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Murtadha D. Mohsin
Department of Physiology, College of Medicine, University of Babylon, Babil, Iraq, Murtadha.dhiaa@gmail.com

Ban J. Edan
Department of Physiology, College of Medicine, University of Babylon, Babil, Iraq, med.ban.edan@uobabylon.edu.iq

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ORIGINAL STUDY

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Impact of Physical Activity and Body Size on Serum Level of Anti-Müllerian Hormone in Women in Babylon Province

Murtadha D. Mohsin *, Ban J. Edan

Department of Physiology, College of Medicine, University of Babylon, Babil, Iraq

Abstract

Background: Anti-Müllerian hormone (AMH) is a glycoprotein produced by granulosa cells and has gained recognition as the most dependable serum biomarker for assessing ovarian reserve. AMH levels serve as an indicator of the quantity of primordial follicles and their likely response to external gonadotropins. Obesity may impact female fertility through direct harm to oocyte health and differentiation or by indirectly interfering with the pituitary-hypothalamic axis, leading to dysfunctional oogenesis.

Objectives: This study aims to evaluate the role of physical activity and body size on serum AMH levels in women.

Patients and Methods: A cross-sectional study was carried out on 150 women aged between 19 and 40 (31.43 ± 5.38 years). Women were collected from a dietary clinic in Al-Emam Al-Sadeq Teaching Hospital and from a private clinic (from September 2023 to March 2024). Physical Activity questionnaire was done and Body measurements such as height (cm), weight (kg), arm circumference, thigh circumference, hip circumference, and waist circumference (cm) were recorded, and basal metabolic rate was calculated. At cycle day 2 or 3, blood was collected to measure AMH using an AMH Kit.

Results: Anti-Müllerian hormone (AMH) Level was measured in the study group. AMH levels were insignificantly lower in overweight and obese patients than in the normal weight group (P = 0.39). The logistic regression was done to know the effect of Physical activity on AMH level, there was an insignificant relation between physical activity and AMH level (P=0.28). There was a significant negative correlation between AMH and waist circumferences (P = 0.001, r (correlation coefficient) = −0.66). Also, there was an insignificant correlation between AMH with body mass index (BMI) and other body circumferences.

Conclusion: Our research identified an inverse relationship between AMH and thigh circumference, with no associations observed for other body measures or physical activity.

Keywords: Body mass index, Anti-Mullerian hormone, Physical activity, Body circumferences

1. Introduction

The gonadal hormone, known as anti-Müllerian hormone (AMH), is one of many hormones classified within the transforming growth factor-β (TGF-β) superfamily. This glycoprotein is produced by granulosa cells and has gained recognition as the most dependable serum biomarker for assessing ovarian reserve. AMH levels offer a clue about the quantity of primordial follicles and their likely response to external gonadotropins [1].

AMH plays a major role in prenatal gonadal sex differentiation as it inhibits the development of Müllerian ducts in males [2]. Even in the earliest stages of ovarian development (primordial follicles), both granulosa cells and theca cells within the follicle produce AMH, although at relatively low levels. However, significantly elevated levels of AMH, measurable in the bloodstream, are detected in preantral and small antral follicles typically ranging from 2 to 4 millimeters in diameter [3].

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* Corresponding author.
E-mail addresses: Murtadha.dhiaa@gmail.com (M. D. Mohsin), med.ban.edan@uobabylon.edu.iq (B. J. Edan).

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The amount of AMH in the blood (serum AMH concentration) is a good indicator of a woman's remaining egg supply (follicle pool). This is especially true for the number of antral follicles early in the menstrual cycle (follicular phase) [3–5].

In simple terms, WHO defines physical activity (PA) as any bodily movement that uses your muscles and burns energy [6] and recommends more than 150 minutes of High-intensity physical activity per week for overall health benefits [7]. Physical activity (PA) might help with fertility through various biological and physiological mechanisms. These include boosting the body's natural defenses against cell damage (antioxidant defenses) and reducing inflammation throughout the body (fluids, organs, and tissues) [8, 9]. Diets high in calories (hypercaloric diets) are often linked to obesity, diabetes, and high blood fat levels (hyperlipidemia). These conditions are suspected culprits behind fertility issues in women. They might directly harm the quality and development of egg cells (oocyte health and differentiation). Additionally, these factors could indirectly disrupt the communication system in the brain (pituitary-hypothalamic axis) responsible for regulating ovulation, leading to dysfunctional oogenesis (egg cell production) [10].

Previous studies have highlighted the critical role of AMH in fertility. Research has shown conflicting results regarding the relationship between AMH levels and physical activity. Some studies suggest that regular physical activity may enhance AMH levels [11], while others have found no significant changes in AMH levels [12–14]. Moreover, investigations into the correlation between obesity and AMH levels have produced inconsistent findings. Some research indicates no significant differences in AMH concentrations between obese and non-obese women [15, 16]. However, other studies have identified a connection between obesity and lower AMH levels [17, 18]. However, existing research on the combined effects of physical activity and body size on AMH levels remains inconclusive. While some studies suggest a potential link, others haven't shown a clear association. This lack of consensus highlights the need for further investigation in this area.

Therefore, this study aims to investigate the relationship between physical activity, body size, and serum AMH levels in women. We hypothesize that women who engage in regular physical activity and maintain a healthy weight will have higher serum AMH levels compared to those who are less active or have a higher body mass index (BMI).

2. Patients and methods

In our cross-sectional study, the study participants were recruited throughout the period from September 2023 to March 2024. The sample population consisted of women attending a dietary clinic at Al-Emam Al-Saddeq Teaching Hospital and a private clinic. This research was conducted with the ethical approval of Babylon University, and all 150 women voluntarily agreed to participate (verbal consent). All of them were recruited according to the following criteria:

- Non-smokers
- Not pregnant
- Free from hepatitis and HIV (by screening test)
- Absence of any metabolic or endocrine diseases, like hyperprolactinemia, thyroid dysfunction and
- Any other associated condition that could alter the level of hormones like malignancy and antioxidant therapy.

Physical Activity questionnaire: which involved: Sport training: type, duration, frequency; walk: duration per day; Running: duration per day; and any other sport? duration per day. Physical activity can be quantified using the following formula [19]:

$$\begin{aligned}&\text{Physical Activity Score}\\&\quad = \Sigma\ (\text{MET (Metabolic Equivalent of Task)}\\&\quad \text{value of activity} \times \text{Duration of activity in hours}\\&\quad \times \text{frequency})\ [19].\end{aligned}$$

Body measurements such as height (cm), weight (kg), arm circumference, thigh circumference, hip circumference, and waist circumference (cm) were recorded. Body composition can be defined as the relative amounts of adipose tissue (fat), skeletal muscle, and other lean tissues within the human body. This metric serves as a significant indicator of an individual's overall health and fitness level. Body composition is assessed using Inbody 270.

Basal Metabolic Rate (BMR) signifies the minimal energy expenditure (measured in kilocalories) required by the body at rest to sustain vital physiological processes over 24 hours [20]. Compared to existing equations for predicting Basal Metabolic Rate (BMR) that rely on anthropometric measurements like age, weight, height, and sex, the Pavlidou equations demonstrate superior accuracy and reliability [21]:

$$\begin{aligned}&\text{BMR (females)}:\ (7.38 \times \text{weight in kilogram})\\&\quad + (607 \times \text{height in meter}) - (2.31 \times \text{age in years})\\&\quad + 43.\ [21]\end{aligned}$$

At cycle day 2 or 3, blood was collected to measure AMH hormone using a Centrifuge (Universal 16 A, German) and AMH Kit (Fluorecare, China)

Table 1. Sociodemographic characteristics of women by BMI category (ANOVA).

Characteristics		Normal n = 31	Overweight n = 34	Obese n = 85	Totals n = 150	P value
Marital status	Married	28 (90.3%)	30 (88.2%)	81 (95.3%)	139(92.6%)	0.351
	Unmarried	3 (9.7%)	4 (11.8%)	4 (4.7%)	11 (7.4%)	
Presence of children	Yes	13 (41.9%)	20 (58.8%)	50 (58.8%)	83(55.4%)	0.242
	No	18 (58.1%)	14 (41.2%)	35 (41.2%)	67 (44.6%)	
Address	Rural	6 (19.3%)	10 (29.4%)	40 (47%)	56(37.3%)	0.1
	Urban	25 (80.6%)	24 (70.5%)	45 (52.9%)	94(62.6%)	
Age (years) (Mean ± SD)		26.29 ± 3.68	27.50 ± 4.6	28.66 ± 6.27		0.11

*P-value < 0.05 was significant, SD = standard deviation.

3. Statistical analysis

Statistical analysis for this study was conducted using the SPSS software (Statistical Package for Social Science; Version 23). We ran various analyses on our data: some compared means between groups (one-way ANOVA), some employed to assess variances between groups in categorical variables (chi-square), and others explored how measurements correlate with each other (Pearson's correlation analysis). A general linear model was used to detect the odds ratio for continuous data as a dependent variable. P < 0.05 was considered statistically significant.

4. Results and discussion

In our study, we analyzed data from 150 women between the ages of 19 and 40 (mean age 31.43 years ± 5.38 SD).

Table 1 presents the characteristics of women in the study, divided by BMI categories. The majority were married (92.6%), with the highest percentage in the obese group (95.3%). Around 55.4% had children, with the highest percentages in the overweight and obese groups (both 58.8%). Most participants lived in urban areas (62.6%), with the proportion of urban residents decreasing as BMI increased (80.6% in normal weight, 70.5% in overweight, and 52.9% in obese). There were no statistically significant differences in marital status, presence of children, address, or age across the BMI categories.

Our study observed that the anti-mullerian hormone (AMH) level was measured in the study group as shown in Table 2. AMH level was insignificantly lower in overweight and obese patients than the normal weight group (P = 0.392). This may be due to excess adipose tissue affecting hormone production and metabolism, as well as obesity-related insulin resistance and inflammation impacting ovarian function.

The logistic regression was done to know the effect of physical activity on AMH level, as shown in Table 3, there was an insignificant relation between physical activity and AMH level (P = 0.28). Physical activity might not directly impact AMH unless it significantly alters body fat distribution or metabolic status. As a marker of ovarian reserve, AMH may not be immediately responsive to changes in physical activity levels.

Our analysis revealed a statistically significant negative correlation between anti-Müllerian hormone (AMH) levels and waist circumference measurements (P = 0.001). Additionally, there was an insignificant negative correlation between AMH and BMI and other body circumferences (P > 0.05) Table 4 and Figs. 1 to 8. Central adiposity, indicated by increased waist circumference, is linked to metabolic disturbances and hormonal imbalances that can affect ovarian function and AMH production.

Levels of AMH were not markedly lower in overweight or obese patients compared to the reference group with normal weight (P = 0.38 and 0.76 respectively). General obesity measures may not capture the specific metabolic effects of central obesity on AMH. Individual variability in obesity's impact on ovarian function likely contributes to the lack of a significant correlation.

These findings are consistent with those reported by Moslehi *et al.* [22], This author analyzed data from 211 obese and 233 non-obese, fertile women without polycystic ovary syndrome (PCOS). The analysis revealed lower AMH (anti-Müllerian hormone) levels

Table 2. Anti-Mullerian hormone (AMH) levels in the studied group (one way ANOVA).

Hormones	Normal	Overweight	Obese	P value	Mean difference (I-J)
AMH (ng/mL)	4.28 ± 1.95	2.88 ± 1.9	2.5 ± 1.30	0.392	Normal vs Overweight (0.36, p = 0.38); Normal vs Obese (−0.1, p = 0.76); Overweight vs Obese (−0.46, p = 0.18)

Table 3. Logistic regression analysis for the effect of physical activity on AMH level in all 150 women.

Physical activity	Normal (OR, CI, P-value)	Overweight (OR, CI, P-value)	Obese (OR, CI, P-value)	Mean difference (I-J)
Walking	0.99 (−0.04 – 0.03, 0.74)	0.97 (−0.07 – 0.025, 0.3)	1.002 (−0.013 – 0.017, 0.76)	Normal vs Overweight (−0.002, p = 0.93); Normal vs Obese (−0.02, p = 0.49); Overweight vs Obese (−0.01, p = 0.53)
duration per day	1.5 (−1.97 – 1.02, 0.7)	0.08 (−3.46 – 1.47, 0.2)	0.32 (−2.9 – 0.75, 0.23)	Normal vs Overweight (−4.7, p = 0.16); Normal vs Obese (−0.8, p = 0.75); Overweight vs Obese (3.8, p = 0.16)
Running	0.96 (−0.13 – 0.06,0.52)	1.1 (0.02 – 0.27,0.18)	0.96 (−0.103 – 0.029,0.26)	Normal vs Overweight (0.09, p = 0.42); Normal vs Obese (0.05, p = 0.61); Overweight vs Obese (−0.04, p = 0.63)
duration per day	0.62 (−1.94 – 2.8, 0.52)	0.95 (0.41 – 4.1, 0.18)	0.72 (−1.4 – 0.8, 0.57)	Normal vs Overweight (1.4, p = 0.46); Normal vs Obese (0.06, p = 0.96); Overweight vs Obese (−1.4, p = 0.39)
Other sport	1.007 (−0.04 – 0.05, 0.78)	0.9 (−0.08 – 0.062, 0.78)	1.01 (−0.05 – 0.2, 0.193)	Normal vs Overweight (0.005, p = 0.89); Normal vs Obese (0.05, p = 0.16); Overweight vs Obese (−0.04, p = 0.19)
Physical Activity Score	0.96 (−0.23 – 0.15, 0.67)	1.17 (−0.1 – 0.43, 0.22)	0.92(−0.26 – 0.11, 0.41)	Normal vs Overweight (0.07, p = 0.81); Normal vs Obese (−0.06, p = 0.79); Overweight vs Obese (−1.4, p = 0.57)

*P-value < 0.05 was significant, r correlation coefficient, OR = odds ratio.

Table 4. Correlation between AMH level and body circumference and body composition (Logistic Regression and Pearson Correlation).

	AMH				
			CI		
Variables	r	Odds ratio	Lower limit	Upper limit	P value
Thigh circumference (cm)	−0.081	0.99	−1.39	1.41	0.34
Arm circumference (cm)	−0.032	0.91	−0.074	1.21	0.704
Waist circumference (cm)	−0.66	0.69	−2.7	−0.609	0.001*
Hip circumference (cm)	0.002	1.107	−0.89	2.432	0.986
Waist/Hip ratio	−0.118	0.97	−0.014	0,011	0.164
Waist/height ratio	−0.078	1.11	−0.006	0.016	0.359
BMI (kg/m^2)	−0.097	0.94	−0.603	1.09	0.246
BMR (calories /day)	−0.029	0.95	−21.9	14.52	0.729

*P value < 0.05 was significant, r correlation coefficient.

in obese women compared to the non-obese group. AMH levels and obesity status exhibited an inverse relationship in our study.

In another study [23], AMH levels in the obese group were on average 32.9% lower than those in the non-obese group; however, this difference was not statistically significant. This suggests that AMH levels might tend to be lower in obese individuals, but more research may be needed to confirm this trend definitively due to the lack of statistical significance in this particular study [23].

A study by Woloszynek *et al*. [24], investigated AMH levels in 100 young women with an average age of 31. The study found no significant difference in AMH levels across different BMI categories (lean, overweight, and obese). This null finding persisted even after controlling for the potential confounding factor of age [24].

Prior research (e.g., Chiofalo *et al*., 2017 [25]; Olszanecka-Glinianowicz *et al*., 2015 [26]) on AMH levels and obesity yields mixed results. These studies notably reported statistically significant reductions in AMH levels among obese women compared to their non-obese counterparts. The reductions in AMH levels ranged from 9.7% to 23.5%. The latter study also identified an inverse association between levels of AMH and BMI. However, it's important to consider that Chiofalo *et al*.'s study involved women with severe obesity (BMI = 46 kg/m2) as part of a bariatric surgery intervention [25, 26]. This suggests that the impact of obesity on AMH levels might be more pronounced in individuals with higher BMI categories.

Regarding the correlation between AMH levels and physical activity, our study did not find a significant link between physical activity and AMH levels.

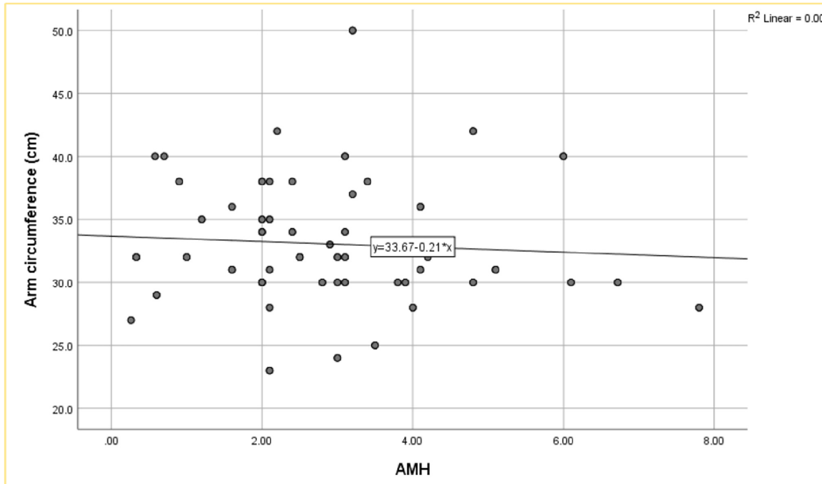

Fig. 1. The correlation between arm circumference and anti-mullerian hormone.

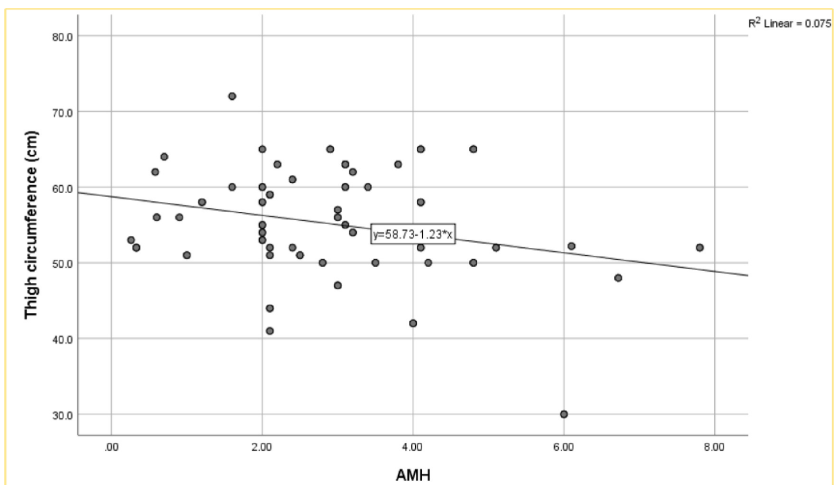

Fig. 2. The correlation between thigh circumference and anti-mullerian hormone.

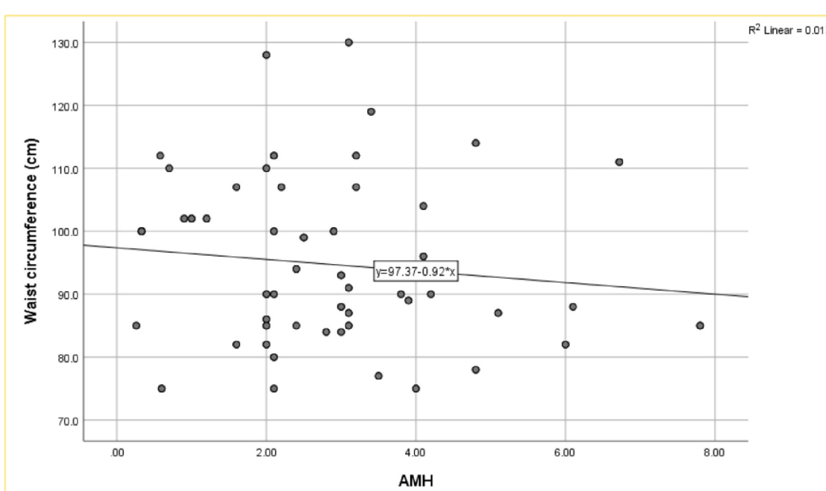

Fig. 3. The correlation between waist circumference and anti-mullerian hormone.

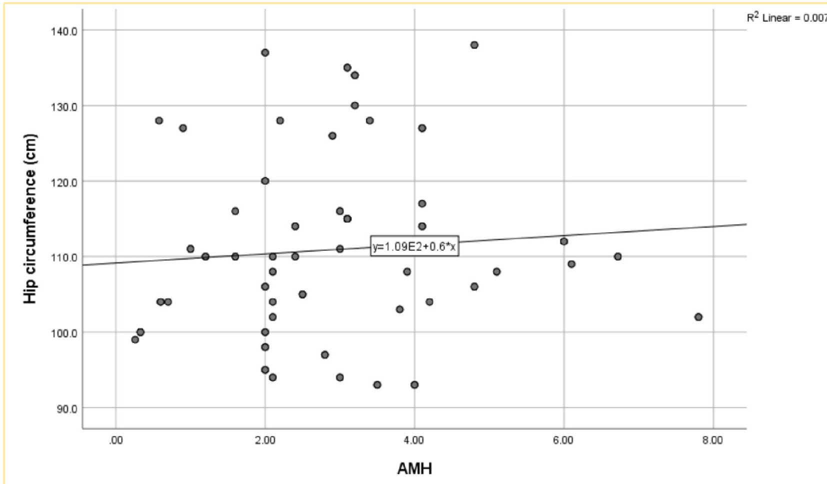

Fig. 4. The correlation between hip circumference and anti-mullerian hormone.

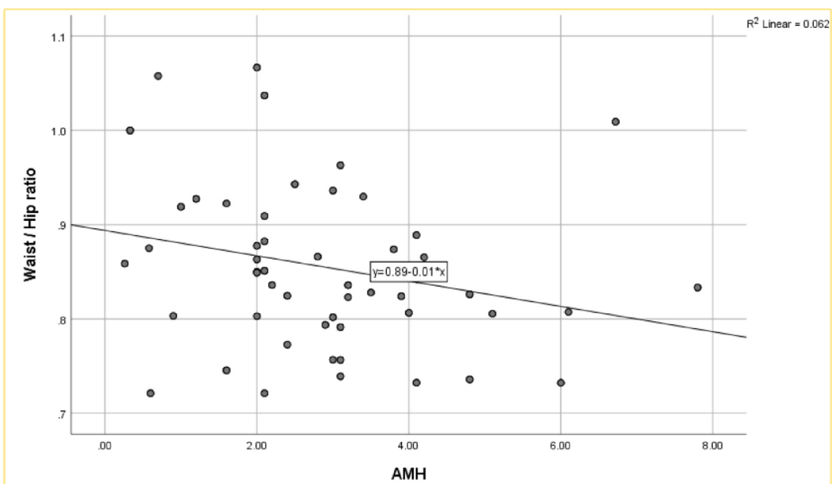

Fig. 5. The correlation between waist/hip ratio and anti-mullerian hormone.

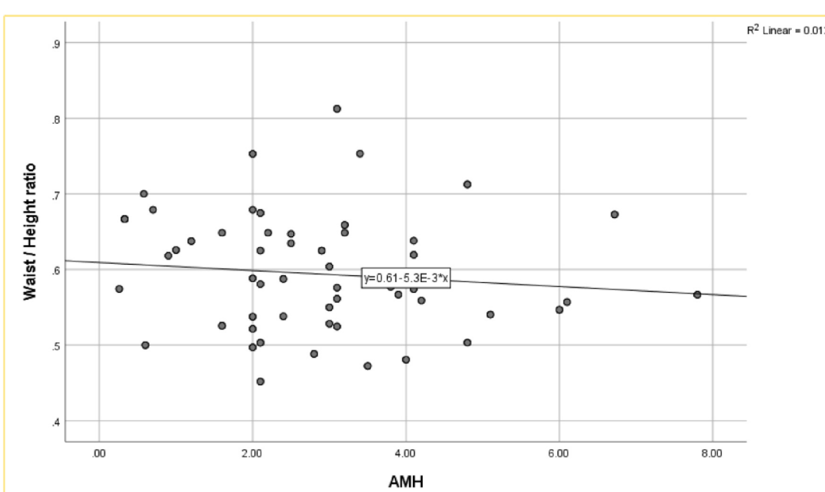

Fig. 6. The correlation between waist/height and anti-mullerian hormone.

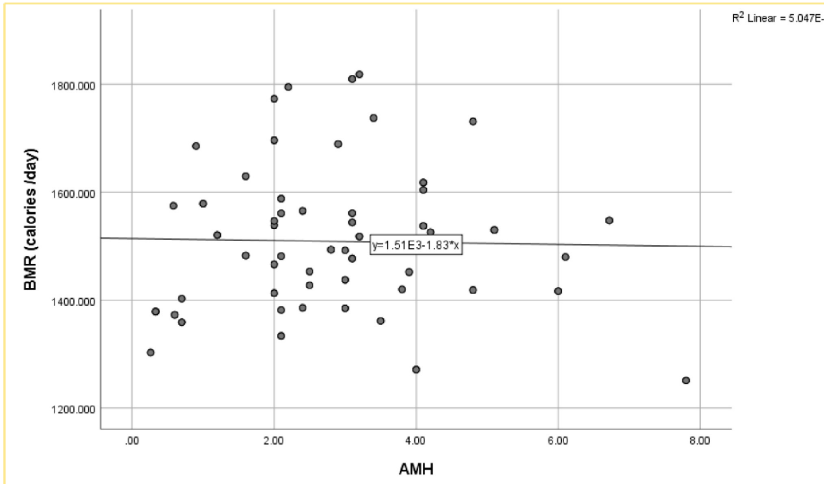

Fig. 7. The correlation between basal metabolic rate and anti-mullerian hormone.

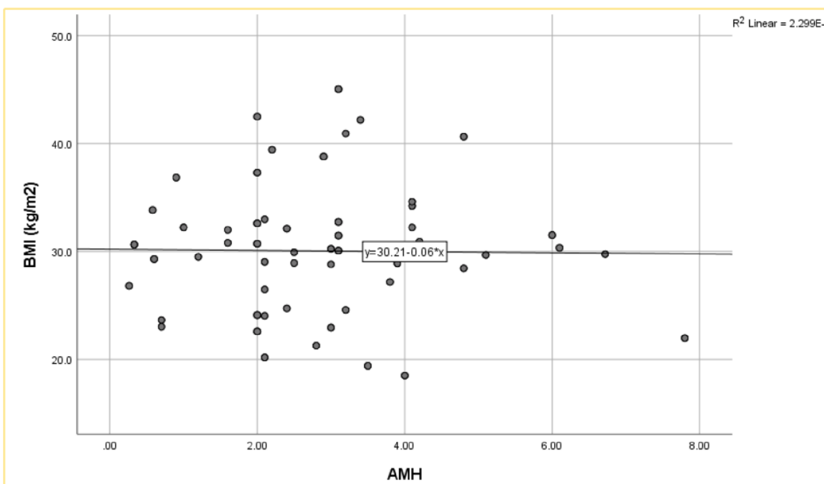

Fig. 8. The correlation between body mass index and anti-mullerian hormone.

A study conducted by Nybacka *et al*. in 2013 [27] yielded similar results, indicating that physical exercise did not lead to a decrease in AMH levels.

Furthermore, another study yielded no significant association between physical activity and AMH levels when stratified by age [28].

A small pilot study conducted by Moran *et al*. [29] showed a significant reduction in AMH levels following a 12-week endurance exercise program, consisting of one-hour treadmill sessions three times per week, among women with PCOS. These findings contrast with our results.

Our study observed a significant negative correlation between AMH levels and thigh circumferences ($P < 0.05$). While the correlations were negative, meaning higher AMH tended to correspond with lower BMI and body circumference, these relationships were not statistically significant in our study ($P > 0.05$). These results agree with Li *et al*. [30] who found that AMH levels exhibited negative correlations with body weight, BMI, fat-free mass, body fat percentage, waist-hip ratio, and visceral fat level [30]. Another study carried out by Francis *et al*. in 2023 [31], demonstrated that AMH levels exhibited an inverse association with average weight, BMI, and waist circumference (WC) throughout the follow-up period.

In another study, conducted by Rios *et al*. in 2020 [32], a significant inverse association was observed between AMH levels and BMI.

On the other hand, Mitchell *et al*. [33], found no evidence of a relationship between AMH and body fat percentage, BMI, lifestyle choices, or stress levels [33].

5. Conclusion

The study does not reveal a clear difference in AMH levels between participants categorized as overweight or obese and those with a normal weight. Similarly, no direct link was established between physical activity levels and AMH concentrations. However, we observed an inverse relationship between AMH levels and thigh circumference, although no significant associations were observed with BMI or other body circumferences.

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Conflicts of interest

There are no conflicts of interest.

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Nil.

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