AL-KUNOOZE SCIENTIFIC JOURNAL
Vol.11 No. 2 (2025)
ISSN 2706-6231 (ONLINE)
ISSN 2706-6223 (PRINT)

Comparison study of AMH levels and BMI in polycystic ovary syndrome patients

Nadia Kadhem fakher[1] and Samah Amer Hammood[1]

[1]*College of Science, University of Kufa, Najaf, Iraq*[1]

Corresponding Author Email Address: nadiak.alkhafaji@student.uokufa.edu.iq

ORCID ID:

Abstract

The ovarian follicles generate the hormone known as AMH (Anti-Müllerian hormone). The hormone AMH shows higher levels in patients who have polycystic ovary syndrome (PCOS). The research investigates the connection between AMH hormone levels in PCOS patients through hormone analysis of women with the syndrome versus a control group. AMH levels are measured to assess the ovary's capacity to generate eggs, which is advantageous for reproductive treatments, and to diagnose PCOS by identifying an increased number of tiny follicles. The current study included 90 Iraqi women (aged 18-40 years): 46 with PCOS and a control group of 44 healthy women. Blood samples were taken from the study participants to evaluate the levels of certain hormones, including AMH, LH, E2, insulin. Blood samples were collected during the early follicular phase of the menstrual cycle (days 2–5) to ensure hormonal consistency. The following parameters were studied: AMH levels were significantly elevated in both normal weight and overweight/obese PCOS women compared to their respective control groups. This is a hallmark of PCOS, reflecting increased ovarian follicle count. AMH levels (ng/ml) were significantly higher in women with PCOS compared to normal weight controls ($p = 0.015$), indicating a strong association between elevated AMH and PCOS

Keywords: Polycystic ovary syndrome, BMI, Hormone disorder, AMH

Introduction

Polycystic ovarian syndrome exists as a common endocrine condition that develops in 5–18% of women within their reproductive years [1]. Polycystic ovarian syndrome is a complex disorder that affects women differently throughout their lives and includes symptoms related to metabolism, endocrine function, reproduction, and psychological aspects [2]. The Rotterdam criteria state that in order to diagnose PCOS, at least two of the three requirements listed below must be met: ovulatory dysfunction (OD) and/or irregular menstruation; biochemical and/or clinical hyperandrogenism; and polycystic ovary morphology (PCOM) [3]. AMH has been suggested as a reliable marker of PCOM due to its strong association with increased follicle number [4]. Anti-Müllerian hormone (AMH) emerges from the theca and granulosa cells of the ovaries, which belong to the TGF-β superfamily. The ovarian folliculogenesis process falls under the control of AMH [5]. The levels of AMH secretion tend to be higher in PCOS patient ovaries than in normal ovarian tissue. Research indicates that AMH stops FSH from activating aromatase while simultaneously blocking FSH's cell growth stimulation, thus reducing estradiol production. This imbalance suggests that PCOS and anovulation are most likely caused by high AMH levels [6]. AMH is believed to be a key factor in the disease's genesis since it can prevent primary follicle development and recruitment, which leads to follicular stoppage [7]. High body mass index, a crucial sign of obesity, has a complicated and multidimensional relationship with PCOS. Hormonal abnormalities in PCOS patients are generally closely linked to high BMI. A higher body mass index results in higher testosterone levels, which are linked to a worse metabolic profile [8].

Methodology

Experimental design

These samples were carefully collected from two main sites: the Fertility Center in Najaf Governorate and Bint Al-Huda Teaching Hospital in Nasiriyah Governorate. The data collection process spanned a specific period, from November 2024 to January 2025, allowing us to collect sufficient samples. The research sample consisted of 90 women between 18 and 45 years old who were split into two groups containing 46 women with PCOS based on Rotterdam criteria diagnosis and 44 women without any hormonal disorders or PCOS. Blood serum samples were collected from all participants, along with demographic and clinical data, such as age, weight, height, medical history, family history, lifestyle, and symptoms. Women in the study were classified based on their body mass index (BMI). Normal-weight women were defined by specific BMI values, while overweight or obese women were classified based on other BMI criteria. Weight and height were measured using precise instruments, and BMI was then calculated based on these criteria. The serum samples were measured for hormone levels using a commercially available ELISA assay from (Bio Tek, U.S.A.) following the manufacturer’s instructions.

Ethical approval:

was obtained from the relevant committee, and all participants provided informed consent before participation.

Diagnosis of PCOS

A gynecologist diagnosed all participants.To check for PCOS, a number of tests are conducted, including as blood tests and hormone testing to measure the body's levels of hormones like (FSH, LH, Testo., Prog., E2, and Prol ,AMH). Examine the ovaries and confirm the presence of multiple cysts,the presence of ovarian cysts that are several times the normal size in PCOS. Ultrasound can also detect changes in the

ovaries and the thickness of the uterine lining of women with PCOS.

Collection of blood samples

When collecting blood samples, we first draw 5 ml of blood using a sterile syringe. The sample is left at room temperature for 30 to 60 minutes to allow the blood to clot naturally. A centrifuge process lasting 10 to 15 minutes at 3,000 rpm produces a separation between serum and cells. The serum is drawn using a sterile microbead and placed in sterile Eppendorf tubes.

Samples are frozen at -20°C or -80°C to preserve them until they are used for analysis. Dividing the serum into several small samples is preferable to avoid repeated freezing and thawing. Each sample must be placed in a tube labeled with the patient's information, such as the name and sample number.

Statistical analysis

The researchers conducted statistical analyses through SPSS version 28.0 (SPSS Inc., Chicago, IL, USA). The statistical analysis employed analysis of covariance to compare clinical data presented as mean ± SD for normal variables or median and interquartile range (IQR) for skewed data. Independent T-tests were used to compare the means of two independent groups.

Result

Table (1) Women with PCOS had significantly higher levels of LH, AMH, prolactin, E2, TSH, and insulin, but significantly lower levels of progesterone. There were no discernible statistically significant variations in the two groups' FSH levels.

BMI and hormonal levels

The data show in table (2) the impact of BMI status (normal weight vs. overweight/obese) on hormonal levels in both PCOS women and control women at $p \leq 0.05$.

BMI and LH levels

The LH (mIU/ml) levels in PCOS women show a significant $p \leq 0.05$ increase in the overweight/obese group. The BMI categories among control women show no significant differences regarding LH levels.

BMI and FSH levels

In PCOS women, FSH (mIU/ml) levels show a statistically significant ($p \leq 0.05$) increase in the normal-weight group compared to other BMI categories. Among control women, FSH levels remain consistent across different BMI categories.

BMI and AMH levels

The AMH (ng/ml) level of PCOS women shows a statistically significant $p \leq 0.05$ increase in the overweight/obese group. The BMI categories for control women do not produce any meaningful difference in AMH levels.

BMI and Prolactin levels

The Prolactin (ng/ml) levels in PCOS women show a significant $p \leq 0.05$ increase in the overweight/obese group. The Prolactin levels in control women remain similar across different BMI categories.

BMI and E2 levels

Results show that PCOS women in the overweight/obese category have elevated E2 (pg/ml) levels when compared to the other BMI groups at $p \leq 0.05$ significance. The E2 levels of control women do not show any meaningful difference between BMI categories.

Table (1): Impact of Hormones in PCOS compared to Healthy Women

Parameter	Group	Mean ± SD	Median (IQR)	P-value
LH (mIU/ml)	PCOS Women	5.15 ± 3.33	3.61 (2.57-6.7)	**0.0001***
	Controls Women	3.04 ± 1.26	2.39 (1.97-4.46)	
FSH (mIU/ml)	PCOS Women	4.93 ± 1.75	4.73 (3.96-5.99)	**0.141 NS**
	Controls Women	5.51 ± 1.94	5.07 (4.22-6.23)	
AMH (ng/ml)	PCOS Women	5.54 ± 2.52	4.9 (3.08-7.7)	**0.0001***
	Controls Women	2.25 ± 0.9	2 (1.64-3)	
Prolactin (ng/ml)	PCOS Women	26.33 ± 9.16	29.35 (17.98-33.9)	**0.014***
	Controls Women	21.99 ± 7.08	21 (16.28-26.08)	
E2 (pg/ml)	PCOS Women	52.85 ± 17.08	48.72 (40.62-68.63)	**0.0001***
	Controls Women	37.82 ± 14.44	35.31 (29.93-41.89)	
Progesterone (ng/ml)	PCOS Women	1.26 ± 0.76	1.18 (0.65-1.76)	**0.0001***
	Controls Women	4.28 ± 2.38	3.91 (1.99-6.88)	
TSH (uIU/ml)	PCOS Women	4.53 ± 1.36	4.4 (3.35-5.47)	**0.0001***
	Controls Women	1.96 ± 0.53	2.12 (1.45-2.37)	
Insulin (µU/mL)	PCOS Women	60.03 ± 17.93	58.5 (44-77.25)	**0.0001***
	Controls Women	4.36 ± 1.82	4 (2.72-6.15)	

**** Significant differences at p-value≤ 0.05. Median (IQR) inter quartile range. Independent t-test . NS: non-significant.***

BMI and Progesterone levels

The Progesterone (ng/ml) levels in PCOS women show no significant $p \leq 0.05$ difference between BMI categories. The Progesterone levels among control women remain unaffected by BMI categories.

BMI and TSH levels

The current study revealed that TSH (uIU/ml) levels were significantly higher ($p \leq 0.05$) in PCOS patients who were overweight or obese compared to lean PCOS patients. In contrast, TSH levels among control women remained relatively stable across all BMI categories, indicating that the observed TSH elevation is more specific to PCOS in the context of increased body weight.

Discussion

The AMH levels of PCOS patients exceeded those of controls in every BMI category, including normal weight, overweight, and obesity. Previous research has highlighted the significance of elevated AMH as a reliable biomarker for PCOS diagnosis since this hormone elevation is linked to the growth of more tiny antral follicles, which usually results in PCOS morphology [9]. The current research findings supported previous observations by demonstrating higher AMH levels in PCOS patients than controls.

Currently, more than one-third of people worldwide suffer from overweight or obesity [10]. AMH levels, which are frequently used to evaluate the ovarian follicular pool and predict responsiveness to gonadotropin stimulation, may be influenced by body mass. Fecundity and in vitro fertilization (IVF) success are known to be compromised in obese women; one study revealed that the number of oocytes recovered per IVF cycle decreased as BMI rose and that women with obesity also had a reduced continuing pregnancy rate per cycle [11]. There is an interaction link between PCOS and BMI. Higher BMI was linked to worsened PCOS development and progression; research revealed that the probability of PCOS increased considerably for every standard deviation rise in BMI [12]. Some recent studies suggest that the relationship between AMH and obesity in

Table (2): Impact of BMI on of Hormones in PCOS compared to Healthy Women

Parameters	BMI Status	PCOS Women		Controls Women	
		Mean ± SD	P-value	Mean ± SD	P-value
LH (mIU/ml)	Normal weight	3.49±1.4	**0.013***	2.99±1.22	**0.695**
	Overweight/ Obesity	5.5±3.52		3.15±1.37	
FSH (mIU/ml)	Normal weight	6.03±1.07	**0.049***	5.28±1.84	**0.285**
	Overweight/ Obesity	4.7±1.78		5.95±2.13	
AMH (ng/ml)	Normal weight	3.84±1.74	**0.015***	2.31±0.97	**0.586**
	Overweight/ Obesity	5.9±2.53		2.15±0.77	
Prolactin (ng/ml)	Normal weight	19.77±6.08	**0.008***	21.51±7.37	**0.535**
	Overweight/ Obesity	27.71±9.15		22.93±6.62	
E2 (pg/ml)	Normal weight	36.57±8.01	**0.001***	36.44±13.46	**0.383**
	Overweight/ Obesity	56.27±16.54		40.5±16.33	
Progesterone (ng/ml)	Normal weight	1.43±1.02	**0.502 NS**	3.9±2.36	**0.150**
	Overweight/ Obesity	1.23±0.71		5±2.33	
TSH (uIU/ml).	Normal weight	3.73±0.71	**0.010***	1.9±0.56	**0.369**
	Overweight/ Obesity	4.7±1.41		2.06±0.46	
Insulin (µU/mL)	Normal weight	45.58±10.73	**0.002***	4.15±1.83	**0.296**
	Overweight/ Obesity	63.07±17.74		4.76±1.79	

**** Significant differences at p-value≤ 0.05. Median (IQR) inter quartile range. Independent t-test . NS: non-significant.***

PCOS patients may be more complex than it appears. Although AMH is often elevated in PCOS, severe obesity may negatively impact AMH levels due to hormonal and inflammatory changes associated with increased body fat. For example, Keane et al., [13]. demonstrated that AMH levels may be lower in obese PCOS patients compared to non-obese patients, suggesting a potential adverse effect of obesity on ovarian AMH production.

Furthermore, obesity may increase insulin resistance, a key factor in the development of PCOS, and may contribute to increased severity of symptoms such as anovulation and increased androgen levels, thereby affecting oocyte quality and ovarian response to stimulation [14]. This supports the idea that weight control may be an

important tool for improving fertility outcomes in women with PCOS, even in cases where AMH is elevated. Furthermore, studies such as Radin et al., [15]. emphasize that focusing solely on AMH as a diagnostic indicator without taking into account weight-related factors may lead to inaccurate estimation of ovarian reserve, especially in obese women, highlighting the importance of a comprehensive approach to assessment and treatment.

Conclusion

The research results demonstrate a strong relationship between anti-Müllerian hormone (AMH) measurements and polycystic ovarian syndrome (PCOS). The AMH levels of women with PCOS exceeded those of control groups, which demonstrated both an enlarged ovarian follicle reserve and abnormal follicle development. This elevation suggests that PCOS patients have an underlying hormonal imbalance characterized by excessive follicular activity and impaired ovulation. Furthermore, the elevated AMH levels in PCOS patients help maintain anovulation and ovarian dysfunction, which strengthens its status as a primary biomarker for the condition.

References:

1- Joham, A.E.; Norman, R.J.; Stener-Victorin, E.; Legro, R.S.; Franks, S.; Moran, L.J.; Boyle, J.; Teede, H.J. Polycystic ovary syndrome. Lancet Diabetes Endocrinol. 2022; 10, 668–680.

2- Neven ACH, Laven J, Teede HJ, Boyle JA. A summary on polycys-tic ovary syndrome: diagnostic criteria, prevalence, clinical manifestations, and management according to the latest international guidelines. Semin Reprod Med. 2018;36(1):5-12.

3- Rotterdam ESHRE/ASRM-Sponsored PCOS consensus workshop group. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS). Hum Reprod. 2004;19(1):41-47.

4- Dietz de Loos A, Hund M, Buck K, Meun C, Sillman J, Laven JSE. Antimüllerian hormone to determine polycystic ovarian morph-ology. Fertil Steril. 2021;116(4):1149-1157.

5- ALmeida, F. R., Costermans, N. G., Soede, N. M., Bunschoten, A., Keijer, J., Kemp, B. & Teerds, K. Presence of anti-Müllerian hormone (AMH) during follicular development in the porcine ovary. PLoS One,2018; 13, e0197894.

6-Simons, P. I., Valkenburg, O., Bons, J. A., Stehouwer, C. D. & Brouwers, M. C.The relationships of sex hormone-binding globulin, total testosterone, androstenedione and free testosterone with metabolic and reproductive features of polycystic ovary syndrome. Endocrinol Diabetes Metab J,2021; 4, e00267.

7- Garg D, Tal R. The role of AMH in the pathophysiology of polycystic ovarian syndrome. Reprod Biomed Online. 2016; 33(1):15–28.

8- Lazúrová, I., Lazúrová, Z., Figurová, J., Ujházi, S., Dravecká, I., Mašlanková, J. & Mareková, M. Relationship between steroid hormones and metabolic profile in women with polycystic ovary syndrome. Physiol. Res,2019; 68.

9- Tsukui, Y., Kitahara, Y., Hasegawa, Y., Kobayashi, M., Osuka, S. & Iwase, A. Anti-Müllerian hormone levels in the diagnosis of adolescent polycystic ovarian syndrome: a systematic review and meta-analysis. Endocr. J., 2022; 69, 897-906.

10- Hruby A, Hu FB. The epidemiology of obesity: a big picture.Pharmacoeconomics. 2015;33(7):673-689. doi:10.1007/s40273-014-0243-x.

11- Pinborg A, Gaarslev C, Hougaard CO, et al. Influence of female bodyweight on IVF outcome: a longitudinal multicentre cohort study of 487 infertile couples. Reprod Biomed Online. 2011;23(4):490-499. doi:10.1016/j.rbmo.2011.06.010.

12-Brower, M., Hai, Y., Jones, M., Guo, X., Chen, Y.-D., Rotter, J., Krauss, R., Legro, R., Azziz, R. & Goodarzi, M. Bidirectional Mendelian randomization to explore the causal relationships between body mass index and polycystic ovary syndrome. Hum Reprod,2019; 34, 127-136.

13- Keane, K. N., et al. The effect of obesity on anti-Müllerian hormone levels in women with and without polycystic ovary syndrome. Reproduction,2017; 153(5), 651–658. https://doi.org/10.1530/REP-16-0645.

14- Lim, S. S., et al. Overweight, obesity and central obesity in women with polycystic ovary syndrome: A systematic review and meta-analysis. Human Reproduction Update,2012; 18(6), 618–637. https://doi.org/10.1093/humupd/dms030.

15- Radin, R. G., et al. Anti-Müllerian hormone as a reproductive biomarker: Considerations of its use in clinical practice. Fertility and Sterility,2015; 103(5), 1159–1170. https://doi.org/10.1016/j.fertnstert.2015.03.002.

ومؤشر كتلة الجسم لدى مرضى متلازمة تكيس المبايض

دراسة مقارنة لمستويات هرمون (AMH)

ناديه كاظم فاخر قسم تحليلات مرضيه في جامعة الكوفة كليه العلوم و سماح عامر حمود - جامعة الكوفة

الخلاصة :

مستويات أعلى لدى المرضى الذين AMH (هرمون مضاد لمولر). يُظهر هرمون AMHتنتج بصيلات المبيض هرمونًا يُعرف باسم لدى مرضى متلازمة تكيس AMH). يبحث البحث في العلاقة بين مستويات هرمون PCOSيعانون من متلازمة تكيس المبايض (لتقييم قدرة AMHالمبايض من خلال تحليل الهرمونات لدى النساء المصابات بالمتلازمة مقابل مجموعة ضابطة. يتم قياس مستويات المبيض على إنتاج البويضات، وهو أمر مفيد للعلاجات الإنجابية، ولتشخيص متلازمة تكيس المبايض من خلال تحديد عدد متزايد من البصيلات الصغيرة. شملت الدراسة الحالية 90 امرأة عراقية (تتراوح أعمارهن بين 18 و40 عامًا): 46 مصابة بمتلازمة تكيس المبايض ومجموعة ضابطة من 44 امرأة سليمة. تم أخذ عينات دم من المشاركات في الدراسة لتقييم مستويات هرمونات معينة، بما في والأنسولين. تم جمع عينات الدم خلال المرحلة الجريبية المبكرة من الدورة الشهرية (الأيام 2-5) لضمان E2 وLH وAMHذلك بشكل ملحوظ لدى كلٍّ من النساء ذوات الوزن الطبيعي AMHالاتساق الهرموني. دُرست المعايير التالية: ارتفعت مستويات هرمون والنساء ذوات الوزن الزائد/السمنة في متلازمة تكيس المبايض، مقارنةً بمجموعاتهن الضابطة. يُعدّ هذا من السمات المميزة لمتلازمة (نانوغرام/مل) أعلى بشكل ملحوظ لدى النساء AMHتكيس المبايض، إذ يعكس زيادة في عدد بصيلات المبيض. كانت مستويات المصابات بمتلازمة تكيس المبايض مقارنةً بالمجموعة الضابطة ذات الوزن الطبيعي (ص = 0.015)، مما يشير إلى وجود ارتباط قوي ومتلازمة تكيس المبايض.AMHبين ارتفاع

كلمات مفتاحيه :متلازمة تكيس المبايض، مؤشر كتلة الجسم، اضطراب الهرمونات، هرمون مضاد مولر