in euthyroid infertile females, as no association was observed between TSH levels and OR markers. In contrast, age was identified as a key factor influencing the AMH levels. These findings suggest that TSH evaluation in euthyroid females may have limited value when assessing OR, whereas age should be considered as a critical factor in patient counseling and planning reproductive treatment strategies. Further research is required to clarify the relationship between TSH and OR markers among women with intact thyroid function.

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Conflicts of Interest. *Nil*

Reference

1. Abbas EM, Saleh BO, Al Juboori OM. Effect of hypothyroidism on ovarian reserve status in Iraqi women: hormonal study. Bionatura. 2023;8:1–8. Available from: http://dx.doi.org/10.21931/rb/css/2023.08.02.17
2. Aghajanova L, Lindeberg M, Carlsson IB, Stavreus-Evers A, Zhang P, Scott JE, et al. Receptors for thyroid-stimulating hormone and thyroid hormones in human ovarian tissue. Reprod Biomed Online. 2009 Mar;18(3):337-47. Available from: http://dx.doi.org/10.1016/s1472-6483(10)60091-0
3. Burger HG. Hormonal changes in the menopause transition. Recent Prog Horm Res. 2002;57:257-75. Available from: http://dx.doi.org/10.1210/rp.57.1.257
4. Deadmond A, Koch CA, Parry JP. Ovarian Reserve Testing. In: Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. 2022 Dec 21. Available from: https://www.ncbi.nlm.nih.gov/books/NBK279058/
5. Demirci T, Apaydin M. The Effect of TSH Level on Ovarian Reserve in Women in The Reproductive Period. Kırıkkale Üniversitesi Tıp Fakültesi Dergisi. 2020;22(3):370-6. Available from: http://dx.doi.org/10.24938/kutfd.809017
6. El-Jabu H, et al. Prediction of Premature Ovarian Insufficiency and prevalence of medical diseases. Global Journal of Fertility and Research. 2019;4(1):19-22. Available from: https://dx.doi.org/10.17352/gjfr
7. Halici M, Seker ME, Gebedek IY, Gokbak MN, Cetisli AF, Ciftci AB, et al. Thyroid hormones and ovarian reserve: a comprehensive study of women seeking infertility care. BMC Womens Health. 2023 Nov 3;23(1):570. Available from: http://dx.doi.org/10.1186/s12905-023-02725-1
8. Hao Y, Wang Y, Yan L, Xu X, Chen D, Zhao Y, et al. Synthetic phenolic antioxidants and their metabolites in follicular fluid and association with diminished ovarian reserve: A case-control study. Environ Health Perspect. 2023 Jun;131(6):067005. Available from: http://dx.doi.org/10.1289/EHP11309
9. Hasegawa Y, Kitahara Y, Osuka S, Tsukui Y, Kobayashi M, Iwase A. Effect of hypothyroidism and thyroid autoimmunity on the ovarian reserve: A systematic review and meta-analysis. Reprod Med Biol. 2022 Jan 20;21(1):e12427. Available from: http://dx.doi.org/10.1002/rmb2.12427
10. Hiraoka T, Wada-Hiraike O, Hirota Y, Hirata T, Koga K, Osuga Y, et al. The impact of elevated thyroid stimulating hormone on female subfertility. Reprod Med Biol. 2016 Feb 10;15(2):121-6. Available from: http://dx.doi.org/10.1007/s12522-015-0221-9
11. 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. Fertil Steril. 2010 Dec;94(7):2846-9. Available from: http://dx.doi.org/10.1016/j.fertnstert.2010.06.010

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12. Jin L, Wang M, Yue J, Zhu GJ, Zhang B. Association between TSH level and pregnancy outcomes in euthyroid women undergoing IVF/ICSI: A retrospective study and meta-analysis. Curr Med Sci. 2019 Aug;39(4):631-637. Available from: http://dx.doi.org/10.1007/s11596-019-2084-5
13. Kabodmehri R, Sharami SH, Sorouri ZZ, Gashti NG, Milani F, Chaypaz Z, et al. The relationship between thyroid function and ovarian reserve: a prospective cross-sectional study. Thyroid Res. 2021 Oct 9;14(1):22. Available from: http://dx.doi.org/10.1186/s13044-021-00112-2
14. Koysombat K, Abbara A, Dhillo WS. Current pharmacotherapy and future directions for neuroendocrine causes of female infertility. Expert Opin Pharmacother. 2023 Jan;24(1):37-47. Available from: http://dx.doi.org/10.1080/14656566.2022.2064217
15. Kuroda K, Uchida T, Nagai S, Ozaki R, Yamaguchi T, Sato Y, et al. Elevated serum thyroid-stimulating hormone is associated with decreased anti-Müllerian hormone in infertile women of reproductive age. J Assist Reprod Genet. 2015 Feb;32(2):243-7. Available from: http://dx.doi.org/10.1007/s10815-014-0397-7
16. Liu Y, Pan Z, Wu Y, Song J, Chen J. Comparison of anti-Müllerian hormone and antral follicle count in the prediction of ovarian response: a systematic review and meta-analysis. J Ovarian Res. 2023 Jun 19;16(1):117. Available from: http://dx.doi.org/10.1186/s13048-023-01202-5
17. Mazzilli R, Medenica S, Di Tommaso AM, Fabozzi G, Zamponi V, Cimadomo D, et al. The role of thyroid function in female and male infertility: a narrative review. J Endocrinol Invest. 2023 Jan;46(1):15-26. Available from: http://dx.doi.org/10.1007/s40618-022-01883-7
18. Mintziori G, Goulis DG, Kolibianakis EM. Thyroid function and IVF outcome: When to investigate and when to intervene? Curr Opin Obstet Gynecol. 2016 Jun;28(3):191-7. Available from: http://dx.doi.org/10.1097/GCO.0000000000000263
19. Rao M, Wang H, Zhao S, Liu J, Wen Y, Wu Z, et al. Subclinical hypothyroidism is associated with lower ovarian reserve in women aged 35 years or older. Thyroid. 2020 Jan;30(1):95-105. Available from: http://dx.doi.org/10.1089/thy.2019.0031
20. Subedi N, Pant PR, Subedi N. Correlation of serum TSH with ovarian reserve in patients of infertility: A retrospective study. J Gyneco Obstet Res. 2023;1(1):1-2. Available from: http://dx.org/10.61440/JGOR.2023.v1.07
21. Sun Y, Fang Y, Xu M, Liu Y. Relationship between thyroid antibody levels and ovarian reserve function in infertile chinese women with normal thyroid-stimulating hormone. J Ovarian Res. 2023 Sep 4;16(1):100. Available from: http://dx.doi.org/10.1186/s13048-023-01174-6
22. Weghofer A, Barad DH, Darmon S, Kushnir VA, Gleicher N. What affects functional ovarian reserve, thyroid function or thyroid autoimmunity? Reprod Biol Endocrinol. 2016 Apr 26;14:26. Available from: http://dx.doi.org/10.1186/s12958-016-0162-0
23. World Health Organization. Infertility [Internet]. World Health Organization. 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/infertility
24. World Health Organization. 1 in 6 people globally affected by infertility: WHO [Internet]. World Health Organization: WHO; 2023. Available from: https://www.who.int/news/item/04-04-2023-1-in-6-people-globally-affected-by-infertility/
25. Wu J, Zhao YJ, Wang M, Tang MQ, Liu YF. Correlation analysis between ovarian reserve and thyroid hormone levels in infertile women of reproductive age. Front Endocrinol (Lausanne). 2021 Sep 13;12:745199. Available from: http://dx.doi.org/10.3389/fendo.2021.745199
26. Xu X, Hao Y, Zhong Q, Hang J, Zhao Y, Qiao J. Low KLOTHO level related to aging is associated with diminished ovarian reserve. Fertil Steril. 2020 Dec;114(6):1250-1255. Available from: http://dx.doi.org/10.1016/j.fertnstert.2020.06.035
27. Zhang Q, Zhang D, Liu H, Fu J, Tang L, Rao M. Associations between a normal-range free thyroxine concentration and ovarian reserve in infertile women undergoing treatment via assisted reproductive technology. Reprod Biol Endocrinol. 2024 Jun 18;22(1):72. Available from: http://dx.doi.org/10.1186/s12958-024-01226-6
28. Zhu Q, Li Y, Ma J, Ma H, Liang X. Potential factors result in diminished ovarian reserve: a comprehensive review. J Ovarian Res. 2023 Oct 3;16(1):208. Available from: http://dx.doi.org/10.1186/s13048-023-01296-x

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