

Evaluation of Thyroid-Stimulating Hormone Levels in Obese Women with Polycystic Ovarian Syndrome at a Tertiary Care Centre

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ABSTRACT

Background: Polycystic ovarian syndrome (PCOS) is a common endocrine disorder among women of reproductive age and is frequently associated with obesity, insulin resistance, menstrual disturbances, hyperandrogenism, and metabolic abnormalities. Thyroid dysfunction may coexist with PCOS and can further influence reproductive and metabolic parameters. Evaluation of thyroid-stimulating hormone (TSH) is therefore important in obese women with PCOS.

Aim: To evaluate thyroid-stimulating hormone levels in obese women with polycystic ovarian syndrome at a tertiary care centre.

Materials and Methods: This hospital-based observational cross-sectional study included 118 obese women diagnosed with PCOS. PCOS was diagnosed according to the Rotterdam criteria. Clinical assessment, anthropometric measurements, thyroid profile, reproductive hormones, fasting glucose, fasting insulin, HbA1c, lipid profile, and HOMA-IR were evaluated. Participants were categorized according to thyroid functional status. Statistical analysis was performed using appropriate comparative and correlation tests, with $p < 0.05$ considered significant.

Results: The mean age was 27.24 ± 4.35 years and mean BMI was 31.75 ± 3.01 kg/m². Thyroid dysfunction was present in 36 (30.51%) women, including subclinical hypothyroidism in 30 (25.42%) and overt hypothyroidism in 6 (5.08%). Women with thyroid dysfunction had significantly higher BMI, waist circumference, waist-to-hip ratio, menstrual irregularity, hirsutism, infertility, fasting glucose, fasting insulin, HOMA-IR,

HbA1c, total cholesterol, triglycerides, and LDL cholesterol, while HDL cholesterol was lower. Serum TSH correlated positively with BMI ($r=0.34$), fasting insulin ($r=0.39$), HOMA-IR ($r=0.42$), and triglycerides ($r=0.29$), and negatively with HDL cholesterol ($r=-0.26$).

Conclusion: Thyroid dysfunction, particularly subclinical hypothyroidism, was common among obese women with PCOS and was associated with adverse anthropometric, reproductive, and metabolic parameters. Routine thyroid evaluation may be useful in the comprehensive assessment of these patients.

Keywords: Polycystic Ovarian Syndrome, Thyroid-Stimulating Hormone, Obesity, Subclinical Hypothyroidism, Insulin Resistance.

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INTRODUCTION

Polycystic ovarian syndrome (PCOS) is one of the most common endocrine and reproductive disorders affecting women of reproductive age. It is a heterogeneous condition characterized principally by ovulatory dysfunction, hyperandrogenism and polycystic ovarian morphology. Its clinical expression varies from menstrual irregularity and infertility to hirsutism, acne, obesity and metabolic disturbances. Because these manifestations overlap with other endocrine disorders, appropriate clinical and biochemical evaluation is essential. Thyroid abnormalities are particularly relevant because altered thyroid function may influence menstrual cyclicity, ovarian function, fertility and metabolic homeostasis. The association between PCOS and thyroid autoimmunity has therefore received increasing clinical

attention.¹ Obesity is frequently encountered in women with PCOS and may intensify the endocrine and metabolic abnormalities associated with the syndrome. Excess adiposity, particularly central obesity, is closely linked to insulin resistance, compensatory hyperinsulinaemia, dyslipidaemia and altered androgen metabolism. These disturbances may aggravate reproductive dysfunction and contribute to cardiometabolic risk. Thyroid function is also related to body weight, energy expenditure, lipid metabolism and insulin sensitivity. Thyroid-stimulating hormone (TSH), therefore, represents an important biochemical parameter when evaluating obese women with PCOS, particularly because thyroid and metabolic abnormalities may coexist.²

PCOS and thyroid disorders share several clinical features, including weight gain, menstrual disturbances, subfertility and alterations in lipid and glucose metabolism. Autoimmune thyroiditis is an important cause of thyroid dysfunction and may remain clinically silent until biochemical abnormalities appear. Women with PCOS may consequently require assessment for coexisting thyroid abnormalities so that manifestations attributable to thyroid dysfunction are not ascribed solely to PCOS. Serum TSH provides a sensitive initial marker for evaluating thyroid function, while free thyroxine and thyroid antibody measurements can further characterize abnormalities when indicated.³

Subclinical hypothyroidism is of particular importance in this setting. It is generally characterized by an elevated serum TSH concentration with circulating free thyroxine remaining within the reference range. Because overt symptoms may be absent or nonspecific, biochemical testing is central to detection. In young women with PCOS, mild thyroid dysfunction is clinically relevant because thyroid hormones participate in reproductive physiology, metabolic regulation and normal ovarian function. Obesity and insulin resistance may also modify interactions between the hypothalamic-pituitary-thyroid axis and reproductive hormones.⁴ Insulin resistance constitutes a major metabolic component of PCOS and is frequently accentuated by obesity. Hyperinsulinaemia can interact with ovarian androgen production, sex hormone-binding globulin and follicular development, thereby connecting metabolic abnormalities with reproductive manifestations. Thyroid dysfunction can also influence carbohydrate metabolism and insulin action. The coexistence of elevated TSH, obesity and insulin resistance may therefore represent an important metabolic interaction in women with PCOS. Evaluation of fasting glucose, fasting insulin and HOMA-IR together with TSH can provide a broader assessment of metabolic status.⁵

The relationship between PCOS and thyroid disease is not restricted to biochemical hypothyroidism. Structural thyroid abnormalities, thyroid autoimmunity and nodular disease have also been investigated in affected women. These observations emphasize that thyroid assessment may be relevant even when classical symptoms are absent. In obese women with PCOS, interpretation of TSH alongside anthropometric indicators such as body mass index, waist circumference and waist-to-hip ratio may be useful because adiposity itself is associated with endocrine and metabolic changes. Assessment of reproductive hormones, androgen status and lipid parameters can further define the clinical profile of women with altered TSH concentrations.⁶

MATERIALS AND METHODS

The present study was conducted as a hospital-based observational cross-sectional study at a Department of Obstetrics and Gynaecology, LN Medical College, Bhopal, Madhya Pradesh, India. A total of 118 obese women diagnosed with polycystic ovarian syndrome (PCOS) who attended the outpatient and inpatient services were included in the study. The study was designed to evaluate serum thyroid-stimulating hormone (TSH) levels and their association with clinical, anthropometric, hormonal, and metabolic parameters among obese women with PCOS. The study included 118 women of reproductive age who fulfilled the diagnostic criteria for PCOS and were classified as obese according to their body mass index (BMI). PCOS was

diagnosed according to the Rotterdam criteria, requiring the presence of at least two of the following three features: oligo- or anovulation, clinical and/or biochemical evidence of hyperandrogenism, and polycystic ovarian morphology on ultrasonography, after exclusion of other possible causes. Obesity was assessed using BMI calculated as weight in kilograms divided by the square of height in metres (kg/m^2).

Inclusion Criteria: Women of reproductive age diagnosed with PCOS according to the Rotterdam criteria, having obesity as determined by BMI, and willing to participate in the study were included. Only patients who provided written informed consent and underwent the required clinical, biochemical, hormonal, and ultrasonographic evaluation were considered eligible for analysis.

Exclusion Criteria: Women with previously diagnosed thyroid disease or those already receiving thyroid hormone replacement or antithyroid medication were excluded. Patients with known diabetes mellitus, Cushing syndrome, congenital adrenal hyperplasia, androgen-secreting tumours, hyperprolactinaemia, severe hepatic or renal disease, pregnancy, and lactation were also excluded. Women receiving hormonal contraceptives, corticosteroids, anti-androgen therapy, ovulation-inducing drugs, or other medications known to affect thyroid or reproductive hormone levels were excluded wherever these medications could interfere with biochemical evaluation.

Clinical Assessment: A detailed clinical history was obtained from each participant with special emphasis on age, menstrual cycle pattern, duration and frequency of menstrual irregularity, infertility, weight gain, acne, hirsutism, and other manifestations of hyperandrogenism. Menstrual cycles were categorized according to the presence of oligomenorrhoea, amenorrhoea, or regular cycles. Clinical signs suggestive of thyroid dysfunction were also recorded. Hirsutism was assessed clinically using the modified Ferriman-Gallwey scoring system wherever applicable.

Anthropometric Assessment: Body weight was measured using a calibrated weighing scale with participants wearing light clothing and without footwear. Height was measured in the standing position using a stadiometer. BMI was calculated in kg/m^2 . Waist circumference was measured midway between the lower margin of the last palpable rib and the top of the iliac crest, while hip circumference was measured at the widest part of the buttocks. Waist-to-hip ratio was calculated to assess central adiposity. Blood pressure was recorded after an adequate period of rest using a standard sphygmomanometer.

Laboratory Investigations: Venous blood samples were collected under aseptic precautions, preferably in the morning after an overnight fast. Serum TSH was measured in all 118 participants using a standard chemiluminescence immunoassay or equivalent validated laboratory method. Free thyroxine (FT4) was measured to further assess thyroid functional status, while free triiodothyronine (FT3) was estimated wherever clinically indicated. Participants with elevated TSH and normal FT4 were categorized as having subclinical hypothyroidism, whereas those with elevated TSH along with reduced FT4 were considered to have overt hypothyroidism according to the laboratory reference range.

Hormonal and Metabolic Parameters: Additional hormonal evaluation included serum luteinizing hormone (LH), follicle-stimulating hormone (FSH), LH/FSH ratio, serum prolactin, and total testosterone where indicated. Metabolic assessment included

fasting blood glucose, fasting serum insulin, glycated haemoglobin (HbA1c), total cholesterol, triglycerides, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol. Insulin resistance was assessed using the homeostatic model assessment of insulin resistance (HOMA-IR), calculated as fasting insulin ($\mu\text{IU/mL}$) $\times$ fasting glucose (mg/dL)/405.

Ultrasonographic Evaluation: Pelvic ultrasonography was performed using transabdominal or transvaginal ultrasonography as clinically appropriate. Ovarian morphology, ovarian volume, number and distribution of follicles, endometrial thickness, and associated pelvic abnormalities were documented. Polycystic ovarian morphology was interpreted according to accepted diagnostic criteria and considered together with clinical and biochemical findings.

Outcome Assessment: The primary outcome was the distribution of serum TSH levels among obese women with PCOS. Secondary outcomes included the association of TSH levels with age, BMI, waist circumference, waist-to-hip ratio, menstrual abnormalities, hirsutism, biochemical hyperandrogenism, fasting glucose, insulin resistance, lipid parameters, and reproductive hormone levels. The prevalence of subclinical and overt hypothyroidism among the study participants was also determined.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. The independent Student's t-test or Mann-Whitney U test was used for comparison of continuous variables according to data distribution. Categorical variables were compared using the Chi-square test or Fisher's exact test. Pearson's or Spearman's correlation analysis was performed to assess the relationship between serum TSH and anthropometric, hormonal, and metabolic parameters. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 118 obese women with polycystic ovarian syndrome were included in the study. Regarding age distribution, the largest proportion of participants belonged to the 26–30 years age group, comprising 49 (41.53%) women. This was followed by 34 (28.81%) women aged 18–25 years, 25 (21.19%) women aged 31–35 years, and 10 (8.47%) women aged more than 35 years. The mean age of the study participants was 27.24 ± 4.35 years. The mean body mass index was $31.75 \pm 3.01 \text{ kg/m}^2$, while the mean waist circumference was $93.09 \pm 8.04 \text{ cm}$. The mean waist-to-hip ratio among the participants was 0.87 ± 0.06 . With respect to menstrual pattern, oligomenorrhoea was the most commonly observed abnormality and was present in 72 (61.02%) women. Amenorrhoea was reported in 24 (20.34%) participants, whereas 22 (18.64%) women had regular menstrual cycles. Hirsutism was observed in 66 (55.93%) participants, while acne was present in 53 (44.92%) women. Infertility was reported in 58 (49.15%) participants. (Table 1)

Assessment of thyroid functional status showed that 82 (69.49%) of the 118 women were euthyroid. Thyroid dysfunction was identified in 36 (30.51%) participants. Among these, subclinical hypothyroidism was present in 30 (25.42%) women, while overt hypothyroidism was detected in 6 (5.08%) women. Thus, subclinical hypothyroidism constituted the major component of

thyroid dysfunction in the study population, while overt hypothyroidism was observed in a smaller proportion of participants. (Table 2)

The mean age of women in the euthyroid group was 26.90 ± 4.20 years, compared with 28.00 ± 4.50 years among women with thyroid dysfunction. This difference was not statistically significant ($p=0.217$). The mean BMI was $31.20 \pm 2.80 \text{ kg/m}^2$ in euthyroid women and $33.00 \pm 3.10 \text{ kg/m}^2$ in women with thyroid dysfunction, and the difference was statistically significant ($p=0.004$). Similarly, the mean waist circumference was significantly higher among participants with thyroid dysfunction, measuring $96.50 \pm 8.20 \text{ cm}$ compared with $91.60 \pm 7.40 \text{ cm}$ in euthyroid women ($p=0.003$). The mean waist-to-hip ratio was 0.90 ± 0.06 in the thyroid dysfunction group and 0.86 ± 0.05 in the euthyroid group, with a statistically significant difference ($p=0.001$). The mean systolic blood pressure was $118.40 \pm 10.10 \text{ mmHg}$ in euthyroid women and $122.10 \pm 11.20 \text{ mmHg}$ among women with thyroid dysfunction. The difference in systolic blood pressure was not statistically significant ($p=0.094$). Menstrual irregularity was observed in 61 (74.39%) euthyroid women compared with 35 (97.22%) women with thyroid dysfunction, and this difference was statistically significant ($p=0.003$). Hirsutism was present in 40 (48.78%) women in the euthyroid group and 26 (72.22%) women in the thyroid dysfunction group, showing a statistically significant difference ($p=0.018$). Acne was observed in 33 (40.24%) euthyroid women and 20 (55.56%) women with thyroid dysfunction. However, this difference was not statistically significant ($p=0.124$). Infertility was reported in 34 (41.46%) euthyroid women compared with 24 (66.67%) participants with thyroid dysfunction, and this difference was statistically significant ($p=0.012$). (Table 3)

The mean serum TSH level was $2.36 \pm 0.75 \text{ mIU/L}$ in euthyroid women compared with $7.18 \pm 3.05 \text{ mIU/L}$ among women with thyroid dysfunction, showing a highly statistically significant difference ($p<0.001$). The mean FT4 level was $1.12 \pm 0.16 \text{ ng/dL}$ in the euthyroid group and $0.93 \pm 0.20 \text{ ng/dL}$ in the thyroid dysfunction group, with the difference also being statistically significant ($p<0.001$). The mean LH level was $11.40 \pm 4.10 \text{ mIU/mL}$ in euthyroid participants and $12.60 \pm 4.50 \text{ mIU/mL}$ among women with thyroid dysfunction; this difference was not statistically significant ($p=0.176$). The mean FSH level was $5.80 \pm 1.60 \text{ mIU/mL}$ in the euthyroid group and $5.50 \pm 1.50 \text{ mIU/mL}$ in the thyroid dysfunction group, with no significant difference between the groups ($p=0.330$). The mean LH/FSH ratio was 2.04 ± 0.71 among euthyroid women compared with 2.34 ± 0.78 among women with thyroid dysfunction. The difference did not reach statistical significance ($p=0.053$). The mean total testosterone level was $54.20 \pm 15.10 \text{ ng/dL}$ in euthyroid participants and $61.60 \pm 16.70 \text{ ng/dL}$ in those with thyroid dysfunction, with a statistically significant difference ($p=0.026$). The mean fasting blood glucose level was $91.40 \pm 9.70 \text{ mg/dL}$ in the euthyroid group compared with $96.70 \pm 10.80 \text{ mg/dL}$ in the thyroid dysfunction group, and this difference was statistically significant ($p=0.014$). Mean fasting insulin was $14.80 \pm 5.10 \mu\text{IU/mL}$ among euthyroid women and $19.70 \pm 6.20 \mu\text{IU/mL}$ among women with thyroid dysfunction, showing a highly significant difference ($p<0.001$). Similarly, the mean HOMA-IR value was 3.34 ± 1.31 in euthyroid participants and 4.72 ± 1.66 in participants with thyroid dysfunction, with a statistically significant

difference ($p < 0.001$). The mean HbA1c level was $5.42 \pm 0.38\%$ in euthyroid women compared with $5.62 \pm 0.43\%$ in women with thyroid dysfunction, and the difference was statistically significant ($p = 0.019$). With respect to lipid parameters, mean total cholesterol was 188.50 ± 31.80 mg/dL in the euthyroid group and 202.30 ± 34.10 mg/dL in the thyroid dysfunction group, with a statistically significant difference ($p = 0.043$). Mean triglyceride levels were 149.20 ± 37.60 mg/dL and 171.40 ± 42.80 mg/dL, respectively, showing a statistically significant difference ($p = 0.009$). The mean HDL cholesterol level was 46.80 ± 8.40 mg/dL among euthyroid women and 42.30 ± 7.60 mg/dL among women with thyroid dysfunction, and this difference was statistically significant ($p = 0.005$). The mean LDL cholesterol level was 112.40 ± 27.90 mg/dL in the euthyroid group compared with 124.80 ± 29.80 mg/dL in the thyroid dysfunction group, with a statistically significant difference ($p = 0.038$). (Table 4)

Correlation analysis showed a weak positive correlation between serum TSH and age ($r = 0.11$); however, this association was not statistically significant ($p = 0.236$). Serum TSH demonstrated a significant positive correlation with BMI ($r = 0.34$, $p < 0.001$),

indicating that higher TSH levels were accompanied by higher BMI values. A significant positive correlation was also observed between TSH and waist circumference ($r = 0.31$, $p = 0.001$) and between TSH and waist-to-hip ratio ($r = 0.27$, $p = 0.003$). Among the reproductive hormonal parameters, serum TSH showed a significant positive correlation with the LH/FSH ratio ($r = 0.20$, $p = 0.030$) and total testosterone level ($r = 0.22$, $p = 0.017$). Serum TSH was also positively correlated with fasting insulin ($r = 0.39$, $p < 0.001$). The highest correlation coefficient in the analysis was observed between serum TSH and HOMA-IR, with a positive correlation of $r = 0.42$ that was statistically significant ($p < 0.001$). Serum TSH also showed a significant positive correlation with triglyceride levels ($r = 0.29$, $p = 0.001$). In contrast, a significant negative correlation was observed between serum TSH and HDL cholesterol, with a correlation coefficient of -0.26 ($p = 0.004$). Thus, among the evaluated parameters, BMI, waist circumference, waist-to-hip ratio, LH/FSH ratio, total testosterone, fasting insulin, HOMA-IR, and triglycerides showed statistically significant positive correlations with serum TSH, whereas HDL cholesterol shows a statistically significant negative correlation. (Table 5)

Table 1. Baseline Demographic, Anthropometric and Clinical Characteristics of Obese Women with PCOS (n = 118)

Parameter	Number (n) / Mean $\pm$ SD	Percentage (%)
Age group (years)		
18–25 years	34	28.81
26–30 years	49	41.53
31–35 years	25	21.19
>35 years	10	8.47
Mean age (years)	27.24 $\pm$ 4.35	—
Mean BMI (kg/m²)	31.75 $\pm$ 3.01	—
Mean waist circumference (cm)	93.09 $\pm$ 8.04	—
Mean waist-to-hip ratio	0.87 $\pm$ 0.06	—
Menstrual pattern		
Oligomenorrhoea	72	61.02
Amenorrhoea	24	20.34
Regular menstrual cycles	22	18.64
Hirsutism	66	55.93
Acne	53	44.92
Infertility	58	49.15

Table 2. Distribution of Participants According to Thyroid Functional Status (n = 118)

Thyroid status	Number (n)	Percentage (%)
Euthyroid	82	69.49
Subclinical hypothyroidism	30	25.42
Overt hypothyroidism	6	5.08
Total thyroid dysfunction	36	30.51
Total	118	100.00

Table 3. Comparison of Anthropometric and Clinical Parameters According to Thyroid Status

Parameter	Euthyroid (n = 82)	Thyroid dysfunction (n = 36)	p value
Age (years), Mean $\pm$ SD	26.90 $\pm$ 4.20	28.00 $\pm$ 4.50	0.217
BMI (kg/m ²), Mean $\pm$ SD	31.20 $\pm$ 2.80	33.00 $\pm$ 3.10	0.004
Waist circumference (cm), Mean $\pm$ SD	91.60 $\pm$ 7.40	96.50 $\pm$ 8.20	0.003
Waist-to-hip ratio, Mean $\pm$ SD	0.86 $\pm$ 0.05	0.90 $\pm$ 0.06	0.001
Systolic blood pressure (mmHg), Mean $\pm$ SD	118.40 $\pm$ 10.10	122.10 $\pm$ 11.20	0.094
Menstrual irregularity, n (%)	61 (74.39%)	35 (97.22%)	0.003
Hirsutism, n (%)	40 (48.78%)	26 (72.22%)	0.018
Acne, n (%)	33 (40.24%)	20 (55.56%)	0.124
Infertility, n (%)	34 (41.46%)	24 (66.67%)	0.012

Table 4. Comparison of Thyroid, Reproductive Hormonal and Metabolic Parameters According to Thyroid Status

Parameter	Euthyroid (n = 82), Mean $\pm$ SD	Thyroid dysfunction (n = 36), Mean $\pm$ SD	p value
TSH (mIU/L)	2.36 $\pm$ 0.75	7.18 $\pm$ 3.05	<0.001
FT4 (ng/dL)	1.12 $\pm$ 0.16	0.93 $\pm$ 0.20	<0.001
LH (mIU/mL)	11.40 $\pm$ 4.10	12.60 $\pm$ 4.50	0.176
FSH (mIU/mL)	5.80 $\pm$ 1.60	5.50 $\pm$ 1.50	0.330
LH/FSH ratio	2.04 $\pm$ 0.71	2.34 $\pm$ 0.78	0.053
Total testosterone (ng/dL)	54.20 $\pm$ 15.10	61.60 $\pm$ 16.70	0.026
Fasting blood glucose (mg/dL)	91.40 $\pm$ 9.70	96.70 $\pm$ 10.80	0.014
Fasting insulin (μ U/mL)	14.80 $\pm$ 5.10	19.70 $\pm$ 6.20	<0.001
HOMA-IR	3.34 $\pm$ 1.31	4.72 $\pm$ 1.66	<0.001
HbA1c (%)	5.42 $\pm$ 0.38	5.62 $\pm$ 0.43	0.019
Total cholesterol (mg/dL)	188.50 $\pm$ 31.80	202.30 $\pm$ 34.10	0.043
Triglycerides (mg/dL)	149.20 $\pm$ 37.60	171.40 $\pm$ 42.80	0.009
HDL cholesterol (mg/dL)	46.80 $\pm$ 8.40	42.30 $\pm$ 7.60	0.005
LDL cholesterol (mg/dL)	112.40 $\pm$ 27.90	124.80 $\pm$ 29.80	0.038

Table 5. Correlation of Serum TSH with Anthropometric, Hormonal and Metabolic Parameters in Obese Women with PCOS (n = 118)

Parameter	Correlation coefficient (r)	p value
Age	0.11	0.236
BMI	0.34	<0.001
Waist circumference	0.31	0.001
Waist-to-hip ratio	0.27	0.003
LH/FSH ratio	0.20	0.030
Total testosterone	0.22	0.017
Fasting insulin	0.39	<0.001
HOMA-IR	0.42	<0.001
Triglycerides	0.29	0.001
HDL cholesterol	-0.26	0.004

DISCUSSION

In the present study, 118 obese women with PCOS had a mean age of 27.24 ± 4.35 years, and the largest proportion, 49 (41.53%), belonged to the 26–30-year age group. The mean BMI was 31.75 ± 3.01 kg/m², mean waist circumference was 93.09 ± 8.04 cm, and mean waist-to-hip ratio was 0.87 ± 0.06 . Oligomenorrhoea was present in 61.02%, amenorrhoea in 20.34%, hirsutism in 55.93%, acne in 44.92%, and infertility in 49.15% of women. Sinha et al. (2013) studied 80 women with PCOS and found that 40.00% belonged to the 15–20-year age group and 30.00% to the 26–30-year group. They reported oligomenorrhoea in 77.50%, amenorrhoea in 15.00%, hirsutism in 72.50%, and BMI >25 kg/m² in 55.00% of PCOS patients. Thus, menstrual abnormalities and hirsutism were common clinical findings in both studies, although hirsutism and oligomenorrhoea were relatively more frequent in their population.⁷

All participants in the present study were obese, with a mean BMI of 31.75 ± 3.01 kg/m², and 81.36% had menstrual irregularity when oligomenorrhoea and amenorrhoea were considered together. Hirsutism and acne were present in 55.93% and 44.92%, respectively. Saxena et al. (2012), in a study of 100 infertile women with PCOS, reported that 42.00% had normal BMI while 58.00% were overweight. Hirsutism was observed in 80.90% of lean and 89.70% of overweight women, irregular cycles in 92.80% and 96.60%, and acne in 9.50% and 15.50%, respectively. Insulin resistance was present in 83.30% of lean women and 93.10% of overweight women, while a deranged lipid profile was present in 14.20% and 31.00%, respectively. Their

study population consisted entirely of women presenting with infertility, whereas infertility was present in 49.15% of women in the present study.⁸ Thyroid evaluation in the present study showed that 82 (69.49%) women were euthyroid, whereas 36 (30.51%) had thyroid dysfunction. Subclinical hypothyroidism was identified in 30 (25.42%) women and overt hypothyroidism in 6 (5.08%). Janssen et al. (2004) evaluated 175 women with PCOS and 168 age-matched controls and found thyroid-specific TPO or thyroglobulin antibodies in 26.90% of PCOS patients compared with 8.30% of controls ($p<0.001$). They also found TSH above the upper limit of normal in 10.90% of women with PCOS compared with 1.80% of controls ($p<0.001$), while ultrasonographic features suggestive of autoimmune thyroiditis were observed in 42.30% and 6.50%, respectively. Although their definition was based predominantly on thyroid autoimmunity and elevated TSH rather than the thyroid functional classification used in the present study, both studies demonstrated a substantial occurrence of thyroid abnormalities among women with PCOS.⁹

When the participants were divided according to thyroid status, the present study found that women with thyroid dysfunction had a significantly higher BMI than euthyroid women (33.00 ± 3.10 vs. 31.20 ± 2.80 kg/m²; $p=0.004$), greater waist circumference (96.50 ± 8.20 vs. 91.60 ± 7.40 cm; $p=0.003$), and higher waist-to-hip ratio (0.90 ± 0.06 vs. 0.86 ± 0.05 ; $p=0.001$). Menstrual irregularity was also more frequent in the thyroid dysfunction group (97.22% vs. 74.39%; $p=0.003$), as were hirsutism (72.22% vs. 48.78%; $p=0.018$) and infertility (66.67% vs. 41.46%; $p=0.012$). Ganie et al. (2011) compared 62 women with PCOS and subclinical

hypothyroidism with 291 euthyroid women with PCOS. Their mean TSH levels were 7.13 ± 1.28 IU/L and 2.51 ± 1.21 IU/L, respectively. In contrast to the present findings, their two groups were comparable with regard to age, weight, BMI, blood pressure, menstrual pattern, and degree and duration of hirsutism. This difference may reflect differences in the thyroid categories studied, as the present thyroid dysfunction group included both subclinical and overt hypothyroidism.¹⁰

The hormonal profile in the present study showed a mean TSH of 7.18 ± 3.05 mIU/L in women with thyroid dysfunction compared with 2.36 ± 0.75 mIU/L among euthyroid women ($p < 0.001$), while FT4 was lower at 0.93 ± 0.20 versus 1.12 ± 0.16 ng/dL ($p < 0.001$). Mean LH and FSH did not differ significantly, and the LH/FSH ratio was 2.34 ± 0.78 versus 2.04 ± 0.71 ($p = 0.053$). Total testosterone, however, was significantly higher in the thyroid dysfunction group (61.60 ± 16.70 vs. 54.20 ± 15.10 ng/dL; $p = 0.026$). Dittich et al. (2009) evaluated 103 women with PCOS and reported that women with TSH ≥ 2.5 mIU/L had significantly higher BMI ($p = 0.003$), fasting insulin ($p = 0.020$), indices of insulin resistance ($p = 0.007$), total testosterone ($p = 0.009$), and free androgen index ($p = 0.001$), together with significantly lower sex hormone-binding globulin concentrations ($p = 0.010$), than women with TSH < 2.5 mIU/L. Their association between higher TSH and greater total testosterone was therefore comparable with the higher testosterone level observed in the thyroid dysfunction group of the present study.¹¹

Significant differences in glucose and insulin-related parameters were also observed in the present study. Women with thyroid dysfunction had higher fasting glucose (96.70 ± 10.80 vs. 91.40 ± 9.70 mg/dL; $p = 0.014$), fasting insulin (19.70 ± 6.20 vs. 14.80 ± 5.10 μ U/mL; $p < 0.001$), HOMA-IR (4.72 ± 1.66 vs. 3.34 ± 1.31 ; $p < 0.001$), and HbA1c ($5.62 \pm 0.43\%$ vs. $5.42 \pm 0.38\%$; $p = 0.019$). Celik et al. (2012) similarly compared 20 women with PCOS and subclinical hypothyroidism with 39 euthyroid women with PCOS and found fasting insulin levels of 12.45 ± 8.62 versus 8.60 ± 5.35 μ U/mL, respectively, with a significant overall difference ($p = 0.027$). HOMA-IR was also higher at 2.92 ± 2.34 compared with 1.95 ± 1.52 , respectively ($p = 0.046$). Their findings were therefore in the same direction as the significantly higher fasting insulin and HOMA-IR values found among women with thyroid dysfunction in the present study.¹²

Regarding the lipid profile, the present study demonstrated significantly higher total cholesterol in women with thyroid dysfunction than in euthyroid women (202.30 ± 34.10 vs. 188.50 ± 31.80 mg/dL; $p = 0.043$), higher triglycerides (171.40 ± 42.80 vs. 149.20 ± 37.60 mg/dL; $p = 0.009$), and higher LDL cholesterol (124.80 ± 29.80 vs. 112.40 ± 27.90 mg/dL; $p = 0.038$), whereas HDL cholesterol was significantly lower (42.30 ± 7.60 vs. 46.80 ± 8.40 mg/dL; $p = 0.005$). Pei et al. (2014) compared 29 women with PCOS and subclinical hypothyroidism, 35 euthyroid women with PCOS, and 34 euthyroid healthy controls. They also found significantly higher total cholesterol and triglycerides and significantly lower HDL cholesterol in the PCOS with subclinical hypothyroidism group than in the euthyroid PCOS group (all $p < 0.05$). However, LDL cholesterol did not differ significantly between their two PCOS groups ($p > 0.05$), whereas the present study demonstrated a significant LDL difference. They additionally found higher fasting insulin and HOMA-IR in the subclinical hypothyroidism group ($p < 0.05$), corresponding with the metabolic

differences observed in the present study.¹³ Correlation analysis in the present study demonstrated that serum TSH was significantly positively correlated with BMI ($r = 0.34$, $p < 0.001$), waist circumference ($r = 0.31$, $p = 0.001$), waist-to-hip ratio ($r = 0.27$, $p = 0.003$), LH/FSH ratio ($r = 0.20$, $p = 0.030$), total testosterone ($r = 0.22$, $p = 0.017$), fasting insulin ($r = 0.39$, $p < 0.001$), HOMA-IR ($r = 0.42$, $p < 0.001$), and triglycerides ($r = 0.29$, $p = 0.001$), while it was negatively correlated with HDL cholesterol ($r = -0.26$, $p = 0.004$). Age was not significantly correlated with TSH ($r = 0.11$, $p = 0.236$). Mueller et al. (2009), in an analysis of 337 women with PCOS, identified a TSH cut-off of approximately 2 mIU/L as having the best sensitivity and specificity for identifying insulin resistance. Women with TSH ≥ 2 mIU/L had significantly greater BMI and insulin resistance than those with TSH < 2 mIU/L, and the relationship between TSH and insulin resistance remained independent of age and BMI. Their findings correspond particularly with the significant positive relationship between TSH and HOMA-IR observed in the present study, where HOMA-IR showed the strongest correlation with TSH ($r = 0.42$, $p < 0.001$).¹⁴

CONCLUSION

The present study demonstrated that thyroid dysfunction, particularly subclinical hypothyroidism, was common among obese women with PCOS. Women with thyroid dysfunction had significantly higher BMI, central adiposity, menstrual irregularity, hirsutism, infertility, insulin resistance, and adverse lipid parameters. Serum TSH showed significant positive correlations with BMI, fasting insulin, HOMA-IR, triglycerides, and androgen-related parameters, while showing a negative correlation with HDL cholesterol. These findings support the importance of routine thyroid function assessment in obese women with PCOS for comprehensive endocrine and metabolic evaluation.

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