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UTILITY OF BODY MASS INDEX AND WAIST–HIP RATIO AS PREDICTORS OF POLYCYSTIC OVARY SYNDROME AND OVARIAN MORPHOLOGY IN REPRODUCTIVE-AGE WOMEN

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Abstract

Background: *certain morphology of the ovaries. PCOS is one of the most common endrocrine disorders in women of reproductive ages. PCOS also has a strong relationship with central obesity. Central obesity increases insulin resistance, which are some of the causes of hyperandrogenism and the severity of PCOS. PCOS morphological features could be predicted with simple and inexpensive measures such as Body mass index (BMI) and waist–hip ratio (WHR). The objective of this study is to establish the link between BMI and WHR to predict PCOS and their correlational parameters with ovarian morphology and serum anti-Müllerian hormone (AMH) levels.*

Methods: *Data was gathered for an analytical cross-sectional study for 100 women of reproductive age (18-40 years). They were allocated equally to each group of women with PCOS and without PCOS according to the 2003 Rotterdam criteria. Anthropometric, clinical, biochemical, and ultrasonographic data were collected. To compare the means of BMI and WHR for the two groups, an independent-samples t-test was performed. WHR and the ovarian morphological parameters were correlated using Spearman's correlation, as were the associations of AMH with BMI and WHR.*

Results: *Women with PCOS exhibited significantly higher BMI (30.8 ± 5.1 kg/m² vs. 24.9 ± 3.9 kg/m²; $p = 0.001$) and WHR (0.87 ± 0.06 vs. 0.81 ± 0.05; $p = 0.002$) compared with non-PCOS controls. A strong positive correlation was observed between WHR and total follicle count ($r = 0.42$, $p = 0.002$), while WHR was negatively correlated with average follicle size ($r = –0.35$, $p = 0.008$). Serum AMH levels were markedly higher in the PCOS group (7.9 ± 2.4 ng/mL vs. 3.1 ± 1.6 ng/mL; $p < 0.001$) and positively correlated with both BMI ($r = 0.36$, $p = 0.009$) and WHR ($r = 0.42$, $p = 0.004$).*

Conclusion: *BMI and WHR are reliable anthropometric predictors of PCOS and associated morphological changes in the ovaries. Higher BMI and WHR have been associated with increased numbers of follicles, smaller sized follicles, and higher AMH levels, demonstrating the impact of obesity and central fat distribution on ovarian dysfunction. The use of these uncomplicated metrics in clinical evaluation will help clinicians identify and manage women who are*

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likely to develop PCOS. Early intervention may enhance outcomes in the metabolic and reproductive health of these women.

INTRODUCTION

Polycystic Ovary Syndrome (PCOS) along with any possible clinical variants remaining as one of the most common endocrine disorders of women in their reproductive age.[1] It affects 6 to20% of women in the world with varying criteria used to define the condition. It consists of the clinically important triad of hyperandrogenemia, ovulatory dysfunction, and polycystic ovarian morphology.[2] The condition further aligns with a number of metabolic disorders, most importantly, insulin resistance, dyslipidemia, and obesity.[3] The metabolic consequences of PCOS become even more marked with the risk of type 2 diabetes mellitus, hypertension, and cardiovascular disease.[4] PCOS needs to be understood as a complex multisystem disorder in order to formulate correspondingly appropriate treatment of the Syndrome which also includes the most profound consequences hypothesized, hyperovulation.[5] The more common of which would be profound endometrial hyperplasia.

Abdominal or central obesity is one of the most common and most profound aggravators of insulin resistance and hyperandrogenemia, and subsequently the entire complex disorder pathophysiology. The defining criteria of obesity and its distribution based on body mass index (BMI) is poorly suited as the defining criteria of central obesity.[6,7] In contrast, the waist–hip ratio (WHR) serves as a much more appropriate approximation of visceral fat and the associated metabolic risks. It is assumed that women with PCOS present with considerably higher BMI and WHR than their peers, although studies across different populations and with different characteristics demonstrate divergent findings.[8] Ultrasound of the ovaries is critical in diagnosing PCOS and demonstrates how the ovaries respond to the hormonal and metabolic shifts that occur with the syndrome.[9] The number and size of follicles, as well as endometrial thickness, demonstrate ovarian dysfunction while assessing the ovaries. The level of ovarian dysfunction is also revealed with assessment of transcavitary sonography. The relationship between the ovarian morphologic features and the covariance with certain anthropometric measures, particularly BMI and WHR, may be of great value in predicting and constructing PCOS.[10]

With PCOS becoming more common and prevalent in South Asian women, particularly in the context of higher central adiposity distributions at lower BMI values, correlating limited and simplified approaches of BMI and WHR is significant. Thus, the objective of this research is to assess the relationship between BMI and WHR in relation to the diagnosis of PCOS and ovarian morphology in women of childbearing age and identify which of the anthropometric measures is a more significant predictor of the ovarian morphology changes associated with PCOS.

METHODOLOGY

STUDY DESIGN AND SETTING

This study was conducted from Jan,2024 to Jan,2025 and was conducted in the Department of Gynecology and Obstetrics, POF Hospital, Wah Cantt. It incorporated women of reproductive age (18-40 years) who approached the department for a routine gynecological check-up, had complaints of menstrual irregularities, or sought evaluation for infertility. The Institutional Review Board granted ethical permission for the research, and all participants provided written informed consent prior to inclusion in the study.

STUDY POPULATION AND SAMPLING

Using a convenient sampling framework, 100 women were sampled. The participants were classified into two groups according to the diagnostic criteria for polycystic ovary syndrome (PCOS):

Group I (PCOS group): Women meeting the Rotterdam 2003 criteria (presence of two out of the following: oligo/anovulation, clinical or biochemical hyperandrogenism, or polycystic ovarian morphology on ultrasound).

Group II (Control group): Age-matched women who demonstrated the criteria of having regular menstrual cycles and had no ultrasound evidence of polycystic ovaries.

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The study excluded women who were recently pregnant or lactating, and those who had received hormonal therapy in the past three months.

DATA COLLECTIONS AND VARIABLES

- Demographic, anthropometric, and clinical details were gathered in a structured proforma.
- Anthropometric data included standard protocols for recording height (cm), weight (kg), waist, and hip circumference (inches). The waist–hip ratio (WHR) is calculated by dividing waist circumference by hip circumference, and the body mass index (BMI) is calculated by dividing weight (kg) by the height (m^2).
- Clinical data included age, marital status, menstrual cycle regularity, weight gain, acne, hirsutism, skin darkening and the presence of any other symptoms.
- Ultrasonography was performed either transvaginally and transabdominally during the early follicular phase of the menstrual cycle, and the number and the average size of the follicles and the endometrial thickness were recorded for the assessment of ovarian morphology.
- Laboratory investigations consisted of obtaining blood samples for serum anti-Müllerian hormone (AMH) levels, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and for fasting blood glucose when appropriate.

STUDY OBJECTIVES

- To establish any relation of BMI and presence of PCOS.
- To asses the relation of waist–hip ratio and ovarian morphology (follicle count and follicle size).
- To evaluate the ability of BMI and WHR in predicting PCOS.

STATISTICAL ANALYSIS

Data were analyzed using IBM SPSS Statistics version 25 and were expressed as mean ± SD (standard deviation), and categorical variables as frequency and percentage. The independent-samples t-test was employed to analyze differences in mean BMI between PCOS and non-PCOS groups. The association between WHR and ovarian morphology parameters (total follicle count, average follicle size) was tested using Spearman's correlation coefficient. BMI and WHR's diagnostic predictive value for PCOS was assessed using Pearson's Correlation. Statistical significance was defined as a p-value of 0.05 or less.

RESULTS

Table 1

Sociodemographic and Clinical Characteristics of the Study Participants (n = 100)

Characteristic	PCOS (n = 50)	Non-PCOS (n = 50)	Total (n = 100)
Age (years), mean ± SD	26.9 ± 4.2	27.4 ± 4.8	27.1 ± 4.5
Marital status			
Married	30 (60%)	32 (64%)	62 (62%)
Unmarried	20 (40%)	18 (36%)	38 (38%)
BMI (kg/m^2), mean ± SD	30.8 ± 5.1	24.9 ± 3.9	27.8 ± 5.3
Waist–Hip Ratio, mean ± SD	0.87 ± 0.06	0.81 ± 0.05	0.84 ± 0.06
Average Hb (g/dL)	12.4 ± 1.3	12.7 ± 1.2	12.5 ± 1.3
Cycle pattern			
Regular	18 (36%)	40 (80%)	58 (58%)
Irregular	32 (64%)	10 (20%)	42 (42%)
Clinical features			
Weight gain	35 (70%)	12 (24%)	47 (47%)
Excess hair growth	28 (56%)	8 (16%)	36 (36%)
Skin darkening	30 (60%)	10 (20%)	40 (40%)
Pimples/acne	26 (52%)	12 (24%)	38 (38%)
Mean systolic BP (mmHg)	121 ± 9	117 ± 10	119 ± 10

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Mean diastolic BP (mmHg)	78 ± 7	75 ± 6	77 ± 7

Table 1 outlines the sociodemographic and clinical characteristics of participants in the study. The average age of women with polycystic ovary syndrome (PCOS) was 26.9 ± 4.2 years, almost the same as 27.4 ± 4.8 years in the non-PCOS group, which indicates no significant age difference. Most participants in both groups were married (60% vs. 64%). Nevertheless, women with PCOS had substantially greater mean BMI (30.8 ± 5.1 kg/m²) and waist–hip ratio (0.87 ± 0.06) in comparison to non-PCOS women (24.9 ± 3.9 kg/m² and 0.81 ± 0.05, respectively), suggesting a greater prevalence of obesity and central adiposity. Among PCOS patients, menstrual cycle irregularity was more prevalent (64%) than in non-PCOS women (20%). Clinically, the PCOS group had a greater prevalence of weight gain (70%), darkened skin (60%), hirsutism (56%), and acne (52%), which aligns with the typical signs of hyperandrogenism and insulin resistance. The average hemoglobin and blood pressure readings were comparable between both groups.

Table 2.
Comparison of Body Mass Index (BMI) Between Women With and Without PCOS (n = 100)

Group	n	Mean ± SD BMI (kg/m²)	Mean Age (yrs)	p-value (t-test)
PCOS	50	30.8 ± 5.1	26.9 ± 4.2	0.001 *
Non-PCOS	50	24.9 ± 3.9	27.4 ± 4.8	

Table 2 compares body mass index (BMI) values among women with polycystic ovary syndrome (PCOS) and those without it. Women's average BMI was considerably higher among those with PCOS (30.8 ± 5.1 kg/m²) compared to those without PCOS (24.9 ± 3.9 kg/m²), and the 0.001 p-value also expresses the difference as statistically significant. Regarding the average age of the groups, it is evident as well that the average age of the women with PCOS was much higher. In this case, the higher average BMI of PCOS women confirms the close link between obesity and PCOS's hormonal and metabolic dysfunctions- that include insulin resistance and hyperglycemia.

Table 3.
Correlation Between Waist–Hip Ratio and Ovarian Morphology (n = 50 PCOS Patients)

Parameter	Mean ± SD	Spearman r	p-value
Waist–Hip Ratio	0.87 ± 0.06	—	—
Total Follicle Count (L + R)	22.5 ± 6.4	**0.42**	0.002 *
Average Follicle Size (mm)	6.8 ± 1.4	**–0.35**	0.008 *
Endometrial Thickness (mm)	7.3 ± 1.6	0.11	0.34

Table 3 lists the correlations between waist–hip ratio and the ovarian morphology of women with PCOS. The data reveals the waist–hip ratio and total follicle count as having a statistically significant positive correlation (waist–hip ratio and total follicle count r = 0.42, p = 0.002), depicting associations between central adiposity and a greater number of ovarian follicles. In contrast, waist–hip ratio and average follicle size portray a significant negative correlation (waist–hip ratio and average follicle size r = −0.35, p = 0.008), indicating the possibility that greater abdominal fat may weaken the maturation of follicles. No significant correlation between waist–hip ratio and endometrial thickness was attained (r = 0.11, p = 0.34). These findings demonstrate the impact of central obesity as evidenced by the negative morphologic and functional consequences to the ovaries associated with PCOS.

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Table 4.
Comparison of BMI and Waist–Hip Ratio Between PCOS and Non-PCOS Women and Their Correlation with AMH Levels (n = 100)

Parameter	PCOS (n = 50) Mean ± SD	Non-PCOS (n = 50) Mean ± SD	p-value (t-test)	Correlation with AMH (r)	p-value (correlation)
Body Mass Index (kg/m²)	30.8 ± 5.1	24.9 ± 3.9	0.001*	0.36	0.009*
Waist–Hip Ratio	0.87 ± 0.06	0.81 ± 0.05	0.002*	0.42	0.004*
AMH (ng/mL)	7.9 ± 2.4	3.1 ± 1.6	<0.001*	–	–

Table 4 illustrates a comparison of BMI and waist-to-hip ratios between women with PCOS and those without and discusses their correlation to AMH levels. Among women with PCOS, BMI (30.8 ± 5.1 vs 24.9 ± 3.9; p = 0.001) and waist-to-hip ratios (0.87 ± 0.06 vs 0.81 ± 0.05; p = 0.002) were significantly higher, thus indicating a higher prominence of adiposity in the pathogenesis of PCOS. In addition, the level of AMH in PCOS women (7.9 ± 2.4 ng/mL) was significantly greater compared to women without PCOS (3.1 ± 1.6 ng/mL; p < 0.001). In addition, significant positive correlations were found between AMH and BMI and waist-to-hip ratios, (BMI; r = 0.36, p = 0.009, waist-to-hip ratio; r = 0.42, p = 0.004) thus demonstrating that obesity and central adiposity are associated with ovarian follicle activity, as evidenced by higher AMH levels.

DISCUSSION

The study investigated how anthropometric measures relate to ovarian morphology and to Anti-Müllerian Hormone (AMH) levels and how these relate to women with and without polycystic ovary syndrome (PCOS). Obesity and central adiposity significantly correlate with features of PCOS, both clinically and biochemically.[11,12] Despite there being no significant differences for average age and marital status, women with PCOS presented much higher body mass index (BMI) and waist–hip ratios (WHR), both prime triggers of PCOS's metabolic and endocrine challenges. As with Europe and North America, Australia also demonstrates higher rates of healthcare access and higher systemic vulnerabilities as compared to women in developing countries.[13] The increased BMI and WHR in our region's women with PCOS highlight the importance of central obesity as a critical factor in the development and severity of symptoms of the condition.

Increased prevalence of irregularities in menstrual cycles, weight gain, hirsutism, skin darkening, and acne are all direct consequences of and reflect the presence of hyperandrogenism and metabolic dysfunction. This has been reported in previous work, which reported that over half of the women diagnosed with PCOS had hirsutism and acne due to increased levels of androgens.[14,15] The similarities in hemoglobin and blood pressure of the PCOS and non-PCOS women in this study suggest that the physiological disturbances that are in play are more metabolic and reproductive, rather than hematologic or cardiovascular at this stage. Nevertheless, the presence of obesity in conjunction with a hyperandrogenic individual does suggest long-term PCOS-related cardiovascular risks, and this should be a cause for concern.[16]

The positive relationship found between WHR and total follicle count in this study may indicate that central adiposity contributes to increased follicular recruitment and/or persistence of immature follicles, which are characteristic of PCOS. In contrast, the negative relationship between WHR and the average follicle size may indicate central fat accumulation leads to impaired follicular development and ovulatory dysfunction.[17] The above relationships suggest impaired lipotoxic and/or thyroid dysfunction PCOS wherein fat may disrupt the ovarian hormonal access and induce dysfunction.[18] The study's results showing no relationship between WHR and the endometrium is consistent with previous

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studies, which suggest that obesity does not directly cause PCOS-related anovulation to cause endometrial hyperplasia.

Findings represent research where women with PCOS attain greater levels of AMH compared to controls, confirming AMH's diagnostic and pathophysiological relevance to the disorder. The positive correlations of AMH with BMI and WHR suggest that higher levels of obesity and the central distribution of adipose tissue are associated with greater activity of the ovarian follicles. This increase is probably due to the accumulation of small antral follicles characteristic of PCOS. This has also been documented by other researchers who reported elevated AMH levels as indicative of an excess of follicles and dysfunctional granulosa cell layers. Elevated AMH levels among obese women with PCOS may also signal an adaptive response to disrupted folliculogenesis, as increased metabolic obesity is more closely integrated with this ovarian reserve marker.[20]

The results of the study show the connection between obesity, reproductive dysfunction, and biochemical markers in women with PCOS. The strong associations of AMH with BMI and WHR further emphasize the necessity of metabolic control and weight loss as critical elements in the management of PCOS. The loss of central abdominal fat is capable of restoring menses and alleviating hyperandrogenic symptoms, most likely by normalizing AMH secretion, thus improving reproductive potential. The impact of the lifestyle and drug therapies on the different aspects of PCOS and the causal relationships between them will most probably be clarified by future studies that will be based on large samples and longitudinal designs.

CONCLUSION

This research confirms both the body mass index (BMI) and waist–hip ratio (WHR) are relevant in predicting the likelihood of women of reproductive age undergoing polycystic ovary syndrome (PCOS) and the associated morphological ovarian changes. Women with PCOS had a greater BMI, WHR and AMH levels, which suggests a higher body fat composition along with a greater degree of hormonal and ovarian dysfunction. The central WHR's positive correlation with follicle count and AMH levels illustrates the central obesity's role in influencing the morphological endocrine function of the ovaries. These findings reinforce the importance of anthropometric PCOS assessments for timely clinical intervention for improved reproductive and metabolic results.

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