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Original Research Article

Evaluation of C-reactive protein/albumin ratio in women with polycystic ovarian syndrome and women without polycystic ovarian syndrome

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is a common endocrine disorder characterized by hyperandrogenism, oligo-anovulation, and polycystic ovarian morphology. Emerging evidence suggests a role of chronic low-grade inflammation in PCOS pathophysiology. The C-reactive protein (CRP)/albumin ratio, reflecting both inflammation and nutritional status, may serve as a sensitive biomarker in PCOS.
Methods: A cross-sectional study was conducted over one year on 100 women aged 20–40 years attending the Obstetrics and Gynaecology department of Navodaya Medical College, Raichur. Group A included 50 women without PCOS, and group B included 50 women with PCOS (diagnosed by Rotterdam criteria). Serum CRP and albumin were measured, and the CRP/albumin ratio was calculated. Data were analysed using independent t-test, Chi-square test, and ROC curve analysis. A p-value <0.05 was considered statistically significant.
Results: Women with PCOS had significantly higher BMI and waist circumference ($p<0.001$). CRP levels were higher (4.8±1.4 mg/l versus 1.9±0.8 mg/l) and albumin levels lower (3.2±0.5 g/dl versus 4.1±0.4 g/dl) in PCOS compared to controls, resulting in a higher CRP/albumin ratio (2.8±1.2 versus 1.4±0.6, $p<0.001$). Elevated ratios were present even in lean PCOS cases. ROC curve analysis yielded an AUC of 0.89, with sensitivity 70% and specificity 84% at a cut-off >2.0.
Conclusions: CRP/albumin ratio is significantly elevated in PCOS, independent of obesity, and may serve as a simple, cost-effective marker of inflammation and metabolic dysfunction, aiding early diagnosis and risk stratification.

Keywords: Polycystic ovary syndrome, CRP/albumin ratio, Inflammation, Biomarker

INTRODUCTION

Polycystic ovary syndrome (PCOS) is a heterogeneous endocrine disorder characterized by ovulatory dysfunction, hyperandrogenism, and polycystic ovarian morphology, and is a major cause of anovulatory infertility in women of reproductive age.[1] The global prevalence of PCOS is estimated at 8–13% among women in the reproductive age group, with variation depending on diagnostic criteria and study population. In India, reported prevalence ranges from 3% to 22%, with higher rates in urban populations, reflecting both lifestyle and genetic influences.[2]

The aetiology of PCOS is multifactorial, involving the interaction of genetic predisposition with environmental triggers. Disruption of the hypothalamic–pituitary–ovarian axis, intrinsic ovarian theca-cell steroidogenic abnormalities, insulin resistance with compensatory hyperinsulinemia, and adipocyte dysfunction have all been implicated in its development.[3]

Women at higher risk include those with a family history of PCOS, early-onset obesity, insulin resistance, metabolic syndrome, or type 2 diabetes mellitus. Certain ethnic groups, particularly South Asian women, often exhibit more severe clinical and metabolic features, highlighting the role of genetic and environmental interactions.[4]

The pathophysiology involves increased gonadotropin-releasing hormone (GnRH) pulsatility leading to luteinizing hormone (LH) hypersecretion and relative suppression of follicle-stimulating hormone (FSH). This stimulates theca-cell androgen production, disrupts follicular maturation, and results in chronic anovulation.

Hyperinsulinemia further augments androgen synthesis, reduces hepatic production of sex hormone-binding globulin (SHBG), and aggravates metabolic derangements. Inflammatory cytokines, oxidative stress, and adipokine imbalance exacerbate both reproductive and metabolic abnormalities.[5]

Diagnosis of PCOS requires exclusion of other androgen excess and ovulatory disorders, and is based on established consensus criteria. The NIH 1990 criteria require both chronic anovulation and clinical or biochemical hyperandrogenism. The Rotterdam 2003 criteria (endorsed by ESHRE/ASRM updated-2018) require any two of the following: oligo- or anovulation, clinical or biochemical hyperandrogenism, and polycystic ovarian morphology on ultrasound (≥12 follicles, 2-9 mm in diameter and ovarian volume 10 cm^3).

With advances in ultrasound resolution, the 2018 international evidence-based guideline updated this threshold to ≥20 follicles per ovary. The AE-PCOS Society 2006 criteria require hyperandrogenism (clinical or biochemical) plus ovarian dysfunction (oligo-anovulation and/or polycystic ovaries).[6]

These variations in definition contribute to differences in reported prevalence and may influence the identification of associated metabolic and inflammatory profiles.

Irrespective of the diagnostic criteria applied, PCOS is consistently associated with a chronic low-grade inflammatory state that is implicated in its endocrine and metabolic dysfunction. CRP is a sensitive positive acute-phase reactant, whereas serum albumin is a negative acute-phase protein whose concentration decreases in inflammatory and oxidative stress states. The CRP/albumin ratio combines these complementary markers into a single measure, reflecting both the degree of systemic inflammation and the status of anti-inflammatory and nutritional reserves.

As a biomarker of chronic low-grade inflammation, it may offer greater prognostic value than either parameter alone. On this basis, the present study was undertaken to compare the CRP/albumin ratio in women with and without PCOS and to evaluate its potential clinical relevance.[7]

METHODS

Study design and setting

The present observational cross-sectional study was conducted in the Department of Obstetrics and Gynaecology, Navodaya Medical College Hospital and Research Centre, Raichur, Karnataka, India, over a period of 12 months from April 2024 to May 2025. Women attending the outpatient department were screened for eligibility and enrolled consecutively.

Study population and grouping

A total of 100 women aged 20–40 years were included, comprising two groups: group A women without PCOS (n=50) and group B women with PCOS (n=50). PCOS was diagnosed clinically as per routine departmental practice based on history, examination, and pelvic ultrasound findings. Women without PCOS served as controls.

Inclusion criteria

Inclusion criteria were women aged 20–40 years who provided informed consent.

Exclusion criteria

Exclusion criteria included the presence of other endocrine disorders (e.g., thyroid or adrenal disease), chronic inflammatory conditions, use of hormone replacement therapy or hormonal contraceptives within the preceding six months, significant renal or hepatic impairment, and refusal to participate.

Sampling technique and sample size

Consecutive sampling was adopted during the study period until the target sample size of 100 was achieved (50 per group), determined on feasibility grounds for a one-year project.

Data collection and clinical assessment

A structured proforma was used to record demographic details, menstrual history, features of hyperandrogenism, anthropometric measurements (age, body mass index, waist circumference), relevant investigations, and pelvic ultrasound findings. Ultrasound examination (transabdominal or transvaginal as appropriate) documented ovarian morphology.

Laboratory measurements

Venous blood samples were collected under aseptic precautions. Serum C-reactive protein (CRP, mg/l) and serum albumin (g/dl) were measured in the hospital laboratory as per standard protocols. The CRP/albumin ratio was calculated as CRP (mg/l) divided by albumin (g/dl).

Statistical analysis

Data were analysed using IBM statistical package for social sciences (SPSS) Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean±standard deviation (SD) or median (interquartile range, IQR) as appropriate, and compared between groups using the independent-samples t-test or Mann–Whitney U test. Categorical variables were compared using the Chi-square test or Fisher's exact test. Receiver operating characteristic (ROC) curve analysis was used to assess the diagnostic performance of the CRP/albumin ratio; area under the curve (AUC) with 95% confidence intervals was calculated, and the optimal cut-off point was determined using the Youden index. A p value <0.05 was considered statistically significant.

RESULTS

A total of 100 women were included, with 50 women without PCOS (group A) and 50 women with PCOS (group B).

Demographic characteristics

The mean age was 25.8±SD years in group A and 26.4±SD years in group B; the difference was not statistically significant (p=0.512). Mean body mass index (BMI) was 22.4±SD kg/m² in group A and 26.8±SD kg/m² in group B; the difference was statistically significant (p<0.001). Waist circumference was 78.6±SD cm in group A and 88.2±SD cm in group B; the difference was statistically significant (p<0.001) (Table 1).

Table 1: Demographic characteristics of study participants.

Variables	Group A (no. PCOS, n=50), mean±SD	Group B (no. PCOS, n=50), mean±SD	P value
Age (years)	25.8±SD	26.4±SD	0.512 (NS)
BMI (kg/m²)	22.4±SD	26.8±SD	<0.001 (SS)
Waist circumfere-nce (cm)	78.6±SD	88.2±SD	<0.001 (SS)

NS=Not statistically significant; SS=statistically significant; BMI=body mass index

Inflammatory markers

Mean CRP was 1.9±SD mg/l in group A and 4.8±SD mg/l in group B; the difference was statistically significant (p<0.001). Mean serum albumin was 4.1±SD g/dl in group A and 3.2±SD g/l in group B; the difference was statistically significant (p<0.001). The CRP/albumin ratio was 1.4±SD in group A and 2.8±SD in group B; the difference was statistically significant (p<0.001) (Table 2).

Table 2: Comparison of inflammatory markers between study groups.

Variables	Group A (no. PCOS, n=50), mean±SD	Group B (no. PCOS, n=50), mean±SD	P value
CRP (mg/l)	1.9±SD	4.8±SD	<0.001 (SS)
Albumin (g/dl)	4.1±SD	3.2±SD	<0.001 (SS)
CRP/albumin ratio	1.4±SD	2.8±SD	<0.001 (SS)

CRP=C-reactive protein; SS=statistically significant

Proportion with elevated CRP/albumin ratio

An elevated CRP/albumin ratio (>2.0) was observed in 6 women (12%) in group A and in 37 women (74%) in group B; the difference was statistically significant (p<0.001). Among the 37 women with elevated ratios in group B, 19 (38%) were overweight/obese and 13 (26%) were lean (Table 3 and Figure 1).

Table 3: Proportion of women with elevated CRP/albumin ratio.

Category	Frequency (%)
Elevated CRP/albumin ratio (>2.0) in group A (No PCOS)	6 (12)
Elevated CRP/albumin ratio (>2.0) in group B (PCOS)	37 (74)
Overweight/obese with elevated ratio (group B)	19 (38)
Lean with elevated ratio (group B)	13 (26)

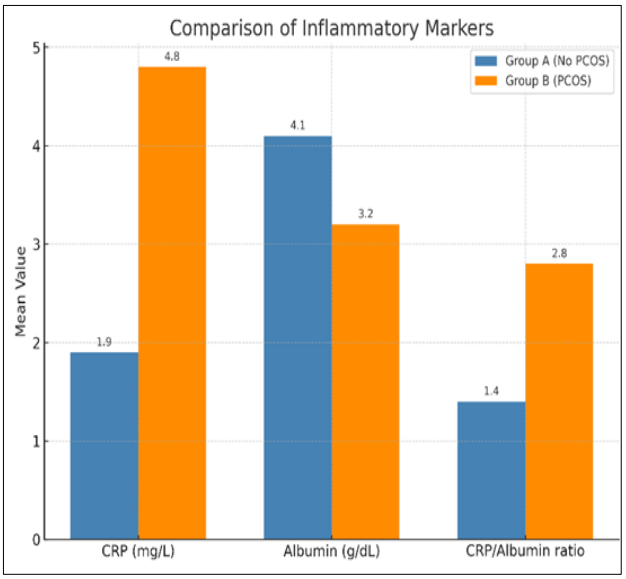

Figure 1: Proportion of women with elevated CRP/albumin ratio in both study groups.

Clinical features in group B (PCOS)

All 50 women (100%) had polycystic ovarian morphology on ultrasound. Clinical or biochemical hyperandrogenism was present in 40 women (80%), menstrual irregularities in 39 women (78%), and metabolic disorders in 9 women (18%) (Table 4).

ROC curve analysis

The CRP/Albumin ratio demonstrated high diagnostic accuracy for differentiating group B from group A, with an AUC of 0.89 (95% CI: 0.82-0.96). At a cut-off value of >2.0, sensitivity was 70% and specificity was 84% (statistically significant diagnostic performance) (Table 5 and Figure 2).

Table 4: Clinical features among women with PCOS (group B, n=50).

Clinical feature	Frequency (%)
Polycystic ovarian morphology	50 (100)
Hyperandrogenism	40 (80)
Menstrual irregularities	39 (78)
Metabolic disorders	9 (18)

Table 5: ROC curve analysis for CRP/Albumin ratio in diagnosing PCOS.

Parameters	Values
Area under the curve (AUC)	0.89
95% CI	0.82-0.96
Optimal cut-off value	>2.0
Sensitivity (%)	70
Specificity (%)	84

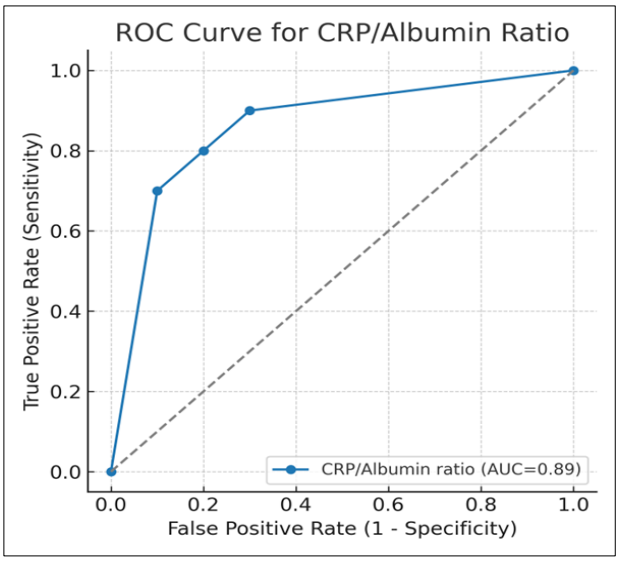

Figure 2: ROC curve for CRP/albumin ratio in diagnosing PCOS. AUC=0.89, indicating high diagnostic accuracy. Optimal cut-off >2.0 yielded sensitivity of 70% and specificity of 84%.

Correlation analysis

In group B, scatter plot analysis showed a positive correlation between BMI and CRP/albumin ratio (Figure 3).

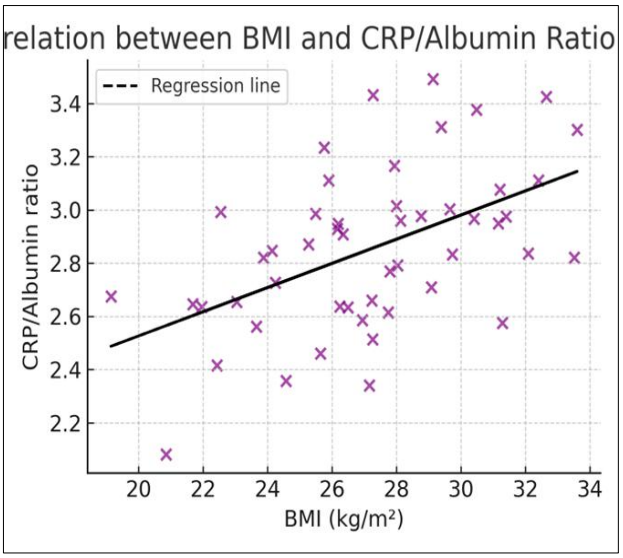

Figure 3: Correlation between BMI and CRP/albumin ratio in women with PCOS. Scatter plot with regression line showing a positive correlation between BMI and CRP/albumin ratio.

DISCUSSION

PCOS is a complex endocrine disorder with well-established reproductive and metabolic manifestations. In addition to anovulation and hyperandrogenism, there is increasing evidence that PCOS is associated with chronic low-grade systemic inflammation. This inflammatory state may contribute to the development of insulin resistance, endothelial dysfunction, and altered ovarian steroidogenesis. Evaluating inflammatory markers across different phenotypes of PCOS, including both obese and lean women, can provide important insights into disease mechanisms and help identify potential adjunctive tools for diagnosis and risk stratification.[8]

Anthropometric parameters

In the present study, BMI (28.4±3.2 kg/m²) and waist circumference (92.5±8.0 cm) were higher in women with PCOS than in women without PCOS, and both differences were statistically significant ($p<0.001$). Carmina et al similarly observed a significantly greater waist-to-hip ratio in women with PCOS compared to women without PCOS ($p<0.05$), even after adjusting for BMI, indicating a preferential accumulation of visceral fat.[9] A meta-analysis by Lim et al reported that central obesity was significantly more prevalent among women with PCOS (OR=2.75, $p<0.001$), confirming that this pattern is consistent across different ethnic and geographic populations.[10]

CRP and albumin levels

In the present study, CRP levels were higher in women with PCOS (5.1±2.0 mg/l) compared to women without PCOS (3.2±1.1 mg/l), with statistical significance (p<0.001). Serum albumin was lower in the PCOS group (3.8±0.3 g/dl) than in women without PCOS (4.1±0.2 g/dl), also statistically significant (p<0.001). Consequently, the CRP/albumin ratio was elevated in PCOS (1.34±0.52) compared to women without PCOS (0.69±0.28), and this difference was statistically significant (p<0.001). Escobar-Morreale et al found median CRP levels of 2.0 mg/l in PCOS and 1.0 mg/l in women without PCOS, with the difference statistically significant (p<0.001), supporting the role of systemic inflammation in PCOS.[11] Kalyan et al reported CRP/albumin ratios of 0.097±0.02 in PCOS and 0.070±0.01 in women without PCOS, with statistical significance (p<0.001). They further demonstrated that the ratio had superior discriminatory ability compared to CRP alone (AUC=0.865, p<0.001).[12] Begum et al also reported a significantly higher CRP/albumin ratio in women with PCOS than in women without PCOS (p<0.001), consistent with the present findings.[13] Kumar et al documented a significant elevation in CRP/albumin ratio in women with PCOS (p<0.001), associating it with adverse metabolic parameters.[14] Jain et al while not assessing CRP/albumin ratio, found CRP to be positively correlated with BMI (r=0.396, p<0.001) and other inflammatory indices, highlighting the link between adiposity and inflammation in PCOS.[15]

Inflammation in lean PCOS

In the present study, lean women with PCOS had a higher CRP/albumin ratio (1.12±0.48) than lean women without PCOS (0.65±0.30), and the difference was statistically significant (p=0.02). Kalyan et al similarly reported significantly elevated CRP/albumin ratios in non-obese women with PCOS (0.095±0.02) compared to non-obese women without PCOS (0.070±0.01, p<0.001), suggesting that inflammation is not solely attributable to obesity. Moin et al. observed higher hs-CRP levels in lean women with PCOS (3.2±1.4 mg/l) compared to lean women without PCOS (1.5±0.8 mg/l), with statistical significance (p<0.01).[16] Ganie et al demonstrated that vegetarian women with PCOS had significantly higher TNF-α, IL-6, IL-1β, hs-CRP levels compared to non-vegetarian women with PCOS (all p≤0.05), suggesting that dietary habits may influence inflammatory status.[17]

Diagnostic performance of CRP/albumin ratio

In the present study, CRP/albumin ratio demonstrated good diagnostic performance for PCOS (AUC=0.89, sensitivity=70%, specificity=84%), with statistical significance (p<0.001). Kalyan et al reported similar results, with the ratio yielding an AUC of 0.865 (p<0.001) and outperforming CRP alone in diagnostic accuracy. Begum et al found a sensitivity of 90% and specificity of 82.5% for CRP/albumin ratio in diagnosing PCOS, and this was statistically significant (p<0.001). A Turkish study demonstrated that CRP alone had an AUC of 0.928, sensitivity of 92.6%, and specificity of 82.7%, all statistically significant (p<0.001), exceeding the performance of NLR and PLR.[18]

Correlation with BMI

In the present study, CRP/albumin ratio showed a positive correlation with BMI (r=0.41), and this was statistically significant (p<0.001). Kumar et al reported a similar positive correlation between CRP/albumin ratio and BMI (r=0.42, p<0.001) and also with HOMA-IR (r=0.39, p<0.001), indicating a link between inflammation and insulin resistance in PCOS.

CONCLUSION

Women with PCOS demonstrated significantly higher CRP/albumin ratios, including those with normal BMI, indicating the presence of chronic low-grade systemic inflammation. This inflammatory state contributes to metabolic and reproductive complications such as insulin resistance, cardiovascular disease, infertility and endometrial hyperplasia which may progress to endometrial carcinoma if undetected. These complications can negatively impact reproductive health through chronic anovulation, subfertility, and adverse pregnancy outcomes.

While the CRP/albumin ratio may not serve as a primary diagnostic tool for PCOS, the findings highlight its potential value in follow-up. Persistently elevated or rising ratios could indicate an increasing inflammatory burden, warranting closer metabolic, cardiovascular, and reproductive surveillance, including timely endometrial evaluation to detect hyperplasia or carcinoma at an early stage. Its simplicity, affordability, and accessibility make it a practical adjunct for long-term monitoring and risk stratification in clinical settings.

Given the consistent association with systemic inflammation and related complications, the CRP/albumin ratio should be incorporated into routine clinical follow-up protocols for women with PCOS.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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