

Study of Anthropometric Measurements, Biochemical Parameters and Hormonal Levels in Women with PCOS

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Abstract:

Background: Over the past decade, our comprehension of the pathophysiology of PCOS has advanced significantly. However, despite our increasing familiarity with this condition, certain fundamental aspects of PCOS remain inadequately recognized and understood. Obesity has been identified as a significant factor contributing to the long-term risk of developing PCOS. Our study underscores that anthropometric measures, particularly BMI and WHR, exhibit significant correlations with lipid profiles in PCOS patients, emphasizing the critical role of early obesity management in preventing future complications. Our objective was to examine anthropometric measurements, hormonal status, and biochemical parameters in females diagnosed with PCOS, investigate their and compare them with a control group.

Methods: In this case-control study, we enrolled 100 women clinically diagnosed with PCOS and 100 healthy female controls matched for age (18-40 years). We assessed body mass index (BMI), waist-to-hip ratio (WHR), fasting blood glucose, lipid profile, and hormonal levels in both groups.

Result: We observed significant elevations in TSH, and prolactin levels, TC, TG, LDL, and TC/HDL ratio levels in females with PCOS compared to healthy females.

Conclusion: There is notable disruption in the hormonal and biochemical profiles of women affected by PCOS, resulting in altered energy metabolism and an endocrinological cascade.

Keywords: PCOS, Anthropometric, Hormone, Lipid Profile

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Introduction

Polycystic ovary syndrome (PCOS) is a prevalent endocrine disorder affecting women during their reproductive years, though its exact underlying cause remains under investigation. This condition is linked to disruptions in the hypothalamic-pituitary-ovarian axis and irregular ovarian estrogen feedback, leading to a relative increase in the LH to FSH release ratio (Singh et al., 2023). Environmental factors such as obesity, influenced by unhealthy eating habits and lack of physical activity, can worsen PCOS. It can increase the likelihood of cardiovascular disease, hypertension, diabetes, and other metabolic conditions, particularly postmenopause (Lim et al., 2019). Throughout the reproductive years, it can cause infertility due to anovulation and is linked to higher rates of pregnancy complications like miscarriage, gestational diabetes, and preeclampsia. Ovarian dysfunction is a primary feature of this condition, rendering it the predominant cause of anovulatory infertility (Marshall and Dunaif, 2012). About half of women with PCOS are overweight or obese, potentially contributing to the onset of insulin resistance and subse-

quent hyperinsulinemia in these individuals. Recent studies conducted among adolescents in schools have reported varying prevalence rates of PCOS, ranging from 9.13% to 36% (Coffin et al., 2023). The prevalence of PCOS can differ significantly based on the diagnostic criteria utilized. Specific clinical, biochemical, and ultrasonographic criteria are employed to define this syndrome. The clinical presentations of PCOS are multifaceted, with patients often displaying a range of symptoms and signs. While certain clinical manifestations of PCOS can vary depending on age, ovarian dysfunction and hyperandrogenism (HA) are common features observed across all age groups (Yasmin et al., 2022). Furthermore, the expenses associated with diagnosis constitute only a small portion of the overall costs of managing PCOS (around 2%) (Sheehan, 2004). Early screening for this disorder could facilitate timely intervention and potentially prevent serious complications. In light of the aforementioned considerations, this study aimed to investigate the correlation between anthropometric measurements, biochemical parameters, and hor-

monal levels among women with PCOS, with a focus on assessing their relevance in low-resource settings.

Material and Methods

Study Population: This case-control study included 100 women diagnosed with PCOS. Women aged 18-40 years attending outpatient services at New Medical College Hospital (NMCH), affiliated with Government Medical College in Kota, India, presenting with primary complaints of menstrual irregularities (amenorrhea or oligomenorrhea) and/or hirsutism, with or without infertility, underwent comprehensive evaluation for polycystic ovarian syndrome. The study involved assessing ovarian size, volume, morphology, and follicle count and size. One hundred healthy women were included as controls during the same timeframe. These women did not exhibit hirsutism, acne, male-pattern baldness, family history of PCOS, or signs of hyperandrogenism. They all had regular menstrual cycles lasting between 28 to 35 days and did not meet any of the revised Rotterdam criteria. All participants were requested to provide a comprehensive medical history covering menstrual irregularities, hirsutism, alopecia, infertility, changes in voice, weight gain, clinical acne, and detailed obstetric history was documented.

Anthropometric Measurements: Standard anthropometric measurements such as height, weight, waist circumference (WC), and hip circumference (HC) were recorded for each participant. Body Mass Index (BMI) was calculated using the formula weight in kilograms divided by height in meters squared (kg/m^2).

The waist-to-hip ratio (WHR) was determined using a tailor's tape measure, ensuring it was applied horizontally. Waist circumference was measured at the midpoint between the iliac crest and the lowest rib margin, while hip circumference was measured at its maximum around the buttocks and anteriorly indicated by the symphysis pubis.

Biochemical Parameters: Following a 12-hour overnight fast, approximately 5 ml of venous blood samples were collected in plain tubes for lipid profile and hormonal profile estimations, and in tubes containing sodium fluoride and oxalate for plasma glucose estimation (GOD-POD method; Trinder,

1969). Serum samples were then separated and stored at -20°C for later analysis. Fasting plasma glucose, serum total cholesterol (TC) (CHOD-PAP method), triglycerides (TG) (GPO-PAP method), and high-density lipoprotein (HDL) levels (Polyvinyl sulfonic acid (PVS) and polyethylene glycol methyl ether (PEGME) coupled precipitation method) were measured using commercial kits. Low-density lipoprotein (LDL) was calculated using the Friedewald formula. Serum prolactin (PRL) and thyroid stimulating hormone (TSH) were analysed using the Chemi Luminescent Immunoassay (CLIA) method. Laboratory controls were employed to ensure the accuracy and consistency of the analyser, reagents, and assay outcomes. The study received approval from the Institutional Research Ethics Committee, and all participants provided informed written consent before participation.

Statistical Analysis: Data analysis was conducted using Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) version 20.0 and Excel (Microsoft, Redmond, WA, USA). The independent t-test was employed to compare normal quantitative variables between women with diagnosed PCOS and healthy controls. Mean values were presented with standard deviations. A p-value of less than 0.05 was considered statistically significant.

Result

The current study aimed to investigate the relationship between anthropometric measurements, biochemical status, and hormonal levels in women with PCOS compared to controls. Differences in anthropometric parameters, lipid profile, hormonal levels, and serum biochemical markers between PCOS patients and healthy controls were analyzed using the independent (unpaired) Student's t-test.

Anthropometric parameters between PCOS women and healthy control: The study included 100 women diagnosed with PCOS and 100 healthy women controls, all aged between 18 and 40 years. The mean age was 24.7 years for women with PCOS and 26.6 years for the controls. Both groups were assessed for fasting blood sugar, serum lipid profile, thyroid stimulating hormone, and prolactin levels. Table 1 presents anthropometric measurements (BMI: body mass index, WHR: waist-to-hip ratio) of both PCOS patients and healthy subjects.

Table 1: Comparison of mean values of anthropometric parameters between PCOS women and healthy control

Parameters	PCOS Women (N=100) (Mean±SD)	Control (N=100) (Mean±SD)	Significant p-value
Weight	60.33±5.9	55.96±4.8	0.000
Height	155.10±6.3	161.03±4.7	0.000
BMI	25.11±2.4	21.58±1.6	0.000
WC	76.24±8.0	72.94±5.9	0.001
HC	96.16±3.7	95.24±6.0	0.201
WHR	0.79±0.07	0.76±0.02	0.001

p < 0.05 is significant

Table 1 illustrates significantly higher mean values of BMI, WC, and waist-to-hip ratio in women diagnosed with PCOS compared to the control group. The mean hip circumference was also elevated in PCOS women, although this difference did not reach statistical significance.

Biochemical parameters between PCOS women and healthy control: Table 2 presents the biochemical parameters of both PCOS patients and healthy subjects. Fasting blood sugar (FBS) levels were significantly higher in PCOS patients compared to healthy subjects. PCOS patients also ex-

hibited significantly elevated levels of all studied lipids including total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and very low-density lipoprotein cholesterol (VLDL-C) compared to the control group ($p < 0.001$).

Conversely, high-density lipoprotein cholesterol (HDL-C) levels were significantly lower in PCOS patients compared to controls ($p < 0.001$). Additionally, lipid risk factors such as LDL-C/HDL-C ratio and TC/HDL-C ratio were significantly higher in PCOS patients compared to controls ($p < 0.001$).

Table 2: Comparison of mean values of Biochemical parameters between PCOS women and healthy control

Parameters	PCOS Women (N=100) (Mean±SD)	Control (N=100) (Mean±SD)	Significant p value
FBS	100.61±21.4	85.64±7.4	0.000
TC	178.10±42.8	155.08±23.1	0.000
TG	131.38±52.8	99.94±63.1	0.000
HDL	42.28±14.4	48.24±9.6	0.001
LDL	111.94±44.4	86.85±27.2	0.000
VLDL	23.87±10.5	19.98±12.6	0.019
LDL/HDL Ratio	3.09±2.0	1.90±.78	0.000
TC/HDL Ratio	4.72±2.1	3.33±.80	0.000

$p < 0.05$ is significant

Table 2 illustrates significantly elevated levels of fasting blood sugar, plasma cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides, as well as lower HDL cholesterol levels, in the PCOS group compared to the control women.

Additionally, statistically significant increases in lipid risk factors such as LDL cholesterol to HDL cholesterol ratio and total cholesterol to HDL cholesterol ratio were observed in PCOS subjects compared to the control group.

Hormonal profile between PCOS women and healthy control:

Table 3 displays the hormonal levels observed in both PCOS patients and healthy subjects.

Our findings reveal significant increases in hormonal parameters including thyroid stimulating hormone (TSH) and prolactin (PRL) among PCOS patients compared to controls ($p < 0.001$).

Table 3: Comparison of mean values of hormonal profile between PCOS women and healthy control

Parameters	PCOS Women (N=100) (Mean±SD)	Control (N=100) (Mean±SD)	Significant p value
TSH	5.57±1.8	2.35±1.0	0.000
Prolactin	26.99±42.4	15.32±5.0	0.007

$p < 0.05$ is significant

Table 3 demonstrates significantly higher levels of TSH (5.57 ± 1.8) and prolactin (26.99 ± 42.4) in the PCOS group compared to the control women.

Discussion

PCOS is a prevalent and diverse endocrine disorder with multiple causes, affecting metabolic and hormonal balance. Beyond reproductive and obstetric concerns, PCOS carries risks extending to metabolic syndrome, characterized by insulin resistance, central obesity, impaired glucose tolerance, dyslipidemia, and hypertension.

(Stegers-Theunissen et al., 2020). This study aims to investigate changes in biochemical and hormonal profiles among women with PCOS. Obesity is a prevalent and intricate condition influenced by genetic and environmental factors (Fruh, 2017). In our study, approximately 50% of women diagnosed with PCOS were found to be overweight or obese based on BMI, consistent with findings reported by Taneja et al. (Taneja et al., 2019).

According to Kumar et al., the most prevalent abnormality observed was increased BMI accompanied by elevated triglycerides (TG) and decreased HDL-C levels (Kumar et al., 2016). Additionally,

approximately 12% of women had a waist circumference exceeding the normal range of 88cm. These findings indicate dyslipidemia and android-type obesity in subjects with PCOS, which corroborate earlier research.

The prevalence of metabolic syndrome rises with increasing BMI and waist-to-hip ratio (WHR). Waist circumference measurement is preferred over total body fat assessment for evaluating high abdominal fat accumulation. In our study, we observed significantly higher mean values of weight, BMI, waist circumference (WC), hip circumference (HC), and WHR in women diagnosed with PCOS (60.33 ± 5.9 kg, 25.11 ± 2.4 kg/m², 76.24 ± 8.0 cm, 96.16 ± 3.7 cm, and 0.79 ± 0.07 cm, respectively) compared to healthy control women (55.96 ± 4.8 kg, 21.58 ± 1.6 kg/m², 72.94 ± 5.9 cm, 95.24 ± 6.0 cm, and 0.76 ± 0.02 cm, respectively). These results align with those reported by Shah AK et al. and Thathapudi S et al., (Shah et al., 2017; Thathapudi et al., 2006) but they differ from the findings of Rasool Suzan Omer, who did not observe a significant increase in waist-to-hip ratio (WHR) among women with PCOS (Rasool et al., 2015).

Elevated body mass index (BMI), waist circumference, waist-to-hip ratio (WHR), fasting blood sugar (FBS), total cholesterol (TC), triglycerides (TG), and LDL cholesterol levels, along with low HDL cholesterol levels, are associated with an increased risk of developing metabolic syndrome (Christian et al., 2009). Our study revealed disrupted lipid profiles in women with PCOS, characterized by higher levels of TC, TG, and LDL cholesterol, and lower levels of HDL cholesterol, consistent with findings from Sarabhai et al., and Kumar et al., indicating a prevalent dyslipidemia in this population (Sarabhai et al., 2016; Kumar et al., 2016). Additionally, our study found a significantly elevated WHR in women with PCOS, consistent with Thathapudi Sujatha et al. (Thathapudi et al., 2006), but in contrast to the findings of Rasool Suzan Omer (Rasool et al., 2015).

Hypothyroidism is characterized by insufficient thyroid hormone production from the thyroid gland. In our study, the mean serum TSH level was notably higher compared to the control group. This finding corroborates the research of Binita et al., who also reported similar observations (Binita et al., 2009). However, it contrasts with the findings of K Gomathi et al. (Gomathi et al., 2012), who found normal TSH levels. The heightened risk of hyperlipidemia associated with hypothyroidism is prevalent in PCOS (Mehra et al., 2023). Our study identified elevated TSH levels in women with PCOS. Therefore, evaluating biochemical, metabolic, and endocrine markers is essential for early PCOS diagnosis and on-going management.

Conclusions

The current study highlights disturbances in both hormonal and biochemical profiles among women with PCOS, contributing to altered energy metabolism and endocrine dysregulation. Our findings revealed a high prevalence of hypothyroidism, dyslipidemia characterized by android-type obesity, and elevated levels of gonadotropin hormones, all of which play pivotal roles in the clinical, hormonal, and metabolic manifestations of polycystic ovarian syndrome (PCOS).

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