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Impact of Obesity on Reproductive and Biochemical Parameters in Women with Polycystic Ovary Syndrome

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ABSTRACT

Background

Polycystic ovary syndrome (PCOS) is a common hormonal disorder in women of reproductive age, often complicated by obesity. While PCOS presents with a range of reproductive and metabolic abnormalities, obesity may further aggravate its clinical and biochemical features.To compare the reproductive and biochemical changes in obese and non-obese women diagnosed with PCOS.

Methods

This comparative cross-sectional study was conducted at Khyber Teaching Hospital, Peshawar, from January 2022 to January 2023. A total of 103 women with PCOS, 'diagnosed using the Rotterdam criteria, were included'. Participants 'were divided into obese and non-obese groups based on body mass index'. Data on menstrual patterns, clinical features, hormone levels, and metabolic markers were collected and analyzed.

Results

Obese women with PCOS had significantly higher levels of total and free testosterone, and LH/FSH ratio they also showed lower HDL cholesterol and levels, and a more disturbed lipid profile. Menstrual irregularities, hirsutism, and acanthosis nigricans were more common among obese participants, indicating a more severe clinical presentation.

Conclusion

Obesity has a considerable 'impact on the hormonal and metabolic profiles of women with PCOS, worsening insulin resistance and hyperandrogenism'. These findings highlight the importance of weight management as part of comprehensive care in PCOS.

Keywords

Polycystic ovary syndrome, obesity, insulin resistance, hyperandrogenism, reproductive hormones, metabolic profile

INTRODUCTION

'Polycystic ovary syndrome (PCOS) is a multifaceted endocrine disorder that affects a significant proportion of women during their reproductive years' (1). 'It is characterized by a combination of menstrual irregularities, clinical or biochemical signs of hyperandrogenism, and the presence of polycystic ovaries on ultrasound' (2). The condition is not only a leading cause of infertility but also associated with a range of metabolic disturbances. Despite its high prevalence, the exact etiology of PCOS remains poorly understood, with current evidence suggesting a complex interaction between genetic predisposition, hormonal imbalance, and environmental influences(3).

Among the 'various factors that contribute to the clinical severity of PCOS, obesity stands out as a key modifier'(4). Women with PCOS who are overweight or obese often experience more pronounced symptoms, including irregular menses, hirsutism, acne, and infertility' (5). Moreover, obesity can intensify underlying 'insulin resistance, which plays a central role in the pathophysiology of PCOS'. This insulin resistance not only disrupts glucose metabolism but also contributes to increased androgen production, thereby worsening both reproductive and metabolic profiles(6).

The impact of obesity on the hormonal and biochemical features of PCOS has been widely reported, yet variations exist across populations. 'Some studies suggest that even in the absence of obesity, women with PCOS can present with significant metabolic disturbances, while others emphasize the amplifying effect of excess weight on disease severity' (7). Understanding these differences is essential, especially in regions where both PCOS and obesity are becoming increasingly prevalent. A more nuanced understanding of how body mass index influences clinical and biochemical parameters may aid in developing more tailored approaches to diagnosis and management.

Given this background, the present study aims to compare the reproductive and biochemical profiles of obese and non-obese women with PCOS. By analyzing key hormonal levels, metabolic indicators, and clinical features, this study seeks to highlight the extent to which obesity alters the expression of PCOS. The findings may help clinicians better recognize the variable nature of the syndrome and reinforce the importance of lifestyle interventions, particularly in women presenting with both PCOS and elevated body weight.

METHODOLOGY

This comparative cross-sectional study was conducted in the Department of Gynaecology and Obstetrics at Khyber Teaching Hospital, Peshawar, over a one-year period from January 2022 to January 2023. The purpose was to assess and compare the 'reproductive and biochemical profiles of obese and non-obese women diagnosed with polycystic ovary syndrome (PCOS)'.

'Ethical approval for the study was obtained from the institutional review board' of Khyber Teaching Hospital. All participants were briefed about the objectives and procedures of the study and were assured of confidentiality. Written informed consent was obtained from each participant prior to data collection.

A total of 103 women aged between 18 and 35 years, who met the Rotterdam criteria for PCOS, were included in the study. Participants were selected using a 'non-probability consecutive sampling technique'. These criteria required 'the presence of at least two out of three features: oligo- or anovulation, clinical or biochemical signs of hyperandrogenism, and polycystic ovarian morphology on ultrasound, with the exclusion of other endocrine disorders'.

Women included in the study had a confirmed diagnosis of PCOS and were not on any hormonal therapy or insulin-sensitizing agents for at least three months prior to enrollment. Those with known thyroid dysfunction, hyperprolactinemia, congenital adrenal hyperplasia, Cushing's syndrome, or any systemic illness were excluded. Pregnant and lactating women were also not considered eligible for participation.

Participants were categorized into 'two groups based on their body mass index (BMI)'. Those with a BMI of 30 kg/m² or higher were classified as obese, while those with a BMI less than 25 kg/m² were categorized 'as non-obese'. 'BMI was calculated using the standard formula (weight in kilograms divided by the square of height in meters)'.

After obtaining informed written consent, demographic data including age, marital status, education level, occupation, and socioeconomic status were recorded using a structured proforma. Clinical details related to menstrual history, hirsutism (assessed via the Ferriman-Gallwey scoring system), acne, acanthosis nigricans, and infertility history were also documented. Pelvic ultrasonography was performed to identify polycystic ovarian morphology.

All participants underwent blood sampling after an overnight fast of at least 8 hours. 'Serum levels of luteinizing hormone (LH), follicle-stimulating hormone (FSH), total and free testosterone, dehydroepiandrosteronesulfate (DHEAS), prolactin, thyroid-stimulating hormone (TSH),and anti-Müllerian hormone (AMH), were measured using standardized immunoassay techniques. .

In addition, 'lipid profile including total cholesterol, HDL-C, LDL-C, and triglycerides' was evaluated using enzymatic colorimetric methods.

To ensure accuracy, all hormonal and biochemical tests were conducted at the hospital's central laboratory using calibrated equipment and standardized protocols. The same radiologist performed all ultrasound examinations to minimize interobserver variability. Data collection tools were reviewed and piloted before final use to confirm clarity and consistency.

Data were entered and analyzed using SPSS version 25. Quantitative variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. 'Independent sample t-tests were used to compare continuous variables between groups, and chi-square tests were applied for categorical data'. A p-value of less than 0.05 was considered statistically significant.

RESULT

The study included a total of 103 women diagnosed with polycystic ovary syndrome (PCOS), out of which 54 were classified as obese and 49 as non-obese based on their BMI. The average age of participants was similar in both groups, with no significant difference. As expected, BMI was significantly higher in the obese group. Other demographic features such as marital status, education level, employment status, and socioeconomic background were comparable between the two groups, indicating that the baseline demographic profiles were largely balanced, except for BMI which was the defining criterion for group classification.

Table 1: Demographic Characteristics of Obese and Non-Obese PCOS Women (n=103)

Variable	Obese (n=54)	Non-Obese (n=49)	p-value
Age (years)	27.6 ± 4.2	26.9 ± 3.8	0.421
BMI (kg/m²)	31.8 ± 2.6	23.3 ± 1.9	<0.001*
Marital Status (Married)	38 (70.4%)	34 (69.4%)	0.910
Educational Level ≥ Graduate	31 (57.4%)	28 (57.1%)	0.977

Employed	22 (40.7%)	24 (49.0%)	0.398
Middle/High SES	36 (66.7%)	37 (75.5%)	0.318

*p < 0.05 indicates statistical significance.

In terms of reproductive history and clinical symptoms, some notable differences emerged. The age at menarche did not differ significantly between the two groups. However, menstrual cycle length was significantly longer in obese women, suggesting a greater degree of menstrual irregularity. Although more obese women reported irregular cycles, this difference was not statistically significant. Hirsutism was significantly more prevalent among obese women, which may be linked to higher androgen levels. Acne 'was reported more in the obese group, but the difference was not statistically meaningful'. Acanthosis nigricans, a marker of insulin resistance, was strikingly more common in obese participants. Rates of infertility and ultrasound-confirmed polycystic ovaries were similar in both groups.

'Table 2: Reproductive and Clinical Features of Obese and Non-Obese PCOS Women'

'Variable'	**'Obese (n=54)'**	**'Non-Obese (n=49)'**	**'p-value'**
Age at Menarche (years)	12.5 ± 1.1	12.3 ± 1.0	0.291
Irregular Menstrual Cycles	41 (75.9%)	30 (61.2%)	0.104
Cycle Length (days)	39.4 ± 6.7	36.2 ± 5.8	0.005*
Hirsutism (FG score ≥8)	37 (68.5%)	24 (49.0%)	0.046*
Acne	29 (53.7%)	18 (36.7%)	0.092
Acanthosis Nigricans	24 (44.4%)	6 (12.2%)	<0.001*
Infertility	26 (48.1%)	20 (40.8%)	0.448
Polycystic Ovaries (TVS)	46 (85.2%)	41 (83.7%)	0.841

When comparing the hormonal profiles, several key differences were observed. The LH/FSH ratio was significantly higher in obese women, supporting the theory of disrupted gonadotropin secretion in this group. Both total and free testosterone levels were significantly elevated in the obese group, indicating more pronounced hyperandrogenism. DHEAS was also higher among obese women, reinforcing this pattern. Prolactin, TSH, and AMH levels showed no significant differences between the two groups, suggesting that not all endocrine markers were influenced by obesity in PCOS patients. The hormonal profile overall reflects that obesity in PCOS may intensify androgen-related disturbances.

Table 3: Hormonal Profile in 'Obese and Non-Obese PCOS Women'

Hormone	**Obese (Mean ± SD)**	**Non-Obese (Mean ± SD)**	**p-value**
LH (mIU/mL)	9.1 ± 2.6	8.4 ± 2.1	0.116
'FSH (mIU/mL)'	5.9 ± 1.5	6.2 ± 1.3	0.243
LH/FSH Ratio	1.56 ± 0.41	1.35 ± 0.36	0.014*
Total Testosterone (ng/dL)	72.3 ± 14.2	65.7 ± 13.1	0.021*
Free Testosterone (pg/mL)	4.8 ± 1.2	4.2 ± 1.1	0.010*
DHEAS (µg/dL)	286.7 ± 67.1	251.2 ± 60.3	0.006*
Prolactin (ng/mL)	16.5 ± 4.3	15.9 ± 3.9	0.464
'TSH (µIU/mL)'	2.7 ± 0.8	2.5 ± 0.9	0.243
'AMH (ng/mL)'	6.8 ± 2.4	6.3 ± 2.1	0.278

The metabolic profile revealed significant disparities between the two groups. Obese women had markedly higher fasting glucose and insulin levels. Lipid levels also showed a concerning trend in the obese group, with higher total cholesterol, LDL-C, and triglycerides, while HDL-C was significantly lower. This lipid imbalance further supports 'the association between obesity and cardiovascular risk factors in PCOS. These findings highlight the metabolic burden faced by obese women with PCOS and point to the need for targeted interventions in this group.

Table 4: Metabolic and Biochemical Parameters

Parameter	**'Obese (Mean ± SD)'**	**'Non-Obese (Mean ± SD)'**	**'p-value'**
Fasting Blood Glucose (mg/dL)	97.2 ± 10.3	90.7 ± 9.8	0.001*
Total Cholesterol (mg/dL)	202.4 ± 25.1	186.3 ± 22.7	0.001*
HDL-C (mg/dL)	39.8 ± 6.4	45.2 ± 5.9	<0.001*
LDL-C (mg/dL)	127.9 ± 21.7	114.5 ± 20.1	0.003*
Triglycerides (mg/dL)	156.2 ± 34.9	132.1 ± 31.2	0.001*

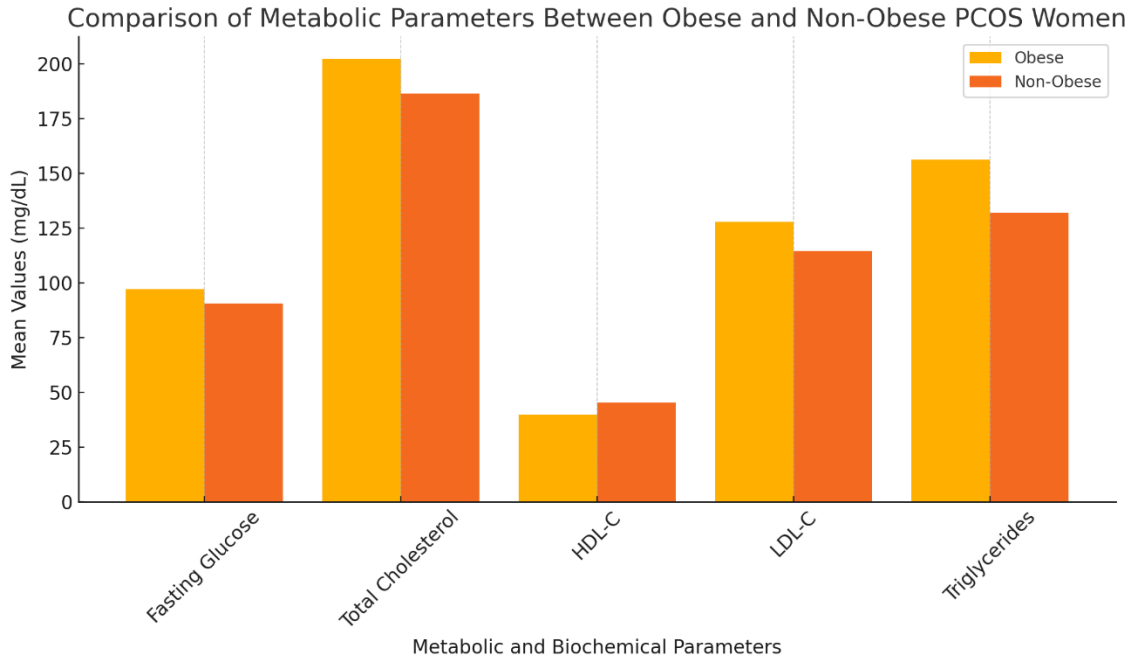

Figure 1

The graph clearly shows that obese PCOS women have worse metabolic parameters than non-obese women. They have higher fasting glucose, total cholesterol, LDL-C, and triglycerides, while their HDL-C is lower. This pattern reflects a higher risk of insulin resistance and cardiovascular issues in the obese group.

DISCUSSION

'This study aimed to explore and compare the reproductive and biochemical characteristics of obese and non-obese women diagnosed with polycystic ovary syndrome (PCOS)'. The findings indicate that obesity significantly 'influences the hormonal and metabolic profile of women with PCOS, with notable differences observed in androgen levels, insulin resistance, and lipid metabolism'.

One of the key findings was the 'higher LH/FSH ratio in obese participants compared to non-obese women'. Although this ratio remains a debated diagnostic marker, its elevation is often associated with disrupted hypothalamic-pituitary-ovarian axis function in PCOS. Similar findings with studies observed that obesity exacerbates gonadotropin imbalance, potentially contributing to anovulation and menstrual irregularities(8-10).

The present study also found significantly increased total and free testosterone levels among obese women, which were consistent with reports where obesity was linked with heightened androgen excess in PCOS(11-13). This hormonal pattern may explain the higher prevalence of hirsutism observed in the obese group. Additionally, DHEAS levels were elevated in obese women, further supporting the presence of adrenal contribution to hyperandrogenism.

Menstrual irregularity, a hallmark of PCOS, was more commonly reported in obese participants, although 'the difference did not reach statistical significance'. However, the average cycle length was notably longer in this group, aligning with the studies demonstrated that obesity tends to worsen cycle disturbances by affecting follicular development and ovulation(14-19).

The lipid profile of obese PCOS participants revealed elevated triglycerides, LDL-C, and total cholesterol, along with decreased HDL-C levels. This pattern reflects a dyslipidemic state, which poses long-term cardiovascular risks. These results were supported by the observations of studies highlighted that 'dyslipidemia is more pronounced in obese women with PCOS and requires early intervention to prevent complications' (20).

Despite these findings, some parameters such as 'prolactin, TSH, and AMH did not show significant differences between the two groups'. This suggests that while obesity impacts several aspects of PCOS, certain hormonal variables remain unaffected and are likely influenced by other intrinsic factors.

Overall, the results of this study emphasize the complex interplay between obesity and PCOS. 'Obesity appears to amplify the reproductive and metabolic disturbances associated with the syndrome, reinforcing the importance of early weight management and lifestyle interventions in women with PCOS'. Addressing obesity could not only improve hormonal balance but also 'reduce the risk of long-term complications such as type 2 diabetes and cardiovascular disease'.

CONCLUSION

This study highlights that 'obesity significantly worsens the hormonal and metabolic profile in women with PCOS'. Obese participants showed higher androgen levels, insulin resistance, and adverse lipid patterns compared to their non-obese counterparts. These changes contribute to more pronounced clinical symptoms and increased long-term health risks. Early diagnosis and targeted weight management are essential in 'improving outcomes for obese women with PCOS'. Lifestyle modifications should be a key part of treatment strategies to address both reproductive and metabolic concerns.

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