Original Research Article

Impact of Thyroid Dysfunction on Metabolic and Hormonal Profiles in Women with Polycystic Ovary Syndrome

Mahdi H. Hammadi[1]*

[1]Department of Microbiology, College of Science, AL-Karkh University, Baghdad, Iraq

*Corresponding Author: Mahdi H. Hammadi
Department of Microbiology, College of Science, AL-Karkh University, Baghdad, Iraq

Abstract: Polycystic ovary syndrome (PCOS) is frequently associated with metabolic disturbances and thyroid dysfunction, which may exacerbate hormonal and cardiometabolic abnormalities. This study aimed to evaluate the impact of thyroid functional status on metabolic and hormonal parameters in women with PCOS. A total of 100 women diagnosed with PCOS were enrolled and stratified into three groups according to thyroid function: euthyroid (normal TSH, (n = 55), subclinical hypothyroidism (n = 35), and overt hypothyroidism (n = 10). Anthropometric measurements, thyroid hormones, insulin resistance (HOMA-IR), and lipid profile parameters were assessed. Data were expressed as mean ± standard deviation, and group comparisons were performed using one-way ANOVA followed by post-hoc Tukeytest. Significant differences were observed among the three groups for all evaluated parameters. BMI and TSH levels increased progressively with worsening thyroid dysfunction ($p < 0.001$). Serum T3 and T4 levels decreased significantly across groups ($p = 0.02$ and $p = 0.001$, respectively). Insulin resistance was significantly higher in patients with hypothyroidism compared to euthyroid patients ($p = 0.005$). Moreover, triglycerides and LDL-C levels increased, while HDL-C levels decreased significantly with thyroid dysfunction ($p < 0.05$). Thyroid dysfunction, including subclinical hypothyroidism, is associated with adverse metabolic and hormonal alterations in women with PCOS. These findings highlight the importance of routine thyroid function assessment in PCOS patients to identify individuals at higher metabolic risk.

Keywords: Polycystic Ovary Syndrome, Thyroid Dysfunction, Subclinical Hypothyroidism, Insulin Resistance, Dyslipidemia.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is a frequent endocrine and metabolic disorder-which affects women of reproductive age, with an estimated worldwide prevalence ranging from 6% to 13% [1]. It is features by the presence of hyperandrogenism, ovulatory dysfunction and polycystic ovarian morphology as well as metabolic abnormalities such as obesity, insulin resistance and dyslipidemia [2, 3]. The abnormalities pose a significant risk of T2DM and cardiovascular diseases in the long run for women with these abnormalities [4]. The control of energy balance, lipid metabolism and reproductive function are among the central functions influenced by thyroid hormones. There is growing evidence suggesting a strong relationship between PCOS and thyroid disorders, especially SHT and OH [5]. Previous studies and meta-analyses have reported an increased prevalence of subclinical hypothyroidism among PCOS women as compared with the general population [6, 7], with rates reported ranging from 15% to 25%. Even among women with mild thyroid dysfunction, it has been reported that this can promote weight gain, insulin resistance and a lipid disorder leading to the exacerbated metabolic condition of PCOS [8, 9]. Sub clinical and overt hypothyroidism in PCOS have been associated with higher BMI, more insulin resistance and adverse lipid profile (Higher triglycerides, low-density-lipoprotein cholesterol, and lower high-density lipoprotein cholesterol) [10, 11]. These metabolic disturbances could further disrupt ovarian function through the complex mechanisms of insulin signaling, gonadotropin secretion and chronic low-grade inflammation [12]. Although there is an increasing appreciation of the PCOS–thyroid axis, limited information are available on the metabolic implications of varying thyroid status in women with PCOS particularly among Middle eastern population. Thus, the purpose of this study is to compare metabolic and hormonal variables in euthyroid cases control,

subclinical hypothyroid (SHT), overt hypothyroid women affected by PCOS patients to address whether thyroid dysfunction has a clinical significance in these groups of subjects.

MATERIALS AND METHODS

Study Design and Participants
This case–control study was conducted at the Gynecology Department of Baghdad Teaching Hospital between October 2019 and March 2020. A total of 100 women diagnosed with polycystic ovary syndrome (PCOS) were enrolled. PCOS diagnosis was established according to the Rotterdam criteria, requiring at least two of the following: oligo/anovulation, clinical or biochemical hyperandrogenism, and polycystic ovarian morphology on ultrasonography. Fifty apparently healthy women with regular menstrual cycles and no clinical or ultrasonographic evidence of ovarian cysts or endocrine disorders were recruited as age-matched controls.

Inclusion and Exclusion Criteria
Women aged 30–45 years were included. Exclusion criteria comprised pregnancy, menopause, known thyroid disease under treatment, diabetes mellitus, cardiovascular disease, hepatic or renal disorders, and the use of hormonal therapy, lipid-lowering medications, or insulin-sensitizing drugs within the three months preceding enrollment.

Anthropometric Measurements and Sample Collection
Body weight and height were measured using standard procedures, and body mass index (BMI) was calculated as weight (kg) divided by height squared (m²). After an overnight fast of 10–12 hours, 3–5 mL of venous blood was collected from each participant. Serum was separated by centrifugation at 3000 rpm for 10 minutes and stored at −20°C until analysis.

Biochemical and Hormonal Assays
Serum levels of thyroid-stimulating hormone (TSH), triiodothyronine (T3), thyroxine (T4), fasting insulin, and fasting glucose were measured using enzyme-linked immunosorbent assay (ELISA) kits (Bioditech Med Inc., Brussels, Belgium), following the manufacturer's instructions. Insulin resistance was estimated using the homeostasis model assessment of insulin resistance (HOMA-IR) formula:

$$\text{HOMA-IR} = \frac{\text{Fasting insulin (µIU/mL)} \times \text{Fasting glucose (mg/dL)}}{405}$$

Serum triglycerides, low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) were measured using enzymatic colorimetric methods with commercial kits (Randox Laboratories, UK).

Thyroid Function Classification
PCOS patients were classified according to thyroid functional status into three groups:
1. **Euthyroid:** Normal TSH, T3, and T4.
2. **Subclinical hypothyroidism:** Elevated TSH with normal T3 and T4.
3. **Overt hypothyroidism:** Elevated TSH with reduced T3 and/or T4.

Ethical Approval
The study protocol was approved by the Ethical Committee of the College of Science, Al-Karkh University for Science, Baghdad, Iraq. Written informed consent was obtained from all participants, and the study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis
Data were analyzed using SPSS software version 10.0 (SPSS Inc., Chicago, IL, USA). Continuous variables are presented as mean ± standard deviation (SD). Differences among thyroid functional groups were assessed using one-way analysis of variance (ANOVA), followed by Tukey's post-hoc test for multiple comparisons. A p-value < 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Table 1: Comparison of metabolic and hormonal parameters among PCOS patients based on thyroid functional status (Mean ± SD)

Parameter	Normal TSH (n=55)	Subclinical Hypothyroidism (n=35)	Overt Hypothyroidism (n=10)	*P* value
BMI (kg/m²)	28.3 ± 4.1	32.2 ± 3.6	36.4 ± 4.5	<0.001
TSH (µIU/mL)	2.2 ± 0.7	6.2 ± 1.6	13.5 ± 2.5	<0.001

Parameter	Normal TSH (n=55)	Subclinical Hypothyroidism (n=35)	Overt Hypothyroidism (n=10)	P value
T3 (µIU/mL)	117.3 ± 27.2	111.1 ± 27.1	94.5 ± 22.4	0.02
T4 (µIU/mL)	11.1 ± 3.8	9.5 ± 4.1	6.1 ± 2.2	0.001
HOMA-IR	3.1 ± 1.2	3.9 ± 2.1	5.9 ± 3.1	0.005
Triglycerides (mg/dL)	146.1 ± 33.1	185.6 ± 40.9	222.5 ± 49.1	<0.001
LDL-C (mg/dL)	127.1 ± 28.9	163.1 ± 34.5	192.2 ± 37.2	<0.001
HDL-C (mg/dL)	54.1 ± 7.1	48.7 ± 5.8	46.1 ± 5.2	0.01

Statistical Analysis: One-way ANOVA with post-hoc Tukey test.
Significance Level: $p < 0.05$

Table 1 presents the metabolic and hormonal parameters of PCOS patients stratified by thyroid functional status. Significant differences were observed among the three groups for all evaluated variables. Body mass index (BMI) increased progressively across thyroid categories, with mean values of 28.3 ± 4.1 kg/m² in euthyroid patients, 32.2 ± 3.6 kg/m² in those with subclinical hypothyroidism, and 36.4 ± 4.5 kg/m² in overt hypothyroidism ($p < 0.001$), with post-hoc analysis revealing significant differences between all group pairs. Thyroid-stimulating hormone (TSH) levels differed markedly among groups (2.2 ± 0.7, 6.2 ± 1.6, and 13.5 ± 2.5 µIU/mL in euthyroid, subclinical, and overt hypothyroidism, respectively; $p < 0.001$), with all pairwise comparisons reaching statistical significance. Serum T3 levels showed a significant decline across groups ($p = 0.02$), with the lowest values observed in the overt hypothyroidism group, while T4 levels also decreased significantly from euthyroid to overt hypothyroidism (11.1 ± 3.8, 9.5 ± 4.1, and 6.1 ± 2.2 µIU/mL, respectively; $p = 0.001$). Insulin resistance, assessed by HOMA-IR, differed significantly among groups, increasing from 3.1 ± 1.2 in euthyroid patients to 3.9 ± 2.1 in subclinical and 5.9 ± 3.1 in overt hypothyroidism ($p = 0.005$), with significant differences observed particularly between the overt hypothyroidism group and the other two groups. Lipid profile analysis revealed significant group-related differences, with triglyceride levels rising from 146.1 ± 33.1 mg/dL in euthyroid patients to 185.6 ± 40.9 mg/dL and 222.5 ± 49.1 mg/dL in subclinical and overt hypothyroidism, respectively ($p < 0.001$). Similarly, LDL-C levels increased significantly across groups (127.1 ± 28.9, 163.1 ± 34.5, and 192.2 ± 37.2 mg/dL; $p < 0.001$), while HDL-C levels decreased progressively with thyroid dysfunction (54.1 ± 7.1, 48.7 ± 5.8, and 46.1 ± 5.2 mg/dL; $p = 0.01$).

DISCUSSION

The current study demonstrates a significant association between thyroid functional status and both metabolic and hormonal disturbances in women with polycystic ovary syndrome (PCOS). BMI, insulin resistance (HOMA-IR), and atherogenic lipid parameters progressively worsened with increasing severity of thyroid dysfunction, supporting emerging evidence that subclinical and overt hypothyroidism exacerbate metabolic dysregulation in PCOS populations. Recent meta-analyses indicate that approximately 20% of women with PCOS present with subclinical hypothyroidism, which is significantly associated with higher HOMA-IR and fasting insulin levels compared with euthyroid subjects, thereby increasing cardiometabolic risk [7-10]. Our findings align with previous studies reporting that PCOS women with subclinical hypothyroidism exhibit adverse lipid profiles, characterized by elevated triglycerides and LDL-C and reduced HDL-C, compared with euthyroid counterparts [8, 9]. A recent cross-sectional analysis similarly demonstrated a high prevalence of thyroid dysfunction in PCOS, with TSH levels positively correlated with BMI and total cholesterol, highlighting the metabolic implications of even mild thyroid impairment [9]. Thyroid dysfunction may also influence reproductive endocrinology in PCOS. Emerging evidence suggests that subclinical hypothyroidism may alter the thyroid-prolactin axis and modulate reproductive hormone dynamics, potentially affecting ovarian reserve markers such as anti-Müllerian hormone (AMH), although classic markers such as gonadotropins may remain within normal ranges in some cohorts [10]. The observed progressive decline in HDL-C and elevation in triglycerides and LDL-C across thyroid dysfunction groups is consistent with broader epidemiological data indicating that hypothyroid states contribute to atherogenic lipid alterations in metabolic disorders [6, 7]. Additionally, obesity—a common comorbidity of both PCOS and hypothyroidism—may partly mediate these associations by reducing basal metabolic rate and promoting adiposity, thereby compounding metabolic risk [6-12]. These findings underscore the importance of comprehensive thyroid function assessment in women with PCOS. Early identification and management of subclinical hypothyroidism may mitigate metabolic deterioration and reduce long-term risks such as type 2 diabetes mellitus and cardiovascular disease. However, larger prospective studies are warranted to elucidate causal mechanisms and evaluate the impact of thyroid-targeted interventions in PCOS care [7-10].

Limitations

This study's cross-sectional design limits causal inference between thyroid dysfunction and metabolic or hormonal alterations in PCOS. The overt hypothyroidism group had a small sample due to its low prevalence among PCOS women, which may reduce statistical power. Potential confounders such as diet, physical activity, and genetic factors were not evaluated. Being a single-center study also restricts generalizability. Larger, multicenter, and longitudinal studies are needed to confirm these findings and clarify underlying mechanisms.

CONCLUSION

This study demonstrates that thyroid dysfunction, particularly subclinical and overt hypothyroidism, is associated with a progressive worsening of metabolic and hormonal profiles in women with PCOS. Patients with hypothyroidism exhibited higher BMI, increased insulin resistance, elevated triglycerides and LDL-C, and reduced HDL-C compared with euthyroid counterparts. These findings underscore the clinical significance of routine thyroid screening in PCOS management, as early identification and correction of thyroid dysfunction may improve metabolic outcomes and potentially reduce long-term cardiovascular and endocrine complications. Comprehensive evaluation of thyroid status should therefore be integrated into standard care protocols for women with PCOS.

REFERENCES

1. Azziz R, Carmina E, Chen Z, Dunaif A, Laven JSE, Legro RS, et al. Polycystic ovary syndrome. Nat Rev Dis Primers. 2016; 2:16057.
2. Diamanti-Kandarakis E, Dunaif A. Insulin resistance and the polycystic ovary syndrome revisited: mechanisms and implications. Endocr Rev. 2012;33(6):981–1030.
3. Escobar-Morreale HF. Polycystic ovary syndrome: definition, aetiology, diagnosis and treatment. Nat Rev Endocrinol. 2018;14(5):270–284.
4. Hua R, Li JJ, Yang W, Yun H, Ma YL. Impact of subclinical hypothyroidism on endocrine features in patients with polycystic ovary syndrome. Eur J Med Res. 2025 Aug 8;30(1):725. doi:10.1186/s40001-025-02910-y.
5. Krassas GE, Poppe K, Glinoer D. Thyroid function and human reproductive health. Endocr Rev. 2010;31(5):702–755.
6. Lath R, Shendye R, Jibhkate A. Insulin resistance and lipid profile in polycystic ovary syndrome. Asian J Biomed Pharm Sci. 2015;5(47):30–35.
7. Moustafa MM, Jamal MY, Al-Janabi RD. Thyroid hormonal changes among women with polycystic ovary syndrome: a case–control study. F1000Res. 2019;8:669.
8. Ramezani Tehrani F, Amouzegar A, Tohidi M, Bidhendi Yarandi R, Azizi F. Subclinical hypothyroidism in women with polycystic ovary syndrome: a systematic review and meta-analysis. Endocrine. 2023;81(2):345–356.
9. Shirsath A, Aundhakar N, Kamble P. Does thyroid hormonal level alter in polycystic ovarian disease? A comparative cross-sectional study. Indian J Basic Appl Med Res. 2015;4(3):265–271.
10. Taylor PN, Albrecht D, Scholz A, Gutierrez-Buey G, Lazarus JH, Dayan CM, et al. Global epidemiology of hyperthyroidism and hypothyroidism. Nat Rev Endocrinol. 2018;14(5):301–316.
11. Teede HJ, Misso ML, Costello MF, Dokras A, Laven J, Moran L, et al. Recommendations from the international evidence-based guideline for assessment and management of polycystic ovary syndrome. Hum Reprod. 2018;33(9):1602–1618.
12. Valkenburg O, Steegers-Theunissen RPM, Smedts HPM, Dallinga-Thie GM, Fauser BCJM, Westerveld HE. A more atherogenic serum lipoprotein profile is present in women with PCOS. J Clin Endocrinol Metab. 2008;93(2):470–476.
13. Wagma S, Hussein A, Kareem H. Thyroid disorders and metabolic parameters in women with polycystic ovary syndrome: a cross-sectional study. J Health Wellness Community Res. 2025;(Article 594).
14. Wild RA, Carmina E, Diamanti-Kandarakis E, Dokras A, Escobar-Morreale HF, Futterweit W, et al. Assessment of cardiovascular risk and prevention of cardiovascular disease in women with PCOS. J Clin Endocrinol Metab. 2010;95(5):2038–2049.