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Original Research Article

Clinical and Metabolic Profiling of Polycystic Ovary Syndrome Patients: The Interplay of Anthropometry, Hirsutism, and Insulin Resistance

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Abstract

Background: Polycystic ovary syndrome (PCOS) is a prevalent endocrine disorder in women that affects both reproductive and metabolic systems and is characterized by insulin resistance and other metabolic disturbances. Therefore, the purpose of the study is to evaluate the clinical and metabolic characteristics of Polycystic Ovary Syndrome (PCOS) patients, focusing on anthropometry, hirsutism, and insulin resistance. ***Aim of the study:*** The aim of the study was to evaluate the clinical and metabolic characteristics of Polycystic Ovary Syndrome (PCOS) patients, focusing on anthropometry, hirsutism, and insulin resistance. ***Methods:*** This comparative cross-sectional study at the Department of Obstetrics and Gynecology, ICMH, Dhaka (Oct 2022–Sep 2023) included 66 women aged 18–35 years with PCOS (Rotterdam criteria), grouped by ovarian volume (>10 cc vs ≤10 cc). Anthropometric, clinical, and metabolic parameters—including BMI, waist-to-hip ratio, Ferriman–Gallwey score, fasting glucose, insulin, and HOMA-IR—were assessed. Data were analyzed using SPSS 27, with $p < 0.05$ considered significant. ***Results:*** Among 66 PCOS patients, Group A showed higher BMI (27.49 vs. 26.07 kg/m²) and HOMA-IR (4.83 vs. 3.59; $p = 0.012$). A strong correlation was found between HOMA-IR and ovarian volume ($r = 0.685$, $p < 0.001$). High insulin resistance (≥3.8) was more frequent in Group A (67.6% vs. 21.9%), conferring 7.5-fold higher odds of enlarged ovarian volume (OR = 7.47, 95% CI = 2.48–22.52). ***Conclusion:*** PCOS in women is closely associated with overweight, hirsutism, and insulin resistance, which in turn correlates with increased ovarian volume.

Keywords: Polycystic Ovary Syndrome, Anthropometry, Hirsutism, Insulin Resistance, Metabolic Profiling.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is a prevalent endocrine disorder in women that impacts both reproductive and metabolic systems [1]. The syndrome is characterized by various metabolic irregularities, most notably insulin resistance, along with other components of metabolic syndrome, which increase the likelihood of developing type 2 diabetes and cardiovascular diseases [2]. PCOS is recognized as the most common endocrine disorder among women of reproductive age, affecting roughly 5% to 10% of this population. The Rotterdam consensus defines PCOS by the presence of at least two of the following: oligo- or anovulation, clinical or biochemical signs of hyperandrogenism, and polycystic ovarian morphology [3,4]. Earlier diagnostic criteria from the 1990 NIH guidelines emphasized chronic anovulation and clinical or biochemical hyperandrogenism [5], while the 2004 Rotterdam criteria expanded this definition to require two of three features: oligo-anovulation, hyperandrogenism, and polycystic ovaries confirmed by ultrasound [3].

The clinical significance of PCOS extends across reproductive, metabolic, oncologic, and psychological domains [6,7]. Women with PCOS may

experience menstrual irregularities, infertility, excessive androgen-related symptoms, and complications during pregnancy. Metabolically, these women often present with insulin resistance and an elevated risk of developing type 2 diabetes and cardiovascular disorders. Additionally, they face increased oncological risks, including endometrial, ovarian, and breast cancers, and may also experience psychological issues such as heightened anxiety and depression [8-11]. Research indicates a bidirectional relationship between obesity and PCOS, where excess body weight can worsen the syndrome, while PCOS itself may promote weight gain [12].

At a hormonal level, women with PCOS frequently have reduced levels of sex hormone-binding globulin and elevated androgen production originating from both ovarian and adrenal sources. This hormonal milieu, combined with increased insulin secretion and insulin resistance [13], contributes to the central obesity often observed in these patients [14-16]. Anthropometric assessments, including body mass index (BMI) and waist-to-hip ratio, provide clinically relevant information about body composition—fat mass, lean mass, and bone mass—which is closely linked to metabolic and endocrine disturbances in PCOS [17-20]. Insulin resistance, which affects 35% to 80% of women with PCOS independently of BMI, is central to the persistence of the disorder, driving both metabolic derangements and ovarian dysfunction [21-23]. Interventions, including lifestyle modifications and pharmacological therapy such as metformin, are used to enhance insulin sensitivity, decrease hyperandrogenism, and alleviate both metabolic and reproductive complications associated with the condition [24].

Despite extensive research on the metabolic and reproductive aspects of PCOS, there remains a lack of comprehensive data integrating clinical, anthropometric, and metabolic profiling in affected women, particularly in the regional population. While studies have individually examined insulin resistance, hirsutism, or body composition, few have simultaneously assessed these parameters and their interrelationships with ovarian morphology. This limits the understanding of how clinical and metabolic features collectively influence disease severity and risk stratification in PCOS patients. Therefore, the purpose of the study is to evaluate the clinical and metabolic characteristics of Polycystic Ovary Syndrome (PCOS) patients, focusing on anthropometry, hirsutism, and insulin resistance.

OBJECTIVE

- To evaluate the clinical and metabolic characteristics of Polycystic Ovary Syndrome (PCOS) patients, focusing on anthropometry, hirsutism, and insulin resistance.

METHODOLOGY & MATERIALS

This comparative cross-sectional study was conducted in the Department of Obstetrics and Gynecology at the Institute of Child and Mother Health (ICMH), Matuail, Dhaka, Bangladesh, over a one-year period from October 2022 to September 2023. A total of 66 women aged 18–35 years, diagnosed with polycystic ovary syndrome (PCOS) according to the Rotterdam criteria, were included. Participants were enrolled following predefined inclusion and exclusion criteria to assess the association between insulin resistance and ovarian volume in PCOS. In addition, clinical and metabolic characteristics such as BMI, waist-to-hip ratio, hirsutism score, and insulin resistance indices were compared between the two groups. Based on ovarian volume measured by transvaginal sonography (TVS), subjects were categorized into two groups: Group A (n = 34) with ovarian volume >10 cc, and Group B (n = 32) with ovarian volume ≤10 cc.

Inclusion criteria:

- Women aged 18–35 years diagnosed with PCOS according to the Rotterdam criteria
- Willingness to provide written informed consent
- Group A: Ovarian volume ≥10 cc; Group B: Ovarian volume <10 cc

Exclusion criteria:

- Presence of thyroid disorders, hyperprolactinemia, Cushing syndrome, or congenital adrenal hyperplasia
- Diabetes mellitus or other systemic illnesses such as chronic kidney or liver disease
- Use of medications influencing insulin resistance or ovarian function within the previous six months (e.g., oral contraceptives, glucocorticoids, metformin, ovulation-inducing agents, anti-androgens, or lipid-lowering/anti-obesity drugs)

Ovarian volume was considered the dependent variable, while independent variables included fasting plasma glucose, fasting insulin, and insulin resistance determined by HOMA-IR. Hirsutism was assessed using the Modified Ferriman–Gallwey score, and anthropometric parameters such as BMI and waist-to-hip ratio were measured following standard protocols. After an overnight fast of at least eight hours, 6 mL of venous blood was collected under aseptic conditions to measure fasting plasma glucose and insulin levels at the Department of Biochemistry and Molecular Biology, BSMMU. Ovarian volume was assessed using transvaginal sonography, while demographic, clinical, and obstetric information was obtained through structured interviews and physical examinations.

Data were analyzed using SPSS version 27. Descriptive statistics were expressed as mean ± SD,

frequency, and percentage. Group comparisons were performed using the unpaired t-test for continuous variables and the chi-square or Fisher's exact test for categorical variables. Pearson's correlation coefficient was applied to examine the relationship between HOMA-IR and ovarian volume, and odds ratios (OR) with 95% confidence intervals (CI) were calculated for categorical associations. A p-value <0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Review Board of ICMH. Written informed consent was obtained from all participants, and confidentiality was maintained through unique identification codes. Participants were assured of minimal physical, psychological, or social risk and were free to withdraw from the study at any time.

RESULTS

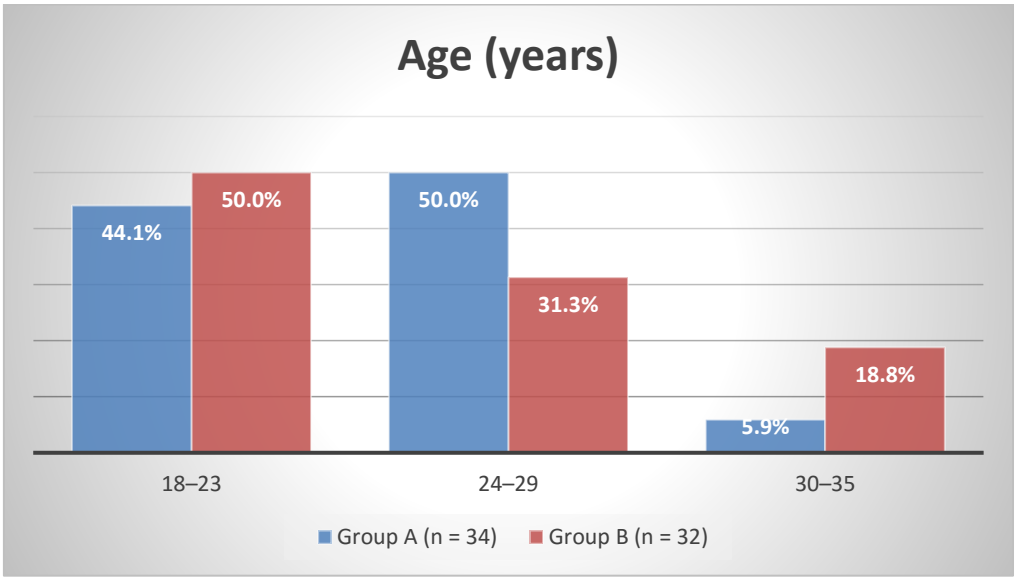

Figure 1: Age Distribution of Respondents by Group (n = 66)

The majority of respondents in both groups were aged 18–29 years. The mean age was slightly lower in Group A (24.47 ± 3.13 years) compared with Group B (25.66 ± 4.36 years), although the difference was not statistically significant (p = 0.207).

Table 1: Anthropometric Characteristics of PCOS Patients by Group (n = 66)

Parameter	Group A (n = 34)	Group B (n = 32)	p-value
BMI (kg/m²)			0.163[c]
Normal (18.5–24.9)	7 (20.6%)	13 (40.6%)	
Overweight (25.0–29.9)	18 (52.9%)	15 (46.9%)	
Obese (≥30.0)	9 (26.5%)	4 (12.5%)	
Mean ± SD	27.49 ± 3.46	26.07 ± 3.22	0.090[b]
Waist-to-hip ratio (Mean ± SD)	0.91 ± 0.08	0.89 ± 0.09	0.223[b]

Table 1 presents the anthropometric profile of participants in Group A and Group B. The mean BMI was slightly higher in Group A (27.49 ± 3.46 kg/m²) compared with Group B (26.07 ± 3.22 kg/m²), though this difference was not statistically significant (p = 0.090). Distribution of BMI categories showed that the majority of participants were overweight in both groups. The mean waist-to-hip ratio was 0.91 ± 0.08 in Group A and 0.89 ± 0.09 in Group B, with no significant difference between the groups (p = 0.223).

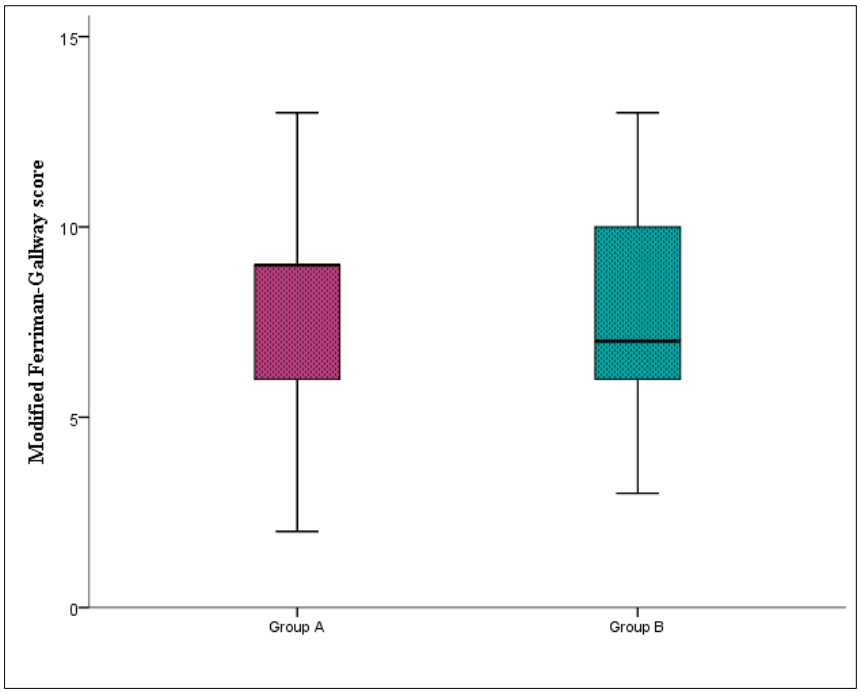

Figure 2: Distribution of Modified Ferriman–Gallwey Scores Among PCOS Patients by Group (n = 66)

Figure 2 shows the distribution of hirsutism, measured by the Modified Ferriman–Gallwey (MFG) score, in Group A and Group B. The mean MFG score was slightly higher in Group A (8.00 ± 2.86) compared with Group B (7.72 ± 2.92), but the difference was not statistically significant ($p > 0.05$).

Table 2: Comparison of Insulin Resistance (HOMA-IR) Between Groups (n = 66)

Group	HOMA-IR (Mean ± SD)	p-value
A (n = 34)	4.83 ± 2.21	0.012[b]
B (n = 32)	3.59 ± 1.67	

Table 2 presents the mean insulin resistance index (HOMA-IR) for Group A and Group B. The mean HOMA-IR was significantly higher in Group A (4.83 ± 2.21) compared with Group B (3.59 ± 1.67) ($p = 0.012$).

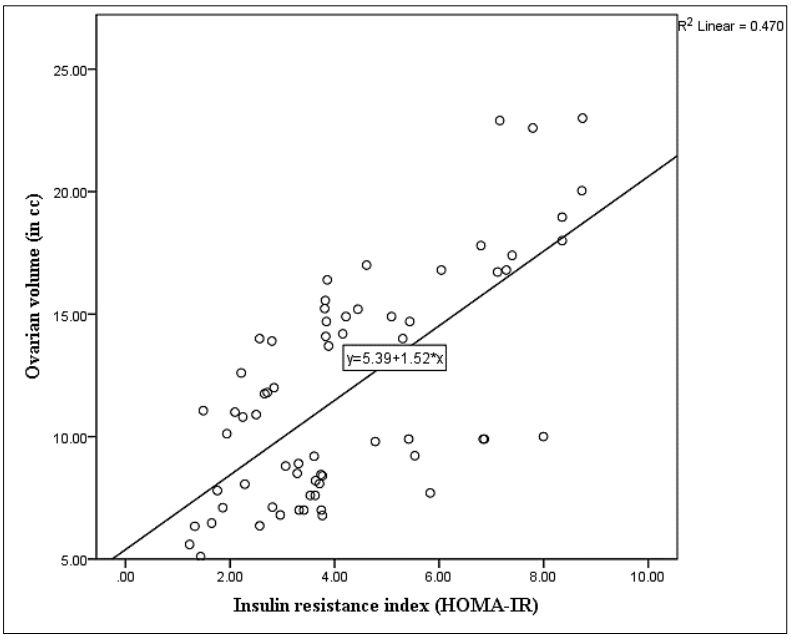

Figure 3: Correlation Between Insulin Resistance (HOMA-IR) and Ovarian Volume in PCOS Patients (n = 66)

Figure 3 illustrates the relationship between insulin resistance, measured by HOMA-IR, and ovarian volume among PCOS patients. A moderate positive correlation was observed ($r = 0.685$, $p < 0.001$), indicating that higher HOMA-IR values are associated with larger ovarian volumes. The coefficient of determination ($R^2 = 0.470$) suggests that approximately 47% of the variance in ovarian volume can be explained by variations in HOMA-IR levels.

Table 3: Odds of Enlarged Ovarian Volume (>10 cc) According to High Insulin Resistance (HOMA-IR ≥ 3.8) in PCOS Patients (n = 66)

HOMA-IR	Group A (n = 34) n (%)	Group B (n = 32) n (%)	p-value	OR (95% CI)
≥ 3.8	23 (67.6%)	7 (21.9%)	<0.001[c]	7.468 (2.476–22.522)
< 3.8	11 (32.4%)	25 (78.1%)		

Table 3 presents the association between high insulin resistance and ovarian volume in PCOS patients. Using a cut-off value for HOMA-IR ≥ 3.8 (Lewandowski *et al.*, 2019), a significantly higher proportion of participants in Group A (67.6%) had elevated insulin resistance compared with Group B (21.9%) ($p = 0.001$). Participants with high insulin resistance had 7.5 times higher odds of having an ovarian volume >10 cc (OR = 7.468; 95% CI = 2.476–22.522).

DISCUSSION

Clinical and metabolic characteristics of women with Polycystic Ovary Syndrome (PCOS) present significant challenges to reproductive and metabolic health, often requiring comprehensive evaluation and management. The findings of this study highlight the interplay between anthropometric measures, hirsutism, and insulin resistance, demonstrating how these factors are associated with variations in ovarian volume. Observed differences in BMI, waist-to-hip ratio, and hirsutism scores, along with the significant correlation between insulin resistance and enlarged ovarian volume, underscore the multifactorial nature of PCOS. These results emphasize the importance of early identification and targeted interventions to mitigate metabolic and reproductive complications in affected women.

In the present study, the majority of respondents in both groups were within the 18–29-year age range, with mean ages of 24.47 ± 3.13 years in Group A and 25.66 ± 4.36 years in Group B, showing no statistically significant difference ($p = 0.207$). This age distribution indicates that PCOS predominantly affects women in their early reproductive years, which aligns with the findings of Vaidya *et al.*,[25], who reported a mean age of 24.9 ± 4.52 years and the highest prevalence among women aged 26–34 years (38%). Similar age trends have been observed in other regional and international studies, reinforcing that PCOS is most frequently diagnosed during the second and third decades of life, coinciding with the period of peak reproductive activity.

The mean BMI in Group A (27.49 ± 3.46 kg/m²) was slightly higher than in Group B (26.07 ± 3.22 kg/m²), with the majority of participants in both groups being overweight or obese. These findings are consistent with Prajapati *et al.*,[26], who reported mean BMI values of 26.39 ± 4.17 kg/m² in PCOS patients and 26.37 ± 3.79 kg/m² in non-PCOS controls, indicating that elevated BMI is common in this population. Similarly, Thathapudi *et al.*,[27] noted that 60–80% of women with PCOS were overweight or obese, further supporting the strong association between PCOS and increased body mass. The mean waist-to-hip ratio (WHR) was also higher in Group A (0.91 ± 0.08) than in Group B (0.89 ± 0.09), aligning with previous evidence that central adiposity is a key anthropometric feature of PCOS, although differences in BMI and WHR were not statistically significant.

The mean Modified Ferriman–Gallwey (mFG) score was slightly higher in Group A (8.00 ± 2.86) compared with Group B (7.72 ± 2.92), though not statistically significant ($p > 0.05$), indicating comparable clinical hirsutism in both groups. This is consistent with Ilagan *et al.*,[28], who reported a mean mFG score of 4.3 ± 3.0 among PCOS patients, significantly higher than the non-PCOS group (2.0 ± 2.2; $p < 0.001$), highlighting the consistent presence of elevated hair growth among women with PCOS. The slightly higher scores in this study may reflect ethnic and genetic variations influencing hair growth severity, as well as differences in diagnostic thresholds and clinical settings.

The mean HOMA-IR value was significantly higher in Group A (4.83 ± 2.21) compared with Group B (3.59 ± 1.67; $p = 0.012$), indicating greater insulin resistance among PCOS patients. This aligns with Lewandowski *et al.*,[29], who reported a mean HOMA-IR of 2.72 ± 2.24 in PCOS women with a mean BMI of 27.61 ± 7.43 kg/m², and Majid *et al.*,[30], who observed a mean HOMA-IR of 3.1 ± 1.7, with approximately 69% of women exhibiting insulin resistance. The comparatively higher HOMA-IR values in the present study suggest a more pronounced metabolic disturbance, underscoring the central role of insulin resistance in the pathophysiology of PCOS.

A moderate positive correlation was observed between HOMA-IR and ovarian volume ($r = 0.685$, $p < 0.001$), indicating that higher insulin resistance is associated with larger ovarian volumes. This is in agreement with Huang *et al.*,[31], who reported a positive correlation between HOMA-IR and ovarian

volume, and Szkodziak *et al.*,[32], who found a strong positive correlation between insulin resistance and ovarian volume/antral follicle count. The coefficient of determination ($R^2 = 0.470$) suggests that nearly 47% of the variance in ovarian volume can be explained by insulin resistance, highlighting the significant impact of metabolic dysfunction on ovarian morphology.

Finally, patients with high insulin resistance (HOMA-IR ≥ 3.8) had significantly higher odds of having enlarged ovarian volume (>10 cc), with 67.6% of Group A compared to 21.9% of Group B affected ($p < 0.001$; OR = 7.468, 95% CI: 2.476–22.522). These results are consistent with Reid *et al.*,[33], who reported that PCOS women with ovarian volume >10 cc had a higher likelihood of abnormal biochemical markers of insulin resistance. This finding underscores the interplay between metabolic dysfunction and ovarian morphology in PCOS, suggesting that insulin resistance is a key contributor to increased ovarian volume and may serve as an important marker for identifying patients at higher metabolic risk.

Limitations of the study

This study had several limitations:

- It was conducted at a single tertiary care hospital, so the findings may not fully represent the broader population.
- The sample size was relatively small and could not be expanded due to financial constraints.
- The diagnosis of PCOS was based on the Rotterdam FN criteria, which may be overly inclusive given advances in ultrasound technology and recent guidelines recommending higher follicle number thresholds.

Therefore, the study findings cannot be generalized to the entire population.

CONCLUSION

This study demonstrates that PCOS predominantly affects women in their early reproductive years, with most patients being overweight or obese. Clinical hirsutism was observed to a comparable extent across groups. Importantly, insulin resistance was higher in one group and showed a positive association with ovarian volume, with elevated insulin resistance significantly increasing the likelihood of enlarged ovaries. These findings highlight the interrelated roles of anthropometric, clinical, and metabolic factors in PCOS and underscore the importance of assessing insulin resistance in managing ovarian and reproductive health in affected women.

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