Comparative Analysis of Clinical and Metabolic Profiles in Insulin-Resistant and Non-Resistant Polycystic Ovary Syndrome Patients

**Abstract**

**Background:** Polycystic ovary syndrome (PCOS) is a common endocrine disorder in reproductive-aged women. It is often associated with insulin resistance (IR), which exacerbates reproductive and metabolic dysfunctions. Understanding the clinical and metabolic variations between insulin-resistant and non-resistant PCOS patients is vital for individualized management. This study aimed to compare the clinical and metabolic profiles of insulin-resistant and non-resistant PCOS patients to identify distinguishing features.

**Methods:** This cross-sectional observational study was conducted at the Department of Obstetrics and Gynaecology, Dhaka Medical College Hospital from June 2022 to May 2023, involving 75 PCOS-diagnosed women aged 18–40. Based on HOMA-IR scores, patients were grouped into insulin-resistant (HOMA-IR >1.9; n=45) and insulin non-resistant (HOMA-IR ≤1.9; n=30) groups. Clinical characteristics, anthropometric data, and biochemical parameters were compared. Statistical analysis was performed using SPSS v23.0.

**Results:** Insulin-resistant patients showed higher prevalence of hirsutism (82.2% vs. 66.7%) and acne (73.3% vs. 56.7%), though not statistically significant. Oligomenorrhea was more frequent in the IR group (86.7% vs. 66.7%). Mean BMI, WHR, and blood pressure values were similar across groups. Notably, elevated TSH levels (>2.5 mIU/L) were significantly more common in the IR group (68.9% vs. 23.3%; p=0.001).

**Conclusion:** Insulin resistance in PCOS is associated with more adverse clinical and metabolic features, particularly elevated TSH levels. Routine assessment of insulin resistance and thyroid function in PCOS patients is essential for early risk stratification and management.

**Keywords:** PCOS, insulin resistance, HOMA-IR, Clinical profile, metabolic profile.

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**Introduction**

Polycystic ovary syndrome (PCOS), which is one of the most common endocrine disorders, affects many reproductive-aged women by leading to elevated androgens, chronic imbalanced ovulation, and polycystic ovarian structure [1]. PCOS affects between 6% and 20% of women around the globe, mostly based on the criteria used [2]. In Bangladesh, as well as in other countries in South Asia, PCOS and its connected problems are on the rise, mainly because of changes in lifestyle, diet, and the trend toward urban settlements [3].

Several PCOS patients have insulin resistance (IR), which is considered a critical factor in the development of the condition. IR is linked to high insulin levels, which adds to high levels of male sex hormones, and can also lead to a higher risk of problems such as type 2 diabetes, dyslipidemia, and cardiovascular disease [4]. Most studies also indicate that insulin resistance affects up to 75% of lean and 95% of overweight or obese women with PCOS [5]. HOMA-IR is often chosen because it is fast and easy to measure insulin resistance in both studies and clinical work [6].

The Rotterdam rules, allowing a diagnosis when any two of the three characteristics are present, have made PCOS visible in more men and women. Therefore, patients with PCOS can have varying metabolic problems depending on their type [7]. While a few phenotypes are mainly connected to reproduction, others often have noticeable problems with metabolism, mainly insulin resistance [8]. Therefore, it is important to understand how symptoms and metabolic markers change between those who are and are not insulin-resistant in PCOS.

Several recent studies have noted that hypothyroidism and thyroid gland issues are commonly connected to PCOS, especially subclinical hypothyroidism, so doctors should consider TSH levels and their influence on insulin in women with PCOS [9,10]. High TSH values, on occasion within the normal range, have been tied to higher HOMA-IR values in women with PCOS [11]. Because of this connection, more studies are being conducted to better understand the link between thyroid function, metabolic parameters, and insulin resistance in women affected by PCOS [12].

Also, patients with PCOS often develop hirsutism, acne, and disturbed periods, and insulin sensitivity affects the outward symptoms [13]. Patients with insulin-resistant PCOS who have central obesity also face greater metabolic threats, which have been found in many studies [14]. BMI and waist-hip ratio (WHR) are often used to measure health, but their tie to insulin resistance in PCOS patients is still unpredictable [15].

While much evidence shows details about the hormonal and reproduction-related aspects of PCOS, very little is known about the comparison of medical and metabolic factors between insulin-resistant and non-resistant types of PCOS in the South Asian population. Few studies address this topic in Western populations or do not use HOMA-IR cut-offs to separate patients with PCOS [16,17].

Hence, this investigation was carried out to assess the differences in clinical and blood tests between insulin-resistant and non-resistant patients with PCOS in a tertiary hospital in Bangladesh. By pinpointing the specific factors linked to insulin resistance, this study aims to help in more accurate diagnosis and early care for any woman suffering from PCOS.

**Objective**

This study aimed to compare the clinical and metabolic characteristics among the insulin-resistant and non-resistant patients with polycystic ovary syndrome.

**Methodology & Materials**

This cross-sectional observational study was conducted at the Department of Obstetrics and Gynaecology, Dhaka Medical College Hospital, Dhaka, Bangladesh, from June 2022 to May 2023. A total of 75 women diagnosed with polycystic ovary syndrome (PCOS), aged between 18 and 40, were included. The participants were selected from the Reproductive Endocrinology and Infertility outpatient department. Based on their HOMA-IR values, the patients were divided into two groups: insulin-resistant (HOMA-IR >1.9; n=45) and insulin non-resistant (HOMA-IR ≤1.9; n=30).

**Inclusion Criteria:**

1. Women aged between 15 and 40 years.
2. Diagnosed with PCOS based on the Rotterdam Criteria.
3. Attended the Reproductive Endocrinology and Infertility OPD at Dhaka Medical College Hospital.

**Exclusion Criteria:**

1. Diagnosed with diabetes mellitus.
2. Clinical or biochemical hyperprolactinemia.
3. History or suspicion of ovarian or adrenal neoplasms.
4. Known hypothyroidism or previous thyroid treatment.
5. Use of steroids or insulin sensitizers in the past six months.

After obtaining informed written consent, detailed clinical and demographic information was collected using a structured questionnaire, including obstetric and menstrual history and anthropometric data. Blood samples were drawn on the third day of a spontaneous or progesterone-induced menstrual cycle following 12 hours of overnight fasting. Blood glucose, fasting insulin, and serum TSH were analyzed using validated laboratory procedures. Fasting plasma glucose was measured using the Glucose Oxidase method, and insulin via Chemiluminescent Microparticle Immunoassay. HOMA-IR was calculated using the formula: [fasting glucose (mmol/L) × fasting insulin (µIU/mL)] 22.5. Patients were divided into insulin-resistant (HOMA-IR >1.9) and non-resistant groups. Statistical analysis was performed using SPSS v23.0. Continuous variables were expressed as mean ± SD and compared using independent t-tests. Categorical data were analyzed using Chi-square tests. A p-value <0.05 was considered statistically significant. Ethical approval was obtained from the institutional review board, and confidentiality was maintained throughout the study.

**Results**

**Figure 1: Distribution of the study patients according to HOMA-IR (n=75)**

Figure 1 presents the distribution of the study population based on insulin resistance status using the HOMA-IR index. Out of the 75 patients diagnosed with PCOS, 45 (60%) were found to be insulin resistant (HOMA-IR > 1.9), while 30 (40%) were classified as insulin non-resistant (HOMA-IR ≤ 1.9). This indicates that a substantial proportion of PCOS patients in the study population exhibited insulin resistance, reinforcing its common association with the syndrome.

**Table 1: Comparison of menstrual and reproductive history between insulin-resistant and non-resistant patients (n=75)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variables** | | **Group I (N=45)** | | **Group II (N=30)** | | **P value** |
| **N** | **%** | **N** | **%** |
| **Parity** | Nulliparous | 41 | 91.1 | 28 | 93.3 | 0.544 |
| Parous | 4 | 8.9 | 2 | 6.7 |
| **Age of menarche (years), Mean±SD** | | 11.36±0.48 | | 11.37±0.49 | | 0.923 |
| **Menstrual cycle** | Normal | 5 | 11.1 | 9 | 30 | 0.109 |
| Oligomenorrhea | 39 | 86.7 | 20 | 66.7 |
| Secondary Amenorrhea | 1 | 2.2 | 1 | 3.3 |

Table 1 compares obstetric and menstrual parameters between insulin-resistant (Group I) and non-resistant (Group II) PCOS patients. The majority of participants in both groups were nulliparous—91.1 % in Group I and 93.3% in Group II—with no significant difference (p=0.544). The mean age of menarche was nearly identical between the two groups (11.36 ± 0.48 years in Group I vs. 11.37 ± 0.49 years in Group II; p=0.923). Menstrual cycle irregularities were typical in both groups. Oligomenorrhea was observed in 86.7% of insulin-resistant patients and 66.7% of non-resistant patients, suggesting a higher prevalence among those with insulin resistance, though the difference was not statistically significant (p=0.109). Overall, this table indicates that reproductive history and menstrual irregularities are prevalent in PCOS regardless of insulin resistance status, with a trend toward more irregularities in the insulin-resistant group.

**Table 2: Comparison of clinical and metabolic parameters between insulin-resistant and non-resistant patients (n=75)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | **Group I (N=45)** | | **Group II (N=30)** | | **P value** |
| **N** | **%** | **N** | **%** |
| **Hirsutism** | 37 | 82.2 | 20 | 66.7 | 0.122 |
| **Acne** | 33 | 73.3 | 17 | 56.7 | 0.134 |
| **BMI (kg/m2)** | | | | | |
| 18.5-24.9 (Normal) | 5 | 11.1 | 2 | 6.7 |  |
| 25.0-29.9 (Overweight) | 30 | 66.7 | 18 | 60 |
| ≥30.0 (Obese) | 10 | 22.2 | 10 | 33.3 |
| Mean±SD | 28.4±2.9 | | 28.6±2.6 | | 0.705 |
| **WHR** | 0.946±0.07 | | 0.954±0.06 | | 0.627 |
| **SBP (mmHg)** | 129.4±10.2 | | 132.7±4.9 | | 0.111 |
| **DBP (mmHg)** | 81.7±5.3 | | 83.7±5.1 | | 0.109 |

Table 2 presents a comparison of clinical and metabolic parameters between insulin-resistant and non-resistant PCOS patients. Hirsutism was more common among insulin-resistant patients (82.2%) compared to non-resistant patients (66.7%), and acne was also slightly more prevalent (73.3% vs. 56.7%), although neither difference reached statistical significance (p=0.122 and p=0.134, respectively). Body mass index (BMI) categories revealed that most patients in both groups were overweight or obese. The mean BMI was similar between the groups (28.4 ± 2.9 kg/m² in Group I vs. 28.6 ± 2.6 kg/m² in Group II; p=0.705). Waist-hip ratio (WHR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were also comparable between the groups, with no significant differences observed. These findings suggest that clinical features such as hirsutism, acne, and elevated BMI are standard in PCOS patients irrespective of insulin resistance status. However, they tend to be more prevalent among those with insulin resistance.

**Table 3: Comparison of serum TSH levels between insulin-resistant and non-resistant PCOS patients (n=75)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Group I (N=45)** | | **Group II (N=30)** | | **OR (95% CI)** | **P value** |
| **n** | **%** | **n** | **%** |
| Serum TSH (>2.5 mIU/L) | 31 | 68.9 | 7 | 23.3 | 7.276 (2.532-20.906) | 0.001 |
| Serum TSH (≤2.5 mIU/L) | 14 | 31.1 | 23 | 76.7 |

Table 3 presents the association between serum TSH levels and insulin resistance status in PCOS patients. Among insulin-resistant women, 68.9% had elevated TSH levels (>2.5 mIU/L), compared to only 23.3% in the non-resistant group. This difference was statistically significant (p=0.001), with an odds ratio of 7.276 (95% CI: 2.532–20.906), indicating that PCOS patients with elevated TSH levels were over seven times more likely to be insulin resistant. This finding highlights the potential link between thyroid dysfunction and insulin resistance as part of the broader metabolic disturbances observed in PCOS.

**Discussion**

The findings of this study reinforce the growing body of evidence that insulin resistance (IR) plays a pivotal role in defining the clinical and metabolic profiles of women with polycystic ovary syndrome (PCOS). In our cohort, 60% of the patients exhibited IR based on HOMA-IR >1.9, which aligns with previous literature indicating a high prevalence of IR in PCOS populations.

In the present study, 60% of PCOS patients were insulin resistant, and 40% were found to be insulin sensitive. Azargoon et al. found insulin resistance among 39.3% of PCOS subjects [18], and Enzevaei et al. observed that the prevalence of insulin resistance was 22.7% and noninsulin resistance was 77.3%, which are inconsistent with our results [16].

In this study, we observed that oligomenorrhea was found in 39(86.7%) group I and 20(66.7%) group II. Amenorrhea was 1(2.2%) and 1(3.3%) in group I and group II, respectively, which was not significant between the two groups. Similarly, Saha et al. revealed that oligomenorrhea was found in 101(93.5%) of the insulin-resistant group and 98(90.7%) of the insulin-sensitive group. Amenorrhea was 5(4.6%) in insulin resistant group and 3(2.8%) in insulin sensitive group, the difference was not statistically significant between two groups [19].

Azargoon et al. showed that PCOS patients in the IR group had significantly higher systolic and diastolic BP than the non-IR group [18]. However, our study revealed no significant difference in comparing systolic and diastolic BP in the insulin-resistant and nonresistant groups.

The present study revealed hirsutism in 37(82.2%) of group I and 20(66.7%) of group II. Acne was 33(73.3%) in group I and 17(56.7%) in group II. Yu and Wang demonstrated that hirsutism was 76.0%, which is similar to current study findings [20]. A study conducted by Makhija et al. reported that 80.2% of women with PCOS had acne vulgaris, 20.8% had acanthosis nigricans, and 83.3% had hirsutism, which is not analogous to the present study results [15]. According to Akshaya and Bhattacharya, hirsutism was seen in 84%, acanthosis nigricans in 12%, and acne in 18% of PCOS sufferers, which differs from this study [13]. No statistically significant difference was seen in the distribution of hirsutism and acne in insulin-resistant and insulin-sensitive groups in my study, which is analogous to the findings of Azargoon et al. [18].

In this study, most patients were overweight in both groups, 30(66.7%) in group I and 18(60.0%) in group II. In a study done by Fatima et al., it was reported that 19 women (61.3%) were obese and 12 (38.7%) were overweight according to BMI measurements, and the mean BMI was 32.5±3.75 kg/m2 [17]. Yu and Wang described that the mean BMI was 31.2±8.3 kg/m2and majority of the patient were found obese [20]. The above studies are nearly analogous to our study findings. However, the mean BMI in the following studies differs from our findings. Akshaya and Bhattacharya reported that though 56% were obese and the mean BMI was 29.52±2.43 kg/m2, 44% were lean PCOS and the mean BMI was 21.87±1.19 kg/m2 [13]. According to Lee et al., the mean BMI was 22.33±4.50 kg/m2, within the normal range. Moreover, we got a non-significant difference (P= 0.705) comparing the mean BMI of the insulin-resistant group (28.4±2.9 kg/m2) and the insulin-non-resistant group (28.6±2.6 kg/m2) [21]. In contrast, Saha et al. (2021) found a significant difference (P=0.046) analyzing the mean BMI of the insulin-resistant (27.58±3.77 kg/m2) and the insulin-sensitive group (26.65±3.01 kg/m2) [19].

In this study, the mean waist-hip ratio was found to be 0.946±0.07 in group I and 0.954±0.06 in group II, and their comparison is statistically insignificant (P=0.627). According to Saha et al., the distribution of mean waist-hip ratio in the insulin-resistant group (0.94±0.06) and the nonresistant group (0.93±0.05) of PCOS cases was not statistically significant (P=0.184) [19]. The mean waist–hip ratio of PCOS women was 0.90±0.12 as stated by Akshaya et al. [13]. Above all, study findings are analogous to our mean waist-hip ratio of 0.95±0.07. Enzevaei et al. revealed that the mean value of the waist-hip ratio in the euthyroid and subclinical hypothyroid groups of PCOS patients was 0.82±0.08 and 0.83±0.07, respectively, which differs from our mean waist-hip ratio [16].

One of the most significant findings was the elevated TSH levels in insulin-resistant patients. About 68.9% of IR patients had TSH >2.5 mIU/L, versus 23.3% in the non-resistant group, a statistically significant difference. This confirms earlier observations by Saha et al., who reported strong associations between elevated TSH levels and IR in PCOS populations [19]. According to Azargoon et al., 24.8% of insulin-resistant patients and 13.6% of nonresistant patients had serum TSH values>2.5 mIU/L, which differs from our percentage [18].

The odds ratio calculated (7.276) further underscores the potential risk of insulin resistance among PCOS patients with higher TSH levels. This supports the work of Rojhani et al., who emphasized the predictive value of subclinical hypothyroidism in identifying high-risk metabolic PCOS phenotypes [22]. In light of these findings, thyroid screening may be a critical component of metabolic risk assessment in PCOS management.

In summary, the current study supports the assertion that insulin resistance is associated with more severe clinical symptoms, higher TSH levels, and a greater metabolic burden in PCOS. While the cross-sectionaldesign limits causal inference, the data underline the importance of routine metabolic and thyroid screening in PCOS, particularly in resource-limited settings.

**Limitations and recommendations**

As a cross-sectional study, causality between insulin resistance and clinical outcomes could not be established. The sample size was relatively small and limited to a single center. Future research should focus on longitudinal studies involving larger, multi-center cohorts to validate these findings. Regular screening for insulin resistance and thyroid function should be incorporated into PCOS management protocols to guide personalized treatment strategies.

**Conclusion**

This study highlights that insulin resistance is prevalent in most PCOS patients and is associated with more adverse clinical and metabolic profiles, including higher rates of menstrual irregularities, hirsutism, acne, and elevated serum TSH levels. These findings reinforce the importance of assessing insulin resistance routinely in PCOS patients for early intervention and management.

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