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Original Research Article

Prevalence of Metabolic Syndrome in Patients with Polycystic Ovarian Syndrome in the Reproductive Age Group at a Tertiary Care Centre in Barabanki, Uttar Pradesh

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Conflict of interest: Nil

Abstract

Background: Polycystic ovarian Syndrome (PCOS) is among the most common endocrine disorders in young patients. Beyond its reproductive concerns, it carries significant metabolic risks. When PCOS coexists with Metabolic Syndrome (MetS), the chances of developing insulin resistance, type 2 diabetes, and cardiovascular disease rise sharply. While international data are abundant, Indian evidence—especially from semi-urban and rural areas—remains limited.

Objective: To determine how common Metabolic Syndrome is among reproductive-aged patients with PCOS attending a tertiary care hospital in Barabanki, Uttar Pradesh.

Methods: We carried out an 18-month hospital-based cross-sectional study in the Department of Obstetrics and Gynaecology at Hind Institute of Medical Sciences. A total of 150 patients, aged 15–45 years and diagnosed with PCOS using Rotterdam 2003 criteria, were assessed for MetS according to the International Diabetes Federation (IDF) 2022 definition. Clinical, anthropometric, and biochemical parameters were recorded. Data were analyzed with SPSS version 26.0, and significance was set at $p < 0.05$.

Results: Among 150 patients with PCOS, the prevalence of metabolic Syndrome was 25.3%. Central obesity was most frequent (54%), followed by hypertriglyceridemia (40.7%), low HDL (36.7%), hypertension (34.7%), and raised fasting glucose (14%). MetS was significantly associated with higher age, BMI, waist circumference, menstrual irregularities, hirsutism, acanthosis nigricans, and polycystic ovarian morphology, while parity and thyroid status showed no association. Patients with MetS had higher fasting glucose, LH/FSH ratio, and testosterone compared to those without.

Conclusion: Metabolic Syndrome is highly prevalent among patients with PCOS in Northern India, particularly in those with obesity, irregular cycles, and clinical signs of insulin resistance. Routine metabolic screening and early lifestyle interventions should be integrated into the management of PCOS to reduce long-term cardiometabolic complications.

Keywords: Polycystic Ovary Syndrome; Metabolic Syndrome; Insulin Resistance; Obesity; Reproductive Age Patients; Cardiovascular Risk.

Introduction

Polycystic Ovarian Syndrome (PCOS) is one of the most common endocrine disorders affecting patients in their reproductive years. It is typically recognized for its classic triad of hyperandrogenism, chronic anovulation, and polycystic ovarian morphology, but its impact extends far beyond infertility or menstrual irregularities. Over the past two decades, PCOS has increasingly been viewed as a metabolic disorder. Many patients with this condition present with obesity, insulin resistance, and dyslipidaemia, all of which heighten the risk of developing type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) in later life [1,2].

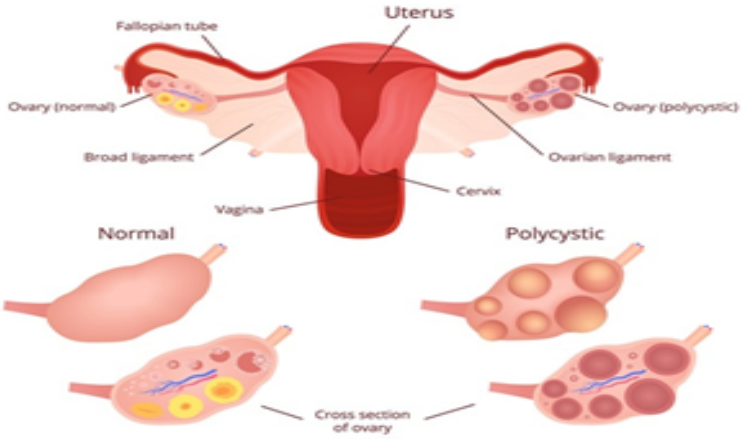

Fig 1: Comparison of Normal and Polycystic Ovarian Morphology

Metabolic Syndrome (MetS), defined as a constellation of central obesity, impaired glucose regulation, dyslipidaemia, and hypertension, shares striking overlap with the metabolic disturbances of PCOS. The common link is insulin resistance and excess adiposity, creating a vicious cycle that worsens both reproductive and metabolic outcomes [3,4]. Global studies have reported a high prevalence of Metabolic Syndrome in patients with PCOS, yet data from India remain inconsistent, with prevalence ranging from 25% to 45% depending on ethnicity, region, and diagnostic criteria applied [5,7].

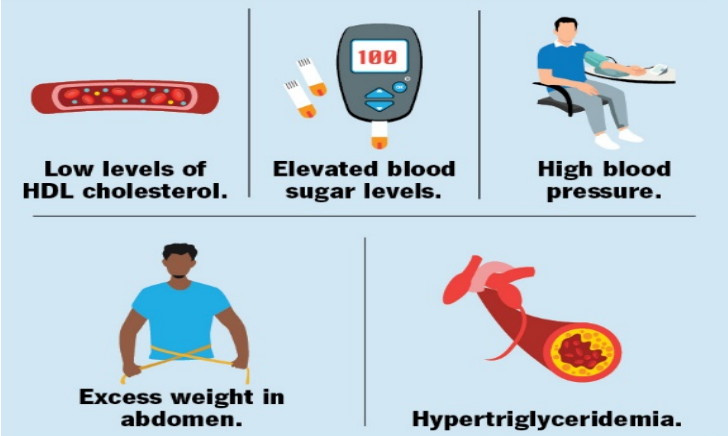

Fig 2: Key Components of Metabolic Syndrome

Most Indian studies to date have been conducted in urban or southern populations, while evidence from northern India—particularly in semi-urban and rural populations—is sparse [6,8]. Given the rising burden of obesity and PCOS in India, exploring this overlap is crucial both from a clinical and public health perspective.

Against this background, the present study was undertaken to estimate the prevalence of Metabolic Syndrome among reproductive-aged patients with PCOS. By generating region-specific data, our study adds to the growing body of evidence and emphasizes the need for early screening and integrated management in this high-risk group.

Materials and Methods

Study design and setting: Hospital-based, cross-sectional observational study conducted over 18 months (12 months recruitment + 6 months analysis) in the Department of Obstetrics and Gynaecology, Hind Institute of Medical Sciences, Safedabad, Barabanki, and Uttar Pradesh.

Study Population: The study enrolled patients in the reproductive age group, between 15 and 45 years, who presented to the outpatient clinic with features suggestive of polycystic ovary Syndrome. Diagnosis of PCOS was made strictly according to the Rotterdam consensus of 2003, which requires at least two of the following three features: oligo- or anovulation, clinical or biochemical hyperandrogenism, and polycystic ovarian morphology on ultrasound, while excluding other endocrinopathies. To be eligible, patients had to provide informed written consent and exhibit at least one of the following: menstrual irregularity, clinical signs such as hirsutism or acne, or ultrasound findings consistent with PCOS. Exclusion was applied to those older than 45 years,

patients with secondary causes of hyperandrogenism (including Cushing's syndrome, congenital adrenal hyperplasia, or androgen-secreting tumors), patients on oral contraceptives within the past three months, and those with chronic systemic illnesses, psychiatric disorders, or ongoing pregnancy.

Sample Size: The sample size was determined using Cochran's formula, with an expected prevalence of metabolic Syndrome in PCOS of around 38% based on previous Indian literature. Setting an absolute error margin at 8% and a confidence level of 95%, the calculation yielded a minimum of 142 participants. To simplify logistics and ensure adequate representation, this number was rounded off, and the final study included 150 patients.

Data Collection and Measurements: After obtaining informed consent, a detailed clinical history was recorded for every participant using a structured proforma.

This included demographic details, menstrual and obstetric history, and relevant lifestyle information. A thorough physical examination was then performed. Anthropometric measurements—height, weight, body mass index (BMI), and waist circumference—were taken following standard procedures.

Blood pressure was measured in a seated position, and signs of insulin resistance were specifically noted. Hirsutism was scored using the Modified Ferriman–Gallwey method, while the presence of acanthosis nigricans was documented clinically.

BMI classification	
Underweight	< 18.5
Normal range	18.5 - 24.9
Overweight	⩾ 25.0
Preobese	25.0 - 29.9
Obese	⩾ 30.0
Obese class I	30.0 - 34.9
Obese class II	35.0 - 39.9
Obese class III	⩾ 40.0

Fig 3: BMI classification

For biochemical assessment, fasting venous blood samples were collected under aseptic conditions. Plasma glucose was estimated using the glucose oxidase–peroxidase (GOD–POD) method. Lipid profile parameters—total cholesterol, triglycerides, HDL, and LDL—were analysed using an automated biochemistry analyzer. Hormonal assays included free testosterone and thyroid-stimulating hormone (TSH), both measured by chemiluminescent immunoassay (CLIA). Additionally, the LH/FSH ratio was calculated. Transvaginal or pelvic ultrasound was performed to identify polycystic ovarian morphology, defined by increased ovarian volume or the presence of multiple small follicles.

Definition of Metabolic Syndrome: The diagnosis of metabolic Syndrome was based on the updated International Diabetes Federation (IDF) 2022 criteria**.** Central obesity, defined as waist circumference ≥80 cm for South Asian patients, was considered essential. Along with this, the presence of at least two of the following components confirmed the diagnosis: fasting plasma glucose ≥100 mg/dL or known diabetes; triglycerides ≥150 mg/dL or on treatment for hypertriglyceridemia; HDL cholesterol <50 mg/dL or on treatment for low HDL; and systolic/diastolic blood pressure ≥130/85 mmHg or current use of antihypertensive medication.

Statistical Analysis: All data were coded and entered into Microsoft Excel before being exported to SPSS version 26.0 for analysis. Descriptive statistics were applied to summarize demographic and clinical characteristics. Continuous variables were expressed as mean with standard deviation, while categorical variables were represented as proportions. For group comparisons, chi-square or Fisher's exact test was applied to categorical variables, while continuous variables were analysed using Student's t-test or the Mann–Whitney U test, depending on data distribution. A p-value of less than 0.05 was taken as statistically significant throughout the analysis.

Results

A total of 150 patients of reproductive age diagnosed with PCOS were included in the study. The findings are presented according to demographic, clinical, anthropometric, biochemical, and metabolic characteristics, along with the associations between metabolic Syndrome (MetS) and various risk factors.

Table: Prevalence of metabolic Syndrome in 150 patients

Metabolic Syndrome	Frequency	Percent
Yes	38	25.3
No	112	74.7
Total	150	100.0

Age distribution: A total of 150 patients with PCOS were evaluated in this study. When grouped by age, the majority clustered in the youngest category. Two-thirds of participants, 100 patients (66.6%), were between 15 and 25 years. The next largest group comprised 25 patients (16.6%) aged 26–30 years, while the smallest group included 19 patients (12.6%) aged 31–45 years. In other words, most patients seeking care for PCOS at our centre were in their early reproductive years, with progressively fewer cases as age advanced.

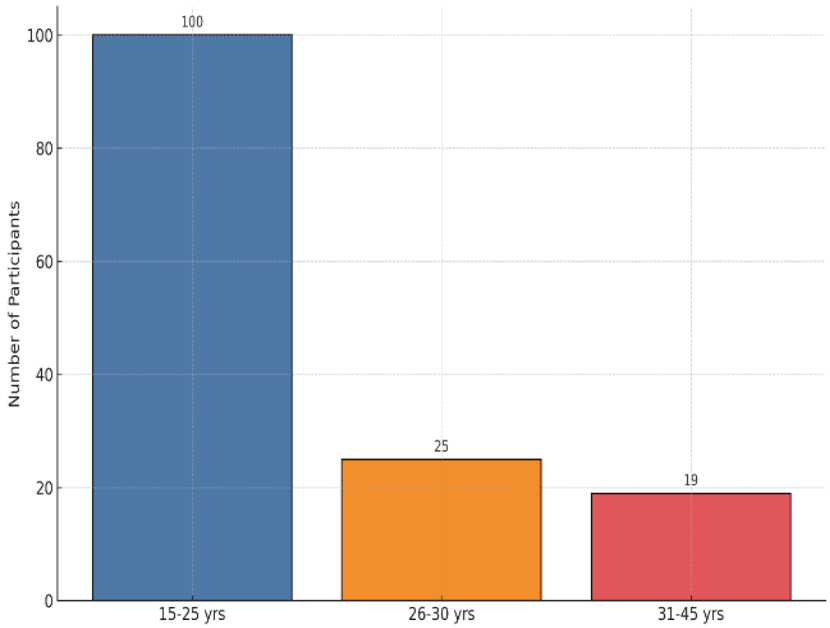

Fig 4: Age distribution of patients with PCOS.

Parity distribution: Parity was almost evenly balanced. Just under half of the patients, 74 (49.3%), were nulliparous, whereas 76 (50.7%) reported having had one or more deliveries. This nearly equal split suggests that PCOS is not restricted to patients who have never conceived; it also continues to affect those who have completed pregnancies.

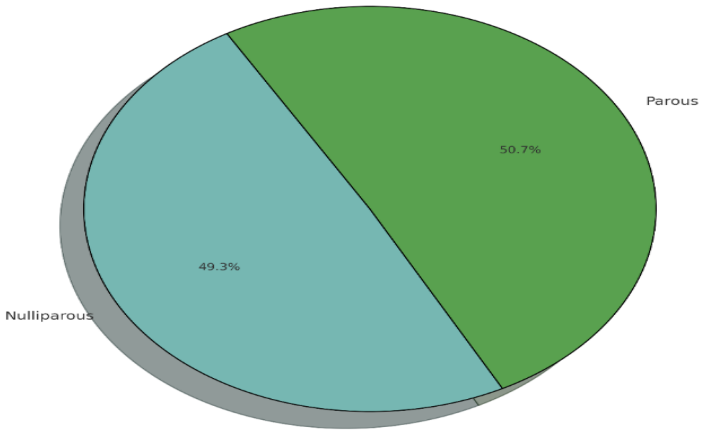

Fig 5: Parity distribution.

Menstrual pattern: Menstrual disturbances emerged as a common clinical feature. Of the 150 patients, 67 (44.7%) described regular menstrual cycles, but the remainder had abnormalities. Specifically, 30 patients (20%) had irregular cycles, 43 (28.7%) experienced infrequent menstruation, and 10 (6.7%) reported frequent cycles. Taken together, more than half of the patients had some degree of cycle irregularity, reaffirming its role as a hallmark feature of PCOS in this population.

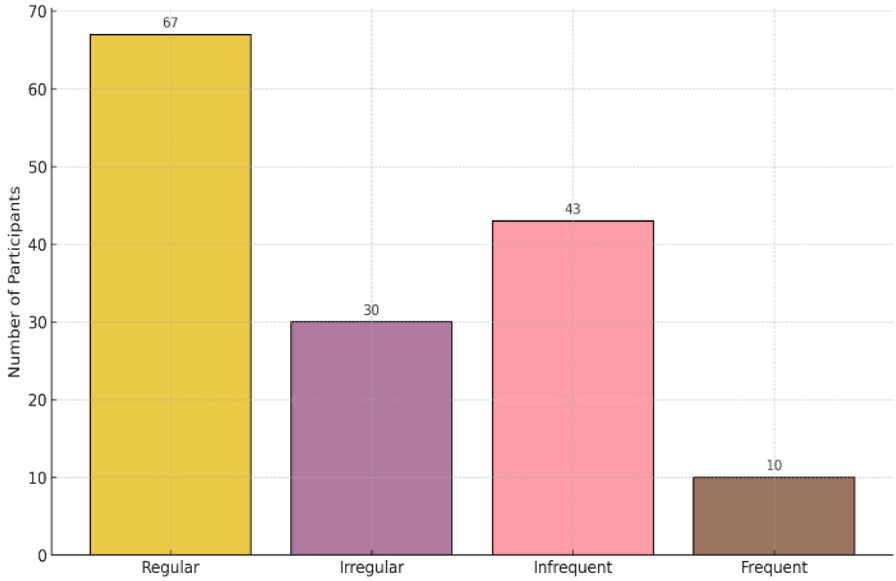

Fig 6: Menstrual pattern among participants.

Hirsutism: Clinical hyperandrogenism was another important finding. Hirsutism, defined by a modified Ferriman–Gallwey score ≥8, was identified in 59 patients (39.3%). The remaining 91 patients (60.7%) did not show excessive hair growth. Thus, while not universal, hirsutism was still present in almost four out of every ten patients, making it a significant contributor to the overall clinical picture.

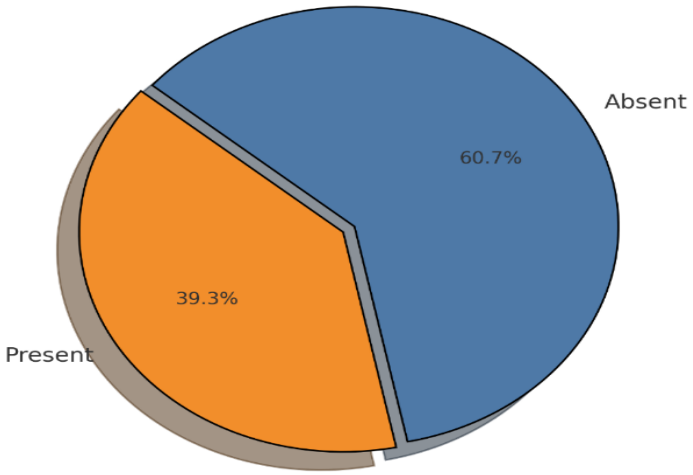

Fig 7: Prevalence of hirsutism.

Acanthosis nigricans: Signs of insulin resistance were evident in the form of acanthosis nigricans. This dark, velvety pigmentation was noted in 50 patients (33.3%), while 100 patients (66.7%) had no such finding. Roughly one-third of patients therefore carried visible evidence of underlying metabolic disturbance.

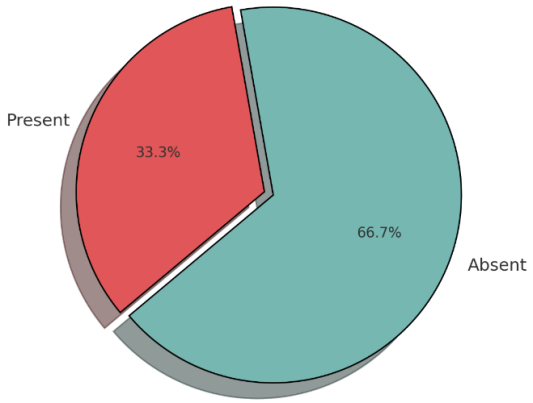

Fig 8: Prevalence of acanthosis nigricans

Waist circumference and central obesity: Central adiposity was also common. Using the IDF cut-off of 80 cm for patients, 81 participants (54.0%) were classified as having central obesity, while 69 (46.0%) fell below this threshold. In effect, more than half the patients had an excess abdominal girth that places them at risk for metabolic complications.

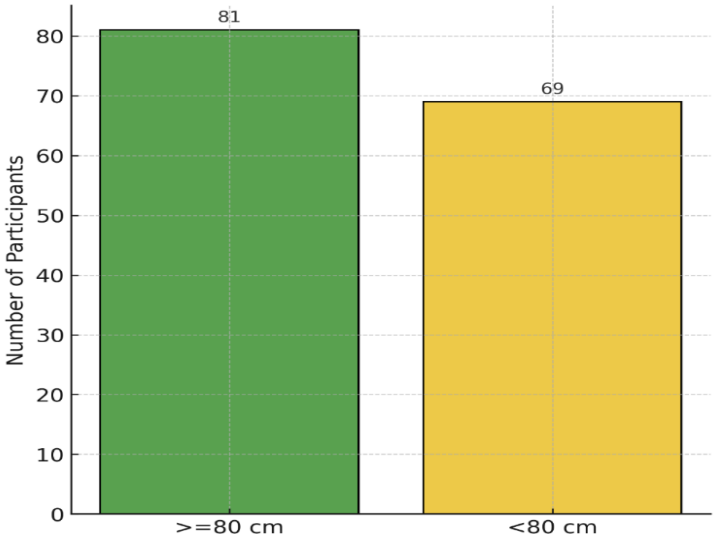

Fig 9: Central obesity (waist circumference)

Anthropometric parameters: The overall body measurements further underlined the metabolic burden. Heights ranged from 144 to 170 cm, with a mean of 157.1 ± 7.37 cm. Body weights varied widely, from 38.4 to 118.8 kg, with a mean of 65.05 ± 20.6 kg. The BMI spanned 18.5 to 42.3, averaging 25.9 ± 6.7, which sits in the overweight category. Waist circumferences ranged from 66.0 to 111.01 cm, with a mean of 83.2 ± 13.2 cm. These averages suggest that overweight and central obesity were highly prevalent among patients in this study.

Table: Table representing Association of Anthropometry with Metabolic Syndrome

Metabolic syndrome		Age	BMI	Height	Weight	Waist circumference	Systolic	Diastolic
No	Mean	22.71	23.5536	156.33	58.33	78.63	120.14	71.61
	SD	5.24	5.32707	7.405	17.278	10.673	6.307	8.058
Yes	Mean	26.89	33.1789	159.66	84.97	96.97	130.13	85.18
	SD	4.78	5.01226	6.767	16.477	10.098	10.751	15.854
Total	Mean	23.77	25.9920	157.17	65.08	83.28	122.67	75.05
	SD	5.431	6.70980	7.371	20.615	13.200	8.794	12.078
p-value		<0.001	<0.001	0.016	<0.001	<0.001	<0.001	<0.001

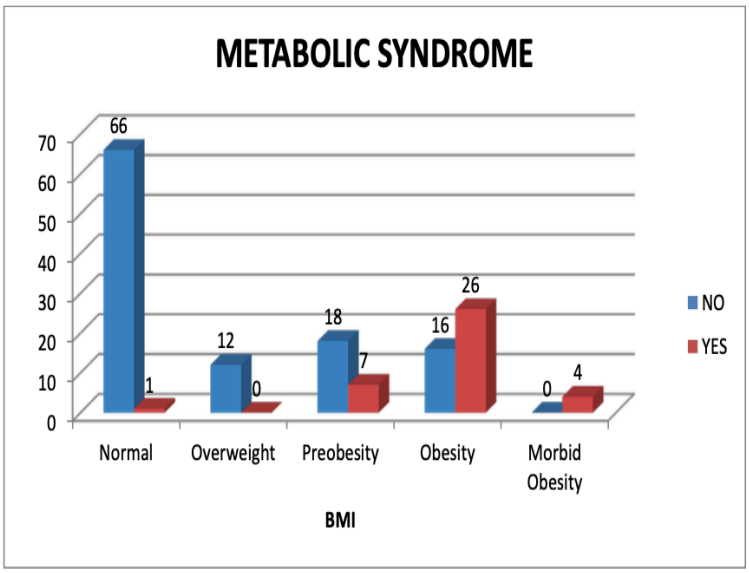

Fig 10: Graph Representing Association of BMI with Metabolic

Metabolic Syndrome components: When individual components of metabolic Syndrome were examined, central obesity stood out as the most frequent abnormality, seen in 81 patients (54%). Hypertriglyceridemia was present in 61 patients (40.7%), while low HDL cholesterol was detected in 55 patients (36.7%). Elevated blood pressure, defined as ≥130/85 mmHg, was found in 52 patients (34.7%).

Finally, raised fasting blood sugar (≥100 mg/dL) was noted in 21 patients (14%). These numbers show that even when the full criteria were not met, many patients carried one or more cardiometabolic risk factors.

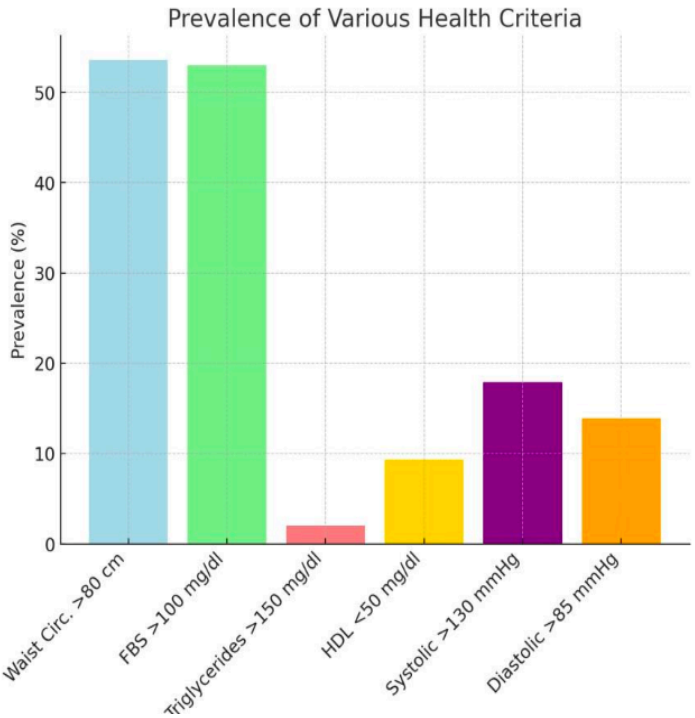

Fig 11: Graph Representing Association of Anthropometry with metabolic Syndrome

Prevalence of metabolic Syndrome: Applying the IDF criteria, 38 patients (25.3%) were diagnosed with metabolic Syndrome, while 112 (74.7%) were not. Put simply, one in every four patients with PCOS in this study also had metabolic Syndrome.

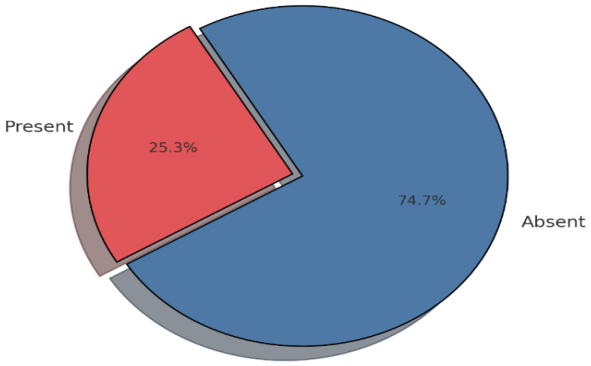

Fig 12: Prevalence of metabolic Syndrome in patients with PCOS

Associations with risk factors: Menstrual irregularities were strongly linked with Metabolic Syndrome. Among the 30 patients who had irregular cycles, 24 (80%) met criteria for metabolic Syndrome. In contrast, only 6 of 67 patients (9%) with regular cycles, 7 of 43 (16%) with infrequent cycles, and 1 of 10 (10%) with frequent cycles had Metabolic Syndrome. This association was statistically significant ($p<0.001$). Parity did not appear to influence the risk. Metabolic Syndrome was present in 15 of 74 nulliparous patients (20.3%) and 23 of 76 parous patients (30.2%), with no significant difference ($p=0.284$). Thyroid disorders showed no meaningful association either. Of the 12 patients with thyroid abnormalities, 3 (25%) had Metabolic Syndrome, compared to 35 of 138 (25.4%) without thyroid problems ($p=0.729$).

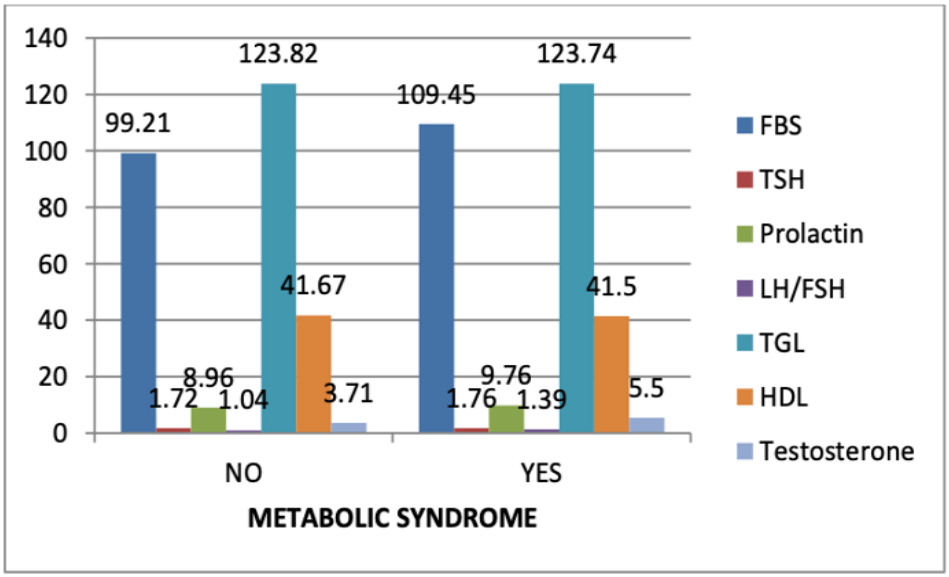

Fig 13: Comparison of the percentage of various parameters of metabolic Syndrome, comparing it with no- metabolic Syndrome.

Similarly, hirsutism and acanthosis nigricans did not demonstrate significant associations. Among patients with hirsutism, 20 of 59 (33.9%) had Metabolic Syndrome, while 18 of 91 (19.7%) without hirsutism did ($p=0.078$). Acanthosis was present in 50 patients, and 15 of them (30%) had Metabolic Syndrome versus 23 of 100 (23%) without acanthosis ($p=0.535$). On the other hand, ultrasound findings did matter. Polycystic ovarian morphology was seen in 52 patients (34.6%). Among them, 21 (40.4%) had Metabolic Syndrome, compared to 17 of 98 (17.3%) without this morphology. This difference was statistically significant ($p=0.002$).

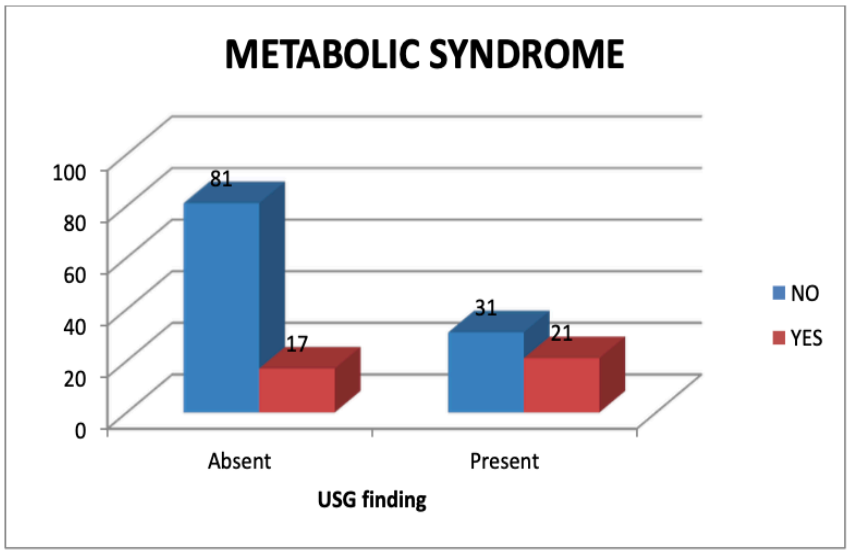

Fig. 14: Ultrasound findings and Metabolic Syndrome.

BMI category was also a powerful predictor. Only 1 of 67 patients (1.5%) with normal BMI had Metabolic Syndrome. None of the 12 overweight patients had Metabolic Syndrome. However, the prevalence jumped to 7 of 25 (28%) in the pre-obese group, 26 of 42 (61.9%) in the obese group, and 4 of 4 (100%) in the morbidly obese group. The association was highly significant ($p<0.001$).

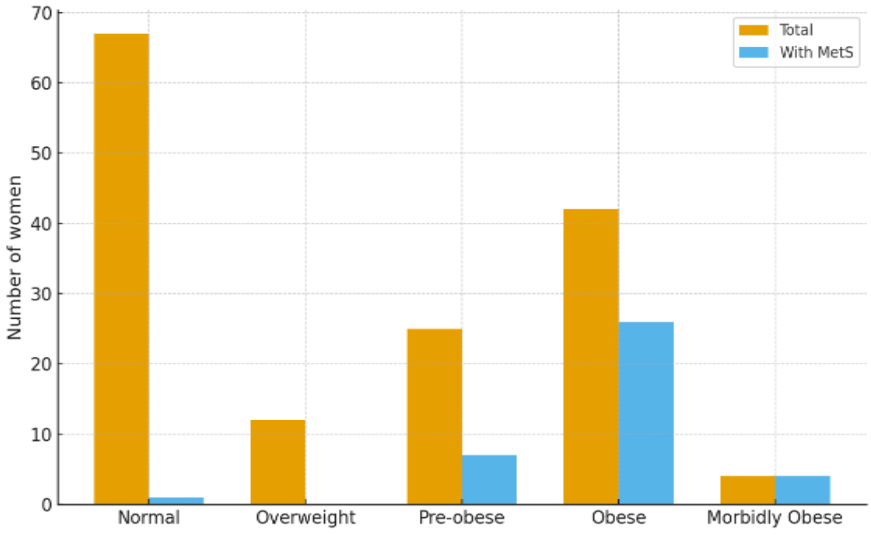

Fig. 15: BMI comparison in Metabolic Syndrome

No participant reported a prior history of diabetes mellitus, myocardial infarction, or asthma.

Anthropometry and blood pressure in relation to Metabolic Syndrome: When patients with and without Metabolic Syndrome were compared directly, striking differences emerged. Those with Metabolic Syndrome (n=38) were on average older (26.89 ± 4.78 vs 22.71 ± 5.24 years) and significantly heavier, with higher BMI (33.18 ± 5.01 vs 23.55 ± 5.33), weight (84.97 ± 16.48 vs 58.33 ± 17.28 kg), and waist circumference (96.97 ± 10.10 vs 78.63 ± 10.67 cm). Their blood pressures were also higher: systolic 130.13 ± 10.75 vs 120.14 ± 6.31 mmHg, and diastolic 85.18 ± 15.85 vs 71.61 ± 8.06 mmHg.

All these differences were highly significant ($p<0.001$). Even height differed modestly, with patients with Metabolic Syndrome being slightly taller (159.66 ± 6.77 vs 156.33 ± 7.41 cm; $p=0.016$).

Biochemical and hormonal parameters in relation to Metabolic Syndrome: Metabolic

differences extended to laboratory findings. Fasting blood sugar was higher in patients with Metabolic Syndrome (109.45 ± 10.70 mg/dL) compared to those without (99.21 ± 8.53 mg/dL; p<0.001). The LH/FSH ratio was also greater in the Metabolic Syndrome group (1.39 ± 0.76 vs 1.04 ± 0.60; p=0.003). Serum testosterone levels stood out, with Metabolic Syndrome patients having significantly higher values (5.50 ± 1.75 ng/mL) than non-Metabolic Syndrome patients (3.71 ± 1.65 ng/mL; p<0.001).

Other parameters showed little difference. TSH averaged 1.76 ± 0.43 µIU/mL in the Metabolic Syndrome group and 1.72 ± 0.45 µIU/mL in the non-Metabolic Syndrome group (p=0.633). Prolactin levels were 9.76 ± 2.48 ng/mL vs 8.96 ± 2.91 ng/mL (p=0.127). Triglycerides were virtually identical (123.74 ± 10.39 vs 123.82 ± 10.04 mg/dL; p<0.001, though statistically significant, the difference was not clinically meaningful). HDL cholesterol levels were also similar (41.50 ± 6.47 vs 41.67 ± 6.54 mg/dL; p=0.890). In summary, the prevalence of metabolic Syndrome in this study was 25.3%. Significant associations were found with menstrual irregularities, obesity and BMI, central obesity, and ultrasound-confirmed polycystic ovarian morphology. Patients with Metabolic Syndrome not only had higher BMI, waist circumference, and blood pressure, but also demonstrated higher fasting blood sugar, LH/FSH ratios, and testosterone levels compared to those without metabolic Syndrome.

Discussion

Metabolic Syndrome (MetS) represents a cluster of metabolic abnormalities such as abdominal obesity, insulin resistance, dyslipidemia, and hypertension, which, when combined with polycystic ovarian syndrome (PCOS), significantly increase the long-term risk of type 2 diabetes mellitus and cardiovascular disease. In our study, the prevalence of Metabolic Syndrome among patients with PCOS was 25.3%. This finding is comparable to that of Indu et al. from Kerala, who reported 25.2%6, and is within the range described in other Indian reports, where prevalence varies between 25–45% [6,8].

Western studies, however, have shown considerably higher figures: Apridonidze et al. reported 46% [5] and Ehrmann et al. documented 43% using NCEP ATP III criteria2. These ethnic differences can be explained by the fact that South Asian patients tend to develop insulin resistance and central adiposity at lower BMI levels than their Western counterparts [7], in addition to variations in diet, lifestyle, and urbanization.

Age showed a significant association with metabolic risk in our cohort. Metabolic Syndrome prevalence was lowest in patients ≤25 years (14%) and increased markedly in those aged 26–30 years (56%) and 31–45 years (40%) (p<0.001). Rajani et al. also demonstrated rising metabolic risk with increasing age among Indian patients with PCOS8, while Ford et al. and Grundy et al. reported similar trends in general populations, confirming the cumulative effect of aging on metabolic risk [9,10].

Obesity and central adiposity were the strongest predictors of Metabolic Syndrome. Only 1.5% of patients with normal BMI had Metabolic Syndrome compared to 28% in the pre-obese group, 61.9% in the obese group, and 100% among morbidly obese patients (p<0.001). Waist circumference ≥80 cm was present in 54% and strongly associated with Metabolic Syndrome. These findings are in agreement with Kaur, who emphasized the central role of visceral fat [7], and Wildman et al., who demonstrated that cardiometabolic clustering is disproportionately higher in overweight and obese individuals11. Importantly, even lean PCOS patients may harbor metabolic abnormalities, as highlighted by Makhija et al., underscoring the need for metabolic screening in all phenotypes [12].

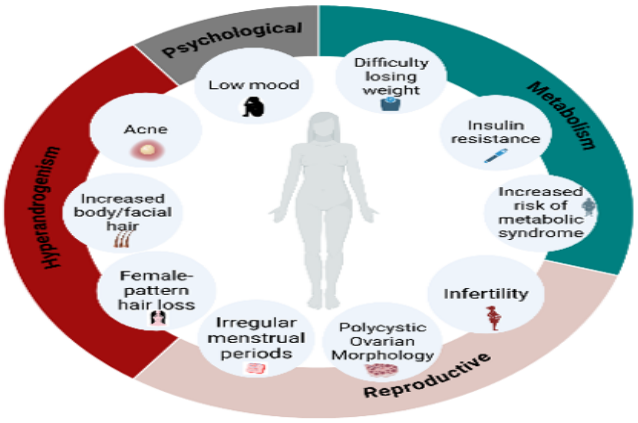

Fig 16: Features of PCOS

Menstrual dysfunction was present in 55.3% of our patients, and its association with Metabolic Syndrome was statistically significant (p=0.024). Patients with infrequent cycles had the highest prevalence (51.2%). Carmina and Lobo earlier demonstrated that oligo-ovulation correlates with hyperinsulinemia [13], while Legro et al. reported a strong link between reproductive disturbances and metabolic dysfunction [4]. Thus, menstrual history can serve as a simple clinical marker for metabolic risk.

Clinical signs of insulin resistance also correlated with metabolic risk. Hirsutism was seen in 39.3% and acanthosis nigricans in 33.3% of patients, both significantly associated with Metabolic Syndrome (p<0.001). These observations are consistent with Ingravallo et al. and Mandrelle et al., who demonstrated that visible clinical markers strongly predict metabolic abnormalities in PCOS [14,15].

Biochemical analysis further highlighted the metabolic derangements. Fasting blood sugar was significantly higher in patients with Metabolic Syndrome (109.45 ± 10.70 mg/dL) compared to those without (99.21 ± 8.53 mg/dL; p<0.001). Elevated LH/FSH ratio (1.39 vs. 1.04; p=0.003) and serum testosterone levels (5.50 vs. 3.71 ng/mL; p<0.001) were also observed, underscoring the overlap between metabolic and endocrine disturbances.

Similar associations were reported by Fulghesu et al., who described links between hyperandrogenaemia, abnormal gonadotropin ratios, and insulin resistance [16]. On the other hand, thyroid disorders and prolactin levels showed no significant correlation, in line with Sinha et al. and Lujan et al., who reported minimal contribution of these parameters to metabolic risk in PCOS [17,18].

Ultrasound findings reinforced the association. Polycystic ovarian morphology was present in 34.6% of patients, and 40.4% of these had Metabolic Syndrome compared to 17.3% without such morphology (p=0.002). This observation is consistent with the work of Neha et al., who demonstrated that morphological ovarian features correlate with systemic metabolic dysfunction [19].

Overall, our findings indicate that one in four patients with PCOS in North India are affected by Metabolic Syndrome, with age, obesity, central adiposity, menstrual irregularity, hyperandrog enism, and ultrasound features serving as key correlates. These results parallel global evidence while adding region-specific insights from semi-urban India. The clinical implication is clear: routine metabolic screening should be integrated into the management of PCOS, and early lifestyle interventions should be emphasized to reduce long-term cardiometabolic complications.

Limitations

The present study was conducted at a single tertiary care centre in North India, which may limit the generalizability of the findings to other regions or populations. The cross-sectional design restricts the ability to establish causal relationships between PCOS, metabolic Syndrome, and associated risk factors. In addition, lifestyle factors such as dietary habits and physical activity, which may strongly influence metabolic risk, were not evaluated in detail. Larger multicentric studies with longitudinal follow-up are required to confirm these findings and to better understand the temporal evolution of metabolic risk in patients with PCOS.

Conclusion

Our study demonstrates that one in four reproductive-aged patients with PCOS also have metabolic Syndrome, highlighting a significant overlap between reproductive and metabolic dysfunction in this population. Advancing age, obesity, increased waist circumference, menstrual irregularities, hirsutism, acanthosis nigricans, elevated fasting blood glucose, higher LH/FSH ratio, increased serum testosterone levels, and polycystic ovarian morphology on ultrasound were strongly associated with the presence of metabolic Syndrome.

In contrast, parity, thyroid disorders, prolactin levels, and socioeconomic status showed no significant associations. These findings emphasize that even young patients with PCOS are at substantial cardiometabolic risk and should undergo routine metabolic screening. Early identification and timely lifestyle interventions focusing on weight reduction, dietary modification, and physical activity are crucial to mitigate long-term risks of type 2 diabetes and cardiovascular disease. Region-specific data such as ours further underscore the importance of integrating metabolic evaluation into routine PCOS care in semi-urban and rural Indian settings.

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