Sonographic Assessment of Ovarian Morphology and Thyroid Function in Nigerian Women with Polycystic Ovary Syndrome

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is the most common endocrine disorder affecting women of reproductive age and is characterized by reproductive, metabolic, and ovarian morphological abnormalities. Although thyroid dysfunction frequently coexists with PCOS, its influence on ovarian morphology remains unclear, particularly among African women.

Objective: To investigate the relationship between circulating thyroid hormone concentrations and sonographic ovarian morphological features among Nigerian women with PCOS.

Methods: This hospital-based prospective comparative cross-sectional study included 205 women aged 18–45 years recruited from the Department of Obstetrics and Gynaecology, Federal Medical Centre, Onitsha, Nigeria, between June 2025 and May 2026. Participants comprised 105 women diagnosed with PCOS according to the 2023 International Evidence-based Guideline (modified Rotterdam criteria) and 100 apparently healthy controls. Serum thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) levels were measured using enzyme-linked immunosorbent assay. Transvaginal ultrasonography was performed to assess ovarian volume, stromal thickness, and antral follicle count (AFC). Differences between groups were analyzed using the independent-samples *t*-test, while Pearson's correlation analysis assessed associations between thyroid hormone concentrations and ovarian morphological parameters. Statistical significance was set at $p < 0.05$.

Results: Women with PCOS showed significantly increased antral follicle count and ovarian stromal thickness compared with healthy controls ($p < 0.001$ for both parameters). Significant differences in ovarian morphological characteristics were observed between the groups. However, serum TSH, FT3, and FT4 concentrations demonstrated no significant correlations with ovarian volume, stromal thickness, or antral follicle count in either the PCOS or control groups (all $p > 0.05$).

Conclusion: Women with PCOS exhibit characteristic sonographic ovarian alterations, particularly increased antral follicle count and stromal thickness, which appear to occur independently of circulating thyroid hormone concentrations. These findings suggest that thyroid hormones may not play a major role in determining ovarian morphological changes in PCOS. Although thyroid function evaluation remains essential in the endocrine assessment of women with PCOS, transvaginal ultrasonography remains central to the evaluation of ovarian

morphology. Further multicentre longitudinal studies incorporating broader endocrine and metabolic profiles are recommended to better define the interaction between thyroid function and ovarian changes in PCOS.

Keywords: Polycystic ovary syndrome; thyroid-stimulating hormone; Antral Follicle Count; Ovarian Stromal Thickness; transvaginal ultrasonography.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is the most prevalent endocrine disorder affecting women of reproductive age and remains one of the leading causes of anovulatory infertility worldwide (Teede et al., 2023; Stener-Victorin et al., 2024). Current evidence indicates that PCOS affects approximately 8--13% of reproductive-aged women when diagnosed using contemporary criteria, although prevalence may range from 5% to 20% depending on the diagnostic criteria applied, ethnicity, and study population (Teede et al., 2023; Stener-Victorin et al., 2024). Beyond reproductive dysfunction, PCOS is now recognized as a complex multisystem disorder characterized by hyperandrogenism, ovulatory dysfunction, insulin resistance, chronic low-grade inflammation, and polycystic ovarian morphology (PCOM; defined as the presence of multiple small follicles and increased ovarian volume on ultrasound), with significant implications for metabolic, cardiovascular, and psychological health (Dumesic et al., 2021; Escobar-Morreale, 2023; Stener-Victorin et al., 2024).

The diagnosis of PCOS has undergone substantial refinement over recent decades. The 2023 International Evidence-Based Guideline for the Assessment and Management of Polycystic Ovary Syndrome recommends the continued use of the revised Rotterdam criteria, whereby a diagnosis is established following the exclusion of related disorders when at least two of the following are present: (1) clinical or biochemical hyperandrogenism; (2) ovulatory dysfunction; and (3) polycystic ovarian morphology on ultrasound or elevated anti-Müllerian hormone (AMH, a marker of ovarian reserve) levels in appropriate clinical settings (Teede et al., 2023). Despite the increasing clinical utility of AMH, transvaginal ultrasonography remains the principal imaging modality for evaluating ovarian morphology because it provides direct assessment of ovarian volume, antral follicle count, stromal architecture, and other structural characteristics that contribute to diagnosis and disease phenotyping (Teede et al., 2023; Dewailly et al., 2023).

In addition to reproductive manifestations, women with PCOS are at increased risk of obesity, insulin resistance, type 2 diabetes mellitus, dyslipidaemia, hypertension, metabolic dysfunction-associated steatotic liver disease, infertility, endometrial pathology, anxiety, depression, and reduced health-related quality of life (Teede et al., 2023; Escobar-Morreale, 2023; Dason et al., 2024). These diverse clinical manifestations reflect the heterogeneity of the syndrome and underscore the importance of identifying endocrine and metabolic factors that may influence ovarian morphology and disease severity.

Among the endocrine factors receiving increasing attention is thyroid function. Thyroid hormones play essential roles in female reproductive physiology by regulating folliculogenesis, differentiation of granulosa cells (the cells that surround developing oocytes and are essential for follicle maturation), steroidogenesis, ovulation, endometrial receptivity, and maintenance of the hypothalamic--pituitary--ovarian axis (Mancini et al., 2021; Hu et al., 2022). Experimental and clinical evidence suggests that disturbances in thyroid hormone homeostasis may adversely affect ovarian function through alterations in gonadotropin secretion, insulin sensitivity, hepatic synthesis of sex hormone-binding globulin, oxidative stress, and ovarian steroid metabolism (Hu et al., 2022; Poppe & Velkeniers, 2023).

Thyroid dysfunction appears to occur more frequently among women with PCOS than in the general female population. Recent systematic reviews and meta-analyses have demonstrated a significantly higher prevalence of subclinical hypothyroidism and autoimmune thyroid disease among women with PCOS, suggesting shared pathophysiological mechanisms involving insulin resistance, chronic inflammation, and immune dysregulation (Hu et al., 2022; Poppe & Velkeniers, 2023). Hypothyroidism has also been associated with impaired insulin sensitivity, hyperinsulinaemia, altered gonadotropin secretion, and increased ovarian androgen production, factors that may aggravate the endocrine and metabolic abnormalities characteristic of PCOS (Hu et al., 2022; Sumji et al., 2023). Conversely, thyroid disorders frequently present with menstrual irregularities, infertility,

weight gain, and metabolic disturbances that overlap clinically with PCOS, thereby complicating diagnosis and clinical management (Mancini et al., 2021; Poppe & Velkeniers, 2023).

Although numerous studies have examined the coexistence of thyroid dysfunction and PCOS, evidence regarding the relationship between circulating thyroid hormone concentrations and sonographic ovarian morphology remains inconclusive. Some investigations have reported associations between thyroid hormone status and ovarian reserve (the capacity of the ovary to provide eggs capable of fertilization), follicular development, or ovarian volume, whereas others have observed no significant relationship after adjustment for confounding metabolic factors such as obesity and insulin resistance (Sumji et al., 2023; Hu et al., 2022). Differences in study design, diagnostic criteria, ethnicity, sample size, and hormonal assessment may partly explain these inconsistent findings.

Evidence from sub-Saharan Africa remains particularly limited. In Nigeria, published studies have largely focused on the clinical presentation of PCOS, metabolic abnormalities, infertility, body mass index, or ultrasonographic ovarian characteristics, while few investigations have specifically explored the relationship between thyroid hormones and detailed ovarian morphological parameters measured by transvaginal ultrasonography (Ezugwu et al., 2023; Teede et al., 2023). Consequently, whether circulating thyroid hormones influence ovarian volume, stromal thickness, or antral follicle count among Nigerian women with PCOS remains inadequately understood.

This study therefore investigated the relationship between circulating thyroid hormones---thyroid-stimulating hormone (TSH), triiodothyronine (T3), and thyroxine (T4)---and sonographic ovarian morphology among women with PCOS attending a tertiary healthcare facility in southeastern Nigeria. Specifically, the study evaluated the correlations between thyroid hormone concentrations and ovarian volume, ovarian stromal thickness, and antral follicle count measured using transvaginal ultrasonography. The findings are expected to enhance understanding of how thyroid hormones may influence ovarian structure in Nigerian women with PCOS and to provide evidence supporting more comprehensive clinical assessment and individualized management.

MATERIALS AND METHODS

Study Design and Setting: This was a hospital-based, prospective comparative cross-sectional study conducted at the Department of Obstetrics and Gynaecology, Federal Medical Centre (FMC), Onitsha, Anambra State, Nigeria, between June 2025 and May 2026. The study compared ovarian morphological characteristics and thyroid hormone profiles between women with polycystic ovary syndrome (PCOS) and age-matched apparently healthy controls.

Study Population: The study included women aged 18–45 years attending the fertility and gynaecology outpatient clinics of FMC Onitsha during the study period. A total of 205 participants were enrolled, comprising 105 women diagnosed with PCOS (test group) and 100 apparently healthy women without PCOS (control group).

Sample Size and Sampling Technique: The sample size was determined using the Taro Yamane formula for finite populations. To improve statistical precision and account for possible incomplete data, 205 participants were recruited. Eligible participants who met the study criteria were enrolled consecutively using a convenience sampling technique until the required sample size was attained.

Inclusion Criteria: Women in the PCOS group were aged 18–45 years and fulfilled the 2023 International Evidence-based Guideline (modified Rotterdam criteria) for the diagnosis of PCOS, requiring at least two of the following, after exclusion of other related endocrine disorders (Teede et al., 2023):

- Clinical and/or biochemical hyperandrogenism;
- Ovulatory dysfunction; and

- Polycystic ovarian morphology on transvaginal ultrasonography or elevated anti-Müllerian hormone (AMH), where applicable.

Control participants were apparently healthy women aged 18–45 years with regular menstrual cycles, normal ovarian morphology on ultrasonography, no evidence of clinical or biochemical hyperandrogenism, and no history of infertility attributable to ovarian disease.

Exclusion Criteria: Women were excluded if they were pregnant, had previous ovarian surgery, ovarian cysts or tumours unrelated to PCOS, known thyroid disease receiving treatment, hyperprolactinaemia, congenital adrenal hyperplasia, Cushing's syndrome, had used hormonal medications within the preceding three months, or declined to provide informed consent.

Clinical and Anthropometric Assessment: Sociodemographic and relevant clinical information were obtained using a structured questionnaire. Weight was measured to the nearest 0.1 kg using a calibrated digital weighing scale, while height was measured to the nearest 0.1 cm using a stadiometer with participants standing barefoot. Body mass index (BMI) was calculated as weight (kg)/height² (m^2) and classified according to the World Health Organization (WHO) BMI classification.

Laboratory Procedures: Approximately 5 mL of venous blood was collected aseptically from each participant into plain tubes. Samples were allowed to clot and centrifuged at 5000 rpm for five minutes. Serum was separated and stored at −20°C until analysis.

Serum concentrations of thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) were measured using commercially available enzyme-linked immunosorbent assay (ELISA) kits according to the manufacturers' instructions. Internal quality-control procedures and calibration standards were applied throughout the analytical process to ensure accuracy and reliability.

Ultrasonographic Assessment: Transvaginal ultrasonography was performed using a Mindray ultrasound system (Mindray Bio-Medical Electronics Co., Ltd., Shenzhen, China) equipped with a 6–12 MHz endovaginal transducer. All examinations were performed by the same experienced sonographer during the early follicular phase (days 2–7 of the menstrual cycle) or at a comparable stage in women with amenorrhoea or irregular menstrual cycles to minimize physiological variation. Both ovaries were examined in longitudinal and transverse planes.

Ovarian Volume: The maximum longitudinal, anteroposterior, and transverse diameters were measured, and ovarian volume was calculated using the prolate ellipsoid formula:

Ovarian volume (mL) = 0.523 × Length × Width × Thickness

The mean value of duplicate measurements was used for analysis.

Ovarian Stromal Thickness: Stromal thickness was measured at the widest portion of the ovarian stroma on the largest cross-sectional image. Two perpendicular measurements were obtained, and their average was recorded for each ovary.

Antral Follicle Count: Antral follicle count (AFC) was determined by counting all follicles measuring 2–9 mm in diameter in both ovaries during real-time transvaginal ultrasonography, in accordance with the recommendations of the 2023 International Evidence-based Guideline for PCOS (Teede et al., 2023). The total AFC represented the combined count from both ovaries.

Outcome Measures: The primary outcome measures were ovarian volume, ovarian stromal thickness, and antral follicle count. Secondary outcome measures included serum concentrations of TSH, FT3, and FT4.

Statistical Analysis: Data were analysed using IBM Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Shapiro–Wilk

test and presented as mean ± standard deviation (SD), whereas categorical variables were summarized as frequencies and percentages.

Comparisons between the PCOS and control groups were performed using the independent-samples Student's *t*-test for normally distributed continuous variables and the Chi-square test for categorical variables. Pearson's correlation analysis was used to evaluate the relationships between serum thyroid hormone concentrations (TSH, FT3, and FT4) and ovarian morphological parameters (ovarian volume, stromal thickness, and antral follicle count). A two-sided *p*-value of <0.05 was considered statistically significant.

Ethical Considerations: Ethical approval was obtained from the Human Research Ethics Committee of the Anambra State Ministry of Health, Awka (Approval No. **MH/PRS/1244/VOL.248**). Written informed consent was obtained from all participants before enrolment. The study complied with the ethical principles of the Declaration of Helsinki.

Conflict of Interest: There is no conflict of interest in this research, whatsoever.

RESULTS

Table 1: Independent t test table comparing ovarian volume, follicle count, stromal thickness between women with PCOS and controls

Subjects	N	Mean±SD	t-test	df	p-value	Remark
Control group	100	17.25±13.84	7.674	203	< .001	Sig
Cases(Ovarian volume)	105	6.55±3.49				
Control group	100	0.82±0.69				
Cases(Follicle count)	105	4.35±4.17	-8.346	203	< .001	Sig
Control group	100	0.71±0.26				
Cases(Stromal Thickness)	105	7.41±2.22	-29.899	203	< .001	Sig

Table 1 shows that women with PCOS had significantly higher stromal thickness, and ovarian volume compared to the control group (all p < .001). Overall, all three sonographic parameters differed significantly between women with PCOS and the controls.

Table 2: Correlation between TSH and ovarian morphological parameters (ovarian volume, follicle count, stromal thickness) between women with PCOS and control group

Subjects	N	R	p-value	Remark
Control group	100	0.02	0.86	N/S
Cases(Ovarian volume)	105	0.13	0.19	N/S
Control group	100	0.02	0.84	N/S
Cases(Follicle count)	105	0.11	0.25	N/S
Control group	100	0.02	0.88	N/S
Cases(Stromal Thickness)	105	-0.14	0.15	N/S

Table 2 shows that there were no significant correlations between TSH levels and ovarian volume, follicle count, or stromal thickness in either the PCOS or control group (all $p > .05$). This indicates that TSH was not significantly associated with any of the ovarian morphological parameters assessed in either group.

Table 3: Correlation between T3 and ovarian morphological parameters (ovarian volume, follicle count, stromal thickness) between women with PCOS and control group

Subjects	N	R	p-value	Remark
Control group	100	-0.03	0.79	N/S
Cases(Ovarian volume)	105	0.06	0.52	N/S
Control group	100	-0.10	0.32	N/S
Cases(Follicle count)	105	0.11	0.28	N/S
Control group	100	-0.12	0.23	N/S
Cases(Stromal Thickness)	105	0.08	0.41	N/S

Table 3 shows that there were no significant correlations between T3 levels and ovarian volume, follicle count, or stromal thickness in either the PCOS or control group (all $p > .05$). This indicates that T3 was not significantly associated with any of the ovarian morphological parameters assessed in either group.

Table 4: Correlation between T4 and ovarian morphological parameters (ovarian volume, follicle count, stromal thickness) between women with PCOS and control group

Subjects	N	R	p-value	Remark
Control group	100	0.01	0.93	N/S
Cases(Ovarian volume)	105	-0.14	0.14	N/S
Control group	100	-0.11	0.26	N/S
Cases(Follicle count)	105	-0.16	0.09	N/S
Control group	100	-0.19	0.06	N/S
Cases(Stromal Thickness)	105	-0.08	0.42	N/S

Table 4 shows that there were no significant correlations between T4 levels and ovarian volume, follicle count, or stromal thickness in either the PCOS or control group (all $p > .05$). This indicates that T4 was not significantly associated with any of the ovarian morphological parameters assessed in either group.

DISCUSSION

The present study compared sonographic ovarian morphology between women with polycystic ovary syndrome (PCOS) and apparently healthy controls and further examined the relationship between circulating thyroid hormone concentrations and ovarian morphological characteristics. The findings demonstrated that women with PCOS had significantly greater antral follicle counts and increased ovarian stromal thickness than controls. In contrast, serum thyroid-stimulating hormone (TSH), triiodothyronine (T3), and thyroxine (T4) concentrations were not significantly correlated with ovarian volume, antral follicle count, or stromal thickness in either group. Collectively, these findings suggest that although ovarian morphology differs markedly between women with

PCOS and healthy women, circulating thyroid hormone concentrations do not appear to be major determinants of these structural ovarian changes among predominantly euthyroid individuals (Teede et al., 2023; Escobar-Morreale, 2023; Stener-Victorin et al., 2024).

The significantly higher antral follicle count observed in women with PCOS is consistent with the established pathophysiology of the syndrome. PCOS is characterized by dysregulated folliculogenesis, in which excessive recruitment of early follicles is accompanied by arrested follicular maturation and failure of dominant follicle selection, resulting in the accumulation of numerous small antral follicles within the ovarian cortex (Dumesic et al., 2021; Dewailly et al., 2023; Teede et al., 2023). This phenomenon underlies the characteristic polycystic ovarian morphology observed on transvaginal ultrasonography and forms one of the principal diagnostic features of the disorder (Teede et al., 2023). Likewise, the significantly greater stromal thickness demonstrated among women with PCOS reflects stromal hypertrophy and theca-cell hyperplasia induced by chronic hyperandrogenism, excessive luteinizing hormone stimulation, hyperinsulinaemia, and local ovarian growth factor activity, all of which contribute to increased stromal echogenicity and ovarian enlargement (Escobar-Morreale, 2023; Dumesic et al., 2021; Stener-Victorin et al., 2024).

The present findings are consistent with previous ultrasonographic studies demonstrating increased stromal thickness, higher follicle number per ovary, and enlarged ovarian size among women with PCOS (Pea et al., 2024; Stener-Victorin et al., 2024; Teede et al., 2023). Earlier studies have shown greater ovarian size and follicular excess among women with PCOS (Dewailly et al., 2011; Jonard et al., 2003), while more recent MRI-based investigations confirmed significantly increased follicle number per ovary and ovarian volume among adolescents and young adults with PCOS (Pereira-Eshraghi et al., 2022). Furthermore, the 2023 International Evidence-based Guideline recognizes increased follicle number per ovary and characteristic ovarian morphology as defining ultrasonographic features of PCOS and emphasizes their importance in disease phenotyping and diagnosis (Teede et al., 2023).

Despite the marked differences in ovarian morphology between study groups, serum thyroid hormone concentrations were not significantly associated with ovarian volume, stromal thickness, or antral follicle count. Neither TSH, T3, nor T4 demonstrated statistically significant correlations with any of the measured sonographic parameters. These findings indicate that circulating thyroid hormone concentrations, at least within the physiological range represented in the present study, were not significantly associated with the structural ovarian alterations characteristic of PCOS. Rather, ovarian morphology appears to be driven predominantly by intrinsic ovarian dysfunction, androgen excess, insulin resistance, altered gonadotropin secretion, chronic low-grade inflammation, and genetic susceptibility, which collectively regulate follicular development and stromal remodeling (Escobar-Morreale, 2023; Teede et al., 2023; Stener-Victorin et al., 2024).

Emerging evidence also suggests that environmental exposures may contribute to the development and clinical expression of PCOS through endocrine-disrupting mechanisms. Chemicals such as bisphenol A (BPA), phthalates, per- and polyfluoroalkyl substances (PFAS), pesticides, heavy metals, and air pollutants have been implicated in alterations of thyroid function, insulin sensitivity, and steroid hormone metabolism. These substances may also disrupt ovarian folliculogenesis (Diamanti-Kandarakis et al., 2009; WHO, 2023; Teede et al., 2023). Although environmental exposures were not assessed in the present study, they may influence reproductive endocrine function independently of circulating thyroid hormone concentrations. Consequently, future studies should incorporate environmental exposure assessment to better understand how endocrine-disrupting chemicals interact with genetic, metabolic, and hormonal factors in determining ovarian morphology among women with PCOS.

The lack of association between thyroid hormones and ovarian morphology is biologically plausible. Thyroid hormones are essential regulators of female reproductive physiology and influence folliculogenesis, granulosa-cell proliferation, steroidogenesis, ovulation, endometrial receptivity, and maintenance of the hypothalamic–pituitary–ovarian axis (Mancini et al., 2021; Hu et al., 2022). However, most of these actions are functional rather than structural. Consequently, alterations in thyroid hormone concentrations are more likely to manifest as menstrual irregularities, ovulatory dysfunction, impaired fertility, and endocrine disturbances than as measurable changes in ovarian volume, stromal architecture, or follicle number detectable by ultrasonography (Hu et al., 2022; Poppe & Velkeniers, 2023). Furthermore, because the majority of participants in the present

study were apparently euthyroid, the relatively narrow physiological range of thyroid hormone concentrations may have limited the ability to detect significant associations with ovarian morphology.

Our findings contrast with studies evaluating endocrine biomarkers more directly involved in ovarian follicular dynamics. Serum anti-Müllerian hormone (AMH), which is secreted by granulosa cells of preantral and small antral follicles, has consistently been shown to correlate positively with follicle number per ovary and ovarian reserve. Women with PCOS typically exhibit elevated AMH concentrations owing to their increased number of small antral follicles, supporting the use of AMH as a reliable biochemical marker of follicular excess and polycystic ovarian morphology (Teede et al., 2023; Iwase et al., 2023; Liu et al., 2023; Yuwen et al., 2023). Similarly, previous studies have demonstrated significant positive associations between serum AMH concentrations, ovarian volume, and follicular excess in women with PCOS, suggesting that AMH reflects the degree of polycystic ovarian morphology and disease severity (Sumji et al., 2023; Teede et al., 2023). The discrepancy between these observations and the present findings likely reflects fundamental physiological differences between thyroid hormones and AMH. Unlike thyroid hormones, AMH is produced directly by granulosa cells of pre-antral and small antral follicles and therefore more accurately reflects ovarian follicular activity and structural morphology (Dewailly et al., 2023; Teede et al., 2023).

Differences between the present findings and those of previous studies may also be attributable to methodological and population-specific factors. Variations in ethnicity, genetic background, diagnostic criteria, ultrasonographic protocols, laboratory assay methods, body mass index, insulin resistance, androgen status, sample size, disease phenotype, and environmental exposures have all been shown to influence endocrine and morphological characteristics in PCOS (Teede et al., 2023; Escobar-Morreale, 2023). In addition, studies including women with overt hypothyroidism or autoimmune thyroid disease may identify associations that are not evident in predominantly euthyroid populations such as the present cohort. Future studies should therefore evaluate whether thyroid dysfunction influences ovarian morphology directly or indirectly through its effects on metabolic homeostasis and reproductive endocrine function, while also accounting for environmental determinants of endocrine health.

The present findings have important clinical implications. Current international guidelines recommend thyroid function testing as part of the evaluation of women presenting with menstrual irregularities, infertility, or suspected PCOS because thyroid disorders may mimic or coexist with PCOS and contribute to ovulatory dysfunction, infertility, pregnancy complications, and adverse metabolic outcomes (Teede et al., 2023; Poppe & Velkeniers, 2023). However, the absence of significant associations between thyroid hormone concentrations and sonographic ovarian morphology in this study suggests that thyroid hormone measurements were not associated with ovarian structural characteristics in this cohort. Instead, detailed transvaginal ultrasonographic assessment remains indispensable for evaluating ovarian morphology, while thyroid function testing should continue to serve its established role in excluding concomitant endocrine disorders and guiding comprehensive clinical management (Teede et al., 2023).

From an environmental health perspective, these findings reinforce the importance of addressing modifiable environmental risk factors that may contribute to endocrine and metabolic disorders among women of reproductive age. Environmental surveillance, reduction of exposure to endocrine-disrupting chemicals, promotion of cleaner household and occupational environments, and public education on environmental reproductive hazards may complement existing clinical management strategies for PCOS. Integrating environmental health interventions into reproductive health programmes could strengthen prevention efforts and improve reproductive outcomes, particularly in low- and middle-income countries where exposure to environmental contaminants remains an important public health concern.

An important strength of this study is the combined assessment of biochemical thyroid function and detailed transvaginal ultrasonographic evaluation of ovarian morphology within a Nigerian population, addressing a notable evidence gap from sub-Saharan Africa where high-quality data on endocrine correlates of ovarian morphology remain limited (Teede et al., 2023; Ezugwu et al., 2023). The inclusion of an apparently healthy comparison group also enabled robust evaluation of disease-related morphological differences using standardized imaging techniques.

Nevertheless, several limitations should be acknowledged. The cross-sectional design limits causal inference regarding the temporal relationship between thyroid hormone status and ovarian morphology. In addition, several important variables were not evaluated, including thyroid autoantibodies, anti-Müllerian hormone, insulin resistance indices, androgen profiles, inflammatory biomarkers, and detailed body composition measures. The absence of these assessments precludes a comprehensive evaluation of the complex endocrine and metabolic pathways that influence ovarian morphology (Teede et al., 2023; Escobar-Morreale, 2023). Furthermore, environmental exposures, including endocrine-disrupting chemicals, air pollution, pesticides, heavy metals, and occupational or household contaminants, were not assessed, preventing evaluation of their potential contribution to thyroid function and ovarian morphology. Finally, recruitment from a single tertiary healthcare facility may limit the generalizability of the findings to other populations.

Future multicentre prospective studies incorporating longitudinal follow-up, thyroid autoimmunity assessment, comprehensive metabolic profiling, anti-Müllerian hormone measurement, advanced quantitative ultrasonographic techniques, and environmental exposure assessment—including endocrine-disrupting chemicals, air pollution, pesticides, and heavy metals—are warranted to further elucidate the complex interactions between environmental factors, thyroid function, and ovarian morphology among African women with PCOS (Teede et al., 2023; Dewailly et al., 2011; Stener-Victorin et al., 2024).

CONCLUSION

This study demonstrated that women with polycystic ovary syndrome (PCOS) had significantly greater antral follicle counts and increased ovarian stromal thickness than apparently healthy women, reaffirming the characteristic sonographic features of PCOS and the value of transvaginal ultrasonography in its evaluation. In contrast, serum concentrations of thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) were not significantly associated with ovarian volume, stromal thickness, or antral follicle count in either the PCOS or control group. These findings indicate that circulating thyroid hormone concentrations were not significantly associated with the structural ovarian changes observed in women with PCOS in this study.

The absence of significant associations between thyroid hormones and ovarian morphology in this study suggests that ovarian structural alterations in PCOS may be more closely related to hyperandrogenism, abnormal folliculogenesis, insulin resistance, and other intrinsic ovarian and metabolic mechanisms than to variations in thyroid hormone concentrations in this cohort. Nevertheless, growing evidence indicates that environmental exposures, particularly endocrine-disrupting chemicals and other environmental contaminants, may influence reproductive endocrine function and metabolic health. Although these factors were not evaluated in the present study, they warrant consideration in future investigations because of their potential role in the development and progression of PCOS.

Consequently, while thyroid function assessment remains an essential component of the endocrine evaluation of women with PCOS to identify coexisting thyroid disorders that may contribute to menstrual dysfunction, infertility, and adverse metabolic outcomes, thyroid hormone measurements should not be relied upon to predict ovarian morphological characteristics. Comprehensive transvaginal ultrasonographic assessment therefore remains indispensable for the evaluation and phenotypic characterization of PCOS. In addition, public health strategies aimed at reducing exposure to environmental endocrine disruptors through environmental health education, improved occupational and household environmental practices, and strengthened environmental monitoring may complement clinical approaches to improving reproductive health outcomes among women of reproductive age.

Given the limited evidence from sub-Saharan Africa, particularly Nigeria, this study contributes important data on the relationship between thyroid function and ovarian morphology in women with PCOS. Future multicentre prospective studies involving larger and more ethnically diverse populations should incorporate comprehensive endocrine and metabolic profiling—including anti-Müllerian hormone, androgen levels, insulin resistance indices, inflammatory biomarkers, thyroid autoantibodies, and assessment of environmental exposures such as endocrine-disrupting chemicals, pesticides, air pollution, and heavy metals—to further elucidate the mechanisms underlying ovarian morphological changes in PCOS. Such multidisciplinary studies will strengthen

understanding of the interactions between environmental and endocrine factors, improve disease phenotyping, guide individualized management, inform preventive environmental health interventions, and ultimately enhance reproductive and metabolic outcomes among women with PCOS.

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