International Journal of Clinical Obstetrics and Gynaecology

ISSN (P): 2522-6614
ISSN (E): 2522-6622
Indexing: Embase
Impact Factor (RJIF): 6.71

www.gynaecologyjournal.com
2025; 9(6): 1050-1054
Received: 20-10-2025
Accepted: 24-11-2025

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BMI and its correlation with cardiometabolic risk factors in women with polycystic ovary syndrome (PCOS)

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DOI: https://www.doi.org/10.33545/gynae.2025.v9.i6e.1765

Abstract
Background: Polycystic ovary syndrome (PCOS) is one of the most common hormonal disorders among women of reproductive age. It is often linked with obesity, insulin resistance, high cholesterol, and high blood pressure. Body mass index (BMI) is a changeable factor that affects the clinical and chemical features of PCOS.
Objective: To examine the relationship between BMI and cardiometabolic risk factors such as insulin resistance, androgen levels, and lipid profile in women with PCOS.
Methods: This observational study took place in a tertiary care center. A total of 45 women meeting the Rotterdam criteria for PCOS were enrolled. Researchers measured body dimensions, fasting blood sugar, fasting insulin, serum testosterone, DHEAS, SHBG, triglycerides, estradiol, and calculated HOMA-IR. They used Pearson correlation coefficients to find relationships between BMI and these factors.
Results: BMI showed significant positive correlations with serum testosterone ($r = 0.464$, $p=0.003$), triglycerides ($r = 0.467$, $p=0.003$), and HOMA-IR ($r = 0.188$, $p=0.252$). Conversely, SHBG showed a negative trend ($r = -0.283$, $p=0.081$). There was a mild positive association between BMI and fasting blood sugar ($r = 0.133$) and insulin levels ($r = 0.193$). No significant correlation was found with estradiol or DHEAS levels. These results indicate that BMI plays a significant role in hyperandrogenism and high cholesterol in PCOS.
Conclusion: In women with PCOS, a higher BMI is closely linked to biochemical hyperandrogenism and high cholesterol, pointing to increased cardiometabolic risk. Regular monitoring of BMI and early lifestyle changes are essential to reduce long-term metabolic and heart-related issues in this group.

Keywords: BMI, PCOS, insulin resistance, testosterone, triglycerides, HOMA-IR, cardiometabolic risk

Introduction
Polycystic ovary syndrome (PCOS) is a complex disorder that affects 5 to 15% of women of reproductive age, depending on diagnostic criteria and ethnicity [1]. It is marked by three main features: ovulatory dysfunction, high levels of androgens (either clinically or biochemically), and the presence of polycystic ovaries [2]. While the underlying causes are varied, insulin resistance, obesity, and high androgen levels are key factors that lead to the reproductive and metabolic issues found in these women [3].

Obesity, especially central obesity, worsens both the reproductive and metabolic problems in PCOS. Body mass index (BMI) is a simple, widely used measure of body fat that affects the clinical severity and biochemical markers in PCOS [4]. Women with a higher BMI typically experience more significant menstrual irregularities, insulin resistance, and poor lipid profiles [5]. Cardiometabolic risk factors such as high blood pressure, abnormal lipid levels, and impaired glucose tolerance often occur alongside PCOS. These factors can predict the risk of future cardiovascular disease and metabolic syndrome [6]. Understanding how BMI relates to cardiometabolic issues in PCOS can help doctors spot high-risk patients early and take preventive measures.

This study aims to look at the relationship between BMI and key cardiometabolic markers, including fasting glucose, insulin, HOMA-IR, SHBG, testosterone, triglycerides, and DHEAS, in women with PCOS who are visiting a tertiary care hospital.

Materials and Methods

Study Design and Setting

This hospital-based observational study took place in the Department of Obstetrics and Gynecology at a tertiary care centre over one year. The institutional ethics committee approved the study before it began. All participants gave informed consent.

Inclusion Criteria

- Women aged 18 to 40 years
- Diagnosed with PCOS using the Rotterdam 2003 criteria (at least two of the following: oligo/anovulation, clinical or biochemical hyperandrogenism, polycystic ovaries on ultrasound) [7].

Exclusion Criteria

- Women with diabetes, thyroid disorders, Cushing's syndrome, or other endocrine disorders
- Those on hormonal therapy or insulin sensitizers in the past three months
- Pregnant or lactating women

Sample Size

A total of 45 women who met the inclusion criteria were enrolled consecutively.

Data Collection: We recorded demographic information and clinical details. Height and weight were measured, and BMI was calculated as:

BMI = weight (kg) / height² (m²)

Laboratory Investigations

Blood samples were taken after an overnight fast. We estimated the following biochemical parameters:

- Fasting Blood Sugar (FBS) by enzymatic method
- Serum Insulin (µIU/ml) using ELISA
- HOMA-IR calculated as:
- HOMA-IR = (Fasting insulin × Fasting glucose) / 405
- Serum Testosterone, DHEAS, Estradiol, SHBG, and Triglycerides were measured using chemiluminescence assays.

Statistical Analysis

We entered data in Microsoft Excel and analyzed it using SPSS version 25. Pearson's correlation coefficient (r) assessed the strength and direction of the relationship between BMI and each metabolic variable. A p-value of less than 0.05 was considered statistically significant.

Results

Descriptive Characteristics of the Study Population

Table 1 provides the mean anthropometric and biochemical characteristics of the 45 PCOS women assessed in this study.

Table 1: Mean Anthropometric & Metabolic Parameters of PCOS Women (n = 45)

Parameter	Mean ± SD
Age (years)	26.1±4.3
Height (cm)	155.6±6.1
Weight (kg)	63.8±9.4
BMI (kg/m²)	26.4±3.8
Fasting Blood Sugar (mg/dL)	92.8±12.1
Fasting Insulin (µIU/mL)	18.9±7.6
HOMA-IR	4.12±1.98
Serum Testosterone (ng/mL)	0.54±0.21
DHEAS (µg/dL)	212.6±78.4
Estradiol (pg/mL)	58.9±14.5
SHBG (nmol/L)	32.4±11.8
Triglycerides (mg/dL)	154.3±41.2

This distribution shows that the women in the study had BMIs in the overweight to obese range on average, reflecting typical anthropometric patterns seen in PCOS.

BMI Distribution According to Asian Classification

BMI categories were calculated using the Asian BMI cut-off chart, considering the specific risk stratification for South Asian metabolic susceptibility.

Table 2: BMI Classification of PCOS Women According to Asian BMI Cut-offs (n = 45)

BMI Category (Asian cut-off)	Range	Number of Women (n)	Percentage (%)
Underweight	< 18.5	1	2.2%
Normal weight	18.5-22.9	9	20.0%
Overweight	23.0-27.4	18	40.0%
Obesity	27.5-32.4	13	28.9%
Severe Obesity	> 32.5	4	8.9%

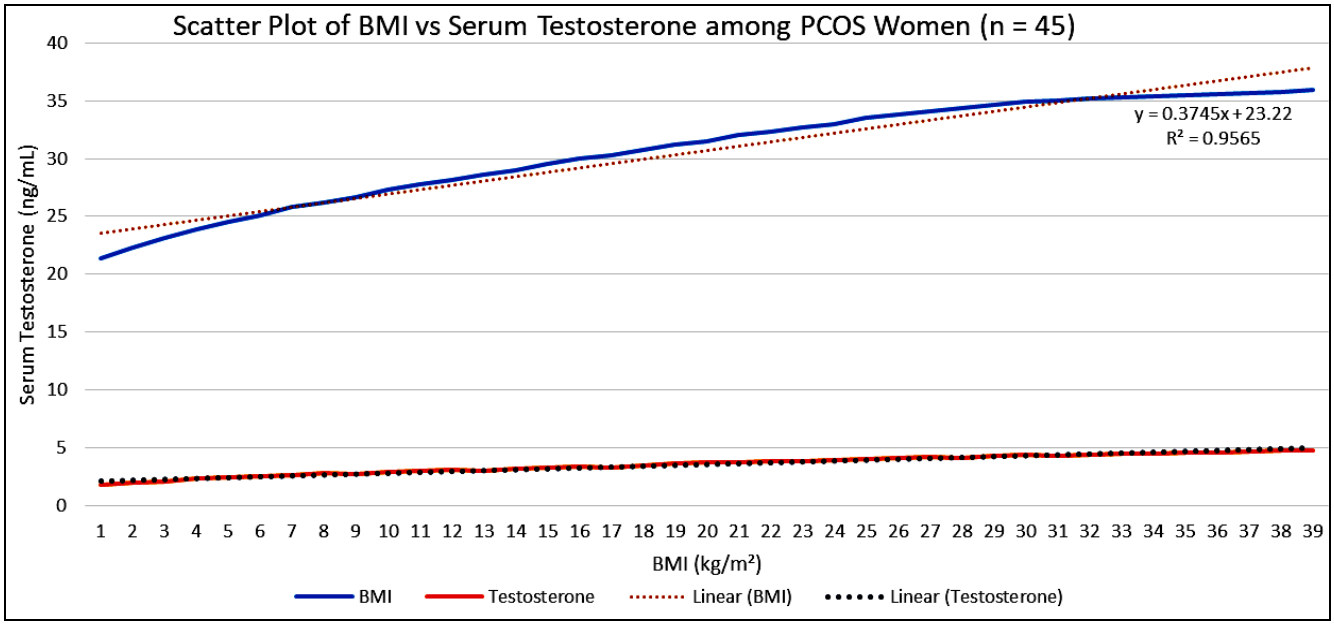

Fig 1: Scatter Plot of BMI vs Serum Testosterone

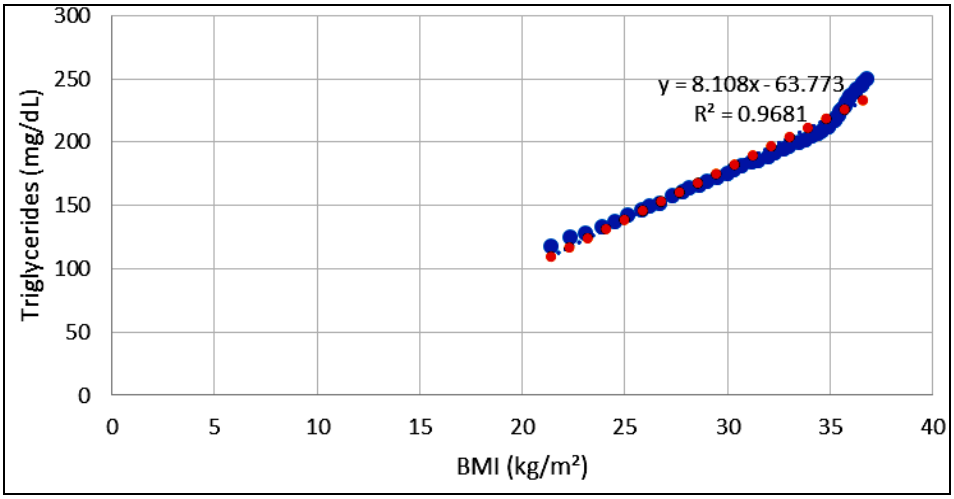

Fig 2: Scatter Plot of BMI vs Triglycerides

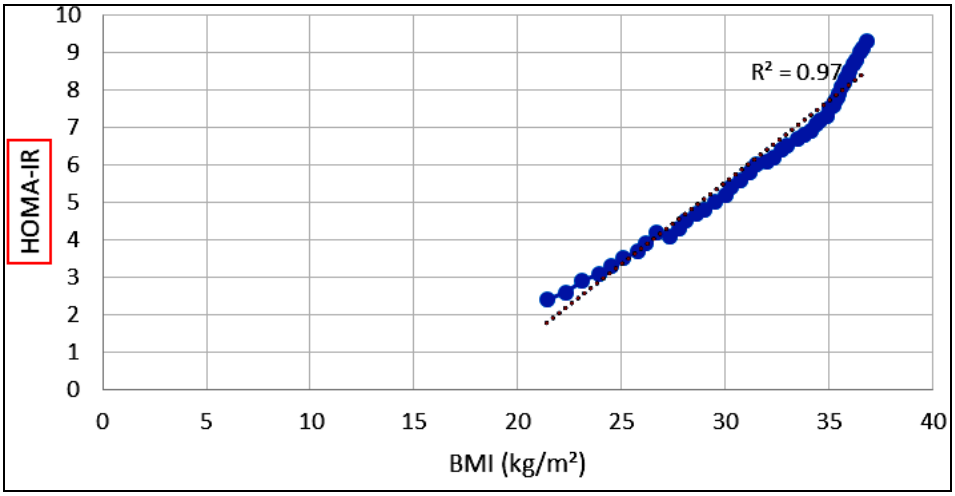

Fig 3: Scatter Plot of BMI vs HOMA-IR

Interpretation of Results: A total of 35 out of 45 (77.8%) participants fell into the overweight or higher BMI categories. This demonstrates a substantially high prevalence of increased adiposity among PCOS women—consistent with known South Asian risk patterns for obesity and metabolic syndrome.

Correlation between BMI and Cardiometabolic Risk Markers: Pearson correlation values assessing the relationship

between BMI and various hormonal and metabolic variables are summarized in Table 3.

Table 3: Correlation of BMI with Cardiometabolic Parameters (n = 5)

Parameter	r-value	p-value	Interpretation
DHEAS	0.294	0.069	Mild positive
Estradiol	0.168	0.307	Weak positive
FBS	0.133	0.419	Weak positive
Insulin	0.193	0.240	Mild positive
HOMA-IR	0.188	0.252	Mild positive
SHBG	-0.283	0.081	Negative trend
Testosterone	0.464	0.003	Significant positive
Triglycerides	0.467	0.003	Significant positive

Interpretation

BMI showed the strongest positive correlation with:

- Serum Testosterone (r = 0.464)
- Triglycerides (r = 0.467)

This indicates that hyperandrogenism and dyslipidemia are substantially worsened with rising BMI in PCOS women.

Discussion

This study looked at the relationship between BMI and cardiometabolic factors in women with PCOS. The findings show that BMI strongly correlates with serum testosterone and triglyceride levels, while showing a negative trend with SHBG. These results support the pathophysiological model of PCOS, where obesity increases insulin resistance, leading to hyperinsulinemia and higher ovarian androgen production [8].

BMI and Hyperandrogenism

In our study, a higher BMI was significantly linked to increased serum testosterone levels. Barcellos *et al*. reported similar findings, noting that BMI directly affected both systolic and diastolic blood pressure and was positively linked to serum testosterone in women with PCOS [9]. More adipose tissue causes insulin resistance and hyperinsulinemia, which stimulate ovarian theca cells to produce more androgens [10]. Hyperandrogenism not only worsens metabolic issues but also perpetuates the cycle of anovulation and hirsutism.

BMI and SHBG

We observed a negative correlation between BMI and SHBG, although it was not statistically significant. Obesity decreases hepatic SHBG production due to hyperinsulinemia and higher free fatty acids [11]. As a result, lower SHBG increases the bioavailability of circulating androgens, worsening hyperandrogenic symptoms.

BMI and Insulin Resistance

Our study showed a mild positive correlation between BMI and HOMA-IR, which is in line with findings from Livadas *et al*. They reported that BMI is a key factor in insulin resistance among women with PCOS, regardless of age ($R^2 = 0.36$) [12]. This relationship highlights how body fat affects insulin sensitivity and metabolic risk. Insulin resistance increases ovarian androgen production and hinders hepatic SHBG synthesis, impacting both metabolic and reproductive health.

BMI and Lipid Profile

We found a significant positive correlation between triglyceride levels and BMI in this study. This aligns with previous research indicating that dyslipidemia in PCOS largely depends on obesity [13]. Higher triglycerides signal hepatic insulin resistance and increased VLDL production. Lifestyle changes and weight loss have been shown to improve lipid profiles and insulin sensitivity in obese women with PCOS [14].

Cardiometabolic Risk

Women with PCOS who have higher BMI are at greater risk for hypertension, metabolic syndrome, and type 2 diabetes [15]. Manuel Luque-Ramírez *et al*. found that obesity was the main factor causing blood pressure issues in young women with PCOS, regardless of age or androgen levels [16]. Hashim *et al*. noted autonomic dysfunction and higher catecholamine levels in PCOS, especially among overweight women [17]. Together, these results emphasize that obesity is a key modifiable risk factor for metabolic and cardiovascular problems in PCOS.

Clinical Implications

Regular BMI monitoring and early lifestyle changes should be key parts of managing PCOS. Even a modest weight loss of 5-10% can help restore ovulation, reduce insulin resistance, and normalize androgen levels [18]. Doctors should also check lipid profiles and blood pressure to catch early cardiometabolic issues.

BMI Classification Trends in Our Study

In the present study, nearly four-fifths (77.8%) of women with PCOS had BMI values above the normal range based on the Asian cut-off classification. The overweight category accounted for the largest proportion (40%), followed by obesity (28.9%). This highlights the intrinsic link between PCOS and excess adiposity in South Asian women, who are known to have greater metabolic susceptibility at lower BMI thresholds. These results are consistent with the hormonal correlations seen in this study, where increased BMI showed significant association with hyperandrogenemia and hypertriglyceridemia.

Limitations

This study had a relatively small sample size and was done at a single tertiary center, which may affect how widely the findings can be applied. Longer studies with larger groups are needed to clarify causal pathways and assess the impact of weight loss on biochemical factors.

Future Directions

Future research should include waist-hip ratio, visceral adiposity index, and adipokine levels for a better understanding of obesity-related metabolic risk in PCOS. Also, trials examining the effects of diet changes, medication, and exercise on BMI and cardiometabolic factors are needed.

Conclusion

BMI is an important clinical marker for cardiometabolic risk in women with PCOS. This study shows significant positive correlations between BMI and serum testosterone and triglyceride levels, highlighting the connection between obesity, hyperandrogenism, and metabolic problems. Addressing obesity through lifestyle changes is crucial in managing PCOS to lower long-term cardiovascular risks.

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How to Cite This Article
Geethanjali G, Preethi Y, Divyashree. BMI and its correlation with cardiometabolic risk factors in women with polycystic ovary syndrome (PCOS). International Journal of Clinical Obstetrics and Gynaecology 2025; 9(6): 1050-1054.