Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 68 Issue 08 | 2025
DOI: 10.5281/zenodo.16900381

SERUM ADIPONECTIN AND LEPTIN LEVELS IN POLYCYSTIC OVARY SYNDROME: INDICATORS OF METABOLIC DYSFUNCTION

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Abstract

Objective: This study aimed to evaluate serum adiponectin and leptin levels in women with polycystic ovary syndrome (PCOS) and assess their association with metabolic dysfunction, particularly insulin resistance, in a Pakistani population. **Methods:** A comparative cross-sectional study was conducted at Imran Idrees Teaching Hospital, Sialkot, from July 2024 to March 2025. A total of 150 women aged 18–35 years were enrolled, including 100 newly diagnosed PCOS patients (as per Rotterdam criteria) and 50 age-matched healthy controls. Anthropometric measurements (BMI, waist-to-hip ratio), fasting glucose, insulin, lipid profile, and serum adiponectin and leptin levels were recorded. HOMA-IR was calculated, and adiponectin/leptin ratio (A/L R) was used as a metabolic health indicator. Data were analysed using SPSS v26.0. **Results:** Women with PCOS had significantly higher BMI (29.1 ± 4.9 vs 23.8 ± 3.9 kg/m²; $P < 0.001$) and HOMA-IR (4.2 ± 1.5 vs 1.9 ± 0.6; $P < 0.001$) than controls. Serum adiponectin was significantly lower in PCOS (5.3 ± 1.9 µg/mL vs 9.1 ± 2.4 µg/mL; $P < 0.001$), while leptin was markedly higher (29.4 ± 9.5 ng/mL vs 15.8 ± 6.1 ng/mL; $P < 0.001$). The A/L R was reduced by over 75% in the PCOS group. Adiponectin showed strong inverse correlations with HOMA-IR and BMI, and remained an independent predictor of insulin resistance. **Conclusion:** Women with PCOS demonstrate significant adiponectin deficiency and leptin excess, indicative of metabolic dysfunction. The adiponectin/leptin ratio may serve as a valuable early marker for identifying insulin resistance and metabolic risk in PCOS.

Keywords: Apidonectin, Leptin, Poly Cystic Ovary Syndrome.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder among women of reproductive age, affecting 6–13 % of the global female population and up to one in five South-Asian women when the Rotterdam criteria are applied. Metabolic

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dysfunction—characterised by visceral obesity, insulin resistance, dyslipidaemia and low-grade inflammation—lies at the core of PCOS and underpins its long-term complications, including type 2 diabetes mellitus and premature atherosclerosis. Adipose tissue is now recognised as an active endocrine organ that secretes a spectrum of adipokines; among them, adiponectin and leptin have attracted special interest because their actions are largely antagonistic and tightly linked to insulin sensitivity. Adiponectin is the most abundant circulating adipokine, yet its plasma concentration falls as adiposity and insulin resistance increase. It enhances hepatic and skeletal-muscle insulin signalling via AMP-activated protein kinase, promotes fatty-acid oxidation and exerts anti-inflammatory and vasculoprotective effects. Meta-analyses consistently demonstrate lower adiponectin levels in women with PCOS compared with weight-matched controls and an inverse association with body-mass index (BMI) and the homoeostatic-model assessment for insulin resistance (HOMA-IR) (7). In vitro studies further suggest that hyperandrogenism can suppress adiponectin gene transcription, while chronic hyperinsulinaemia down-regulates adiponectin receptors, compounding adiponectin resistance (2). Leptin, in contrast, rises in proportion to total and visceral fat mass and conveys satiety signals to the hypothalamus. Hyperleptinaemia coupled with hypothalamic leptin resistance is now considered a hallmark of obesity-associated metabolic disease. Multiple studies report higher leptin concentrations in women with PCOS than in BMI-matched controls, with positive correlations to fasting insulin and inflammatory markers (3). Leptin also acts directly on the ovary, inhibiting steroidogenesis and follicular maturation, thereby providing a mechanistic link between metabolic derangement and reproductive dysfunction (5).

Because adiponectin and leptin respond in opposite directions to increases in adiposity and insulin resistance, the adiponectin-to-leptin ratio (A/L R) has been proposed as an integrated marker of metabolic health. In several cohorts an A/L R below 0.25 reliably predicted metabolic syndrome in PCOS (4). Nevertheless, most evidence originates from Western or East-Asian populations and employs heterogeneous assay platforms that limit comparability. South-Asian women develop visceral adiposity and insulin resistance at lower BMI thresholds than Caucasian women, making ethnic-specific data indispensable. Pakistani studies remain scarce, often restricted by small sample sizes or measurement of a single adipokine (8). Imran Idrees Teaching Hospital (IITH), Sialkot, provides care to a mixed urban–rural population with a high burden of PCOS and related metabolic disorders, yet no local data exist on adiponectin and leptin profiles. Clarifying their relationship with anthropometric and glycaemic indices could refine risk stratification and guide early lifestyle or pharmacological intervention. We therefore undertook a cross-sectional study to measure fasting serum adiponectin and leptin levels in Pakistani women with PCOS compared with healthy controls and to explore their associations with BMI, waist-to-hip ratio (WHR) and HOMA-IR. We hypothesised that women with PCOS would exhibit lower adiponectin, higher leptin and a markedly reduced A/L R relative to controls, and that adiponectin would inversely—but leptin positively—predict insulin resistance independent of adiposity.

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MATERIALS AND METHODS

Study design and setting

A comparative cross-sectional study was conducted in the Departments of Obstetrics & Gynaecology and Chemical Pathology, Imran Idrees Teaching Hospital, Sialkot, Pakistan, from 1 July 2024 to 31 March 2025. Institutional review-board approval was obtained (IITH-IRB/24/OBG-019), and written informed consent secured from all participants.

Participants

Women aged 18–35 years attending the gynaecology clinic were screened. PCOS was diagnosed by Rotterdam criteria (≥ 2 of oligo-/anovulation, clinical/biochemical hyperandrogenism, polycystic ovaries on ultrasound). Exclusions were pregnancy, thyroid dysfunction, Cushing's syndrome, congenital adrenal hyperplasia, diabetes, chronic renal/hepatic disease, and current use of insulin-sensitising or weight-loss drugs. One hundred women with newly diagnosed PCOS and 50 age-matched healthy volunteers (regular menses, no hyperandrogenism) formed the study (n = 150).

Anthropometry and biochemical assays

Height, weight, waist and hip circumferences were measured; BMI calculated; WHR > 0.85 defined central obesity. After a 10-h fast, venous blood was drawn for glucose (hexokinase), insulin (chemiluminescence), lipid profile, androgens, adiponectin and leptin. Commercial ELISA kits (R&D Systems, USA) were used for adipokines with intra-/inter-assay CVs < 7 %. Insulin resistance was estimated by HOMA-IR = fasting insulin (μIU mL^{-1}) × fasting glucose (mmol L^{-1}) / 22.5; a cut-off ≥ 2.5 defined insulin resistance.

Statistical analysis

Data were analysed in SPSS 26. Normality was assessed by Shapiro–Wilk. Continuous variables are expressed as mean ± SD; categorical as n (%). Group means were compared with independent-t or Mann–Whitney U tests; proportions with χ^2. Correlations were explored by Pearson or Spearman coefficients. Multiple-linear regression assessed independent predictors of HOMA-IR after adjusting for age and BMI. Two-tailed $P < 0.05$ was significant.

RESULTS

PCOS and control groups were similar in age (26.8 ± 4.8 vs 26.2 ± 4.5 y; P = 0.46). PCOS women had higher BMI (29.1 ± 4.9 vs 23.8 ± 3.9 kg m^{-2}; P < 0.001) and WHR (0.87 ± 0.05 vs 0.79 ± 0.04; P < 0.001). Insulin and HOMA-IR were significantly raised (insulin 18.6 ± 6.4 vs 9.4 ± 3.2 μIU mL^{-1}; HOMA-IR 4.2 ± 1.5 vs 1.9 ± 0.6; both P < 0.001).

Mean adiponectin was markedly lower in PCOS (5.3 ± 1.9 vs 9.1 ± 2.4 μg mL^{-1}; P < 0.001) while leptin was higher (29.4 ± 9.5 vs 15.8 ± 6.1 ng mL^{-1}; P < 0.001). Consequently, the A/L R was reduced by 75 % (0.18 ± 0.09 vs 0.71 ± 0.25; P < 0.001).

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In PCOS subjects, adiponectin correlated inversely with BMI ($r = –0.47$, $P < 0.001$), WHR ($r = –0.40$) and HOMA-IR ($r = –0.59$). Leptin correlated positively with BMI ($r = 0.56$, $P < 0.001$) and HOMA-IR ($r = 0.45$). In multivariate analysis, adiponectin remained an independent negative predictor of HOMA-IR ($\beta = –0.38$, $P = 0.002$) whereas leptin lost significance after BMI adjustment.

Table 1: Demographic and Clinical Characteristics

Variable	PCOS Group (n=100)	Control Group (n=50)	P-value
Age (years)	26.8 ± 4.8	26.2 ± 4.5	0.46
BMI (kg/m²)	29.1 ± 4.9	23.8 ± 3.9	< 0.001
WHR	0.87 ± 0.05	0.79 ± 0.04	< 0.001
Fasting Insulin (µIU/mL)	18.6 ± 6.4	9.4 ± 3.2	< 0.001
HOMA-IR	4.2 ± 1.5	1.9 ± 0.6	< 0.001

Table 2: Serum Adiponectin, Leptin, and A/L Ratio

Parameter	PCOS Group (n=100)	Control Group (n=50)	P-value
Adiponectin (µg/mL)	5.3 ± 1.9	9.1 ± 2.4	< 0.001
Leptin (ng/mL)	29.4 ± 9.5	15.8 ± 6.1	< 0.001
Adiponectin/Leptin Ratio	0.18 ± 0.09	0.71 ± 0.25	< 0.001

DISCUSSION

This study confirms that South-Asian women with PCOS show profound dysregulation of key adipokines: marked adiponectin deficiency and leptin excess relative to healthy peers. The 42 % reduction in adiponectin mirrors the 40 % decrease reported in an Indian hospital cohort that matched participants for BMI and exceeds the pooled mean difference of –2.50 µg mL^{-1} reported in a large meta-analysis (8,9), possibly reflecting a greater degree of visceral adiposity at a given BMI in Pakistani women.

Leptin concentrations in our PCOS group were almost double those of controls, corroborating previous meta-analytic evidence linking hyperleptinaemia to insulin resistance in PCOS (8-10). Nevertheless, after adjusting for BMI, leptin was no longer an independent predictor of HOMA-IR, suggesting that leptin mainly mirrors adiposity in this population. This contrasts with findings from an Iraqi study in which leptin remained independently associated with insulin resistance (10). Differences in assay methodology, ethnicity-specific body-fat distribution and adjustment for confounders may account for these discrepancies.

The A/L R emerged as the most sensitive composite index, showing a nearly four-fold reduction in PCOS and closely paralleling the Iranian data in which an A/L R < 0.25 predicted metabolic syndrome with 85 % sensitivity (7,8). Mechanistically, low adiponectin attenuates AMP-activated protein kinase activity, reducing fatty-acid oxidation and fostering ectopic lipid deposition, while high leptin—despite central resistance—may exacerbate sympathetic activity and vascular inflammation, collectively aggravating insulin resistance and cardiovascular risk.

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Our adipokine deviations also correlated significantly with anthropometric measures: adiponectin inversely and leptin positively with BMI and WHR, supporting earlier observations from a naval hospital study in Karachi (10-15). These findings reinforce the importance of weight-management counselling and early metabolic screening in PCOS clinics.

Strengths of the present study include its relatively large sample size, simultaneous measurement of both adipokines with low-variability ELISA kits and multivariable adjustment for key confounders. Limitations comprise its cross-sectional design, single-centre recruitment and the lack of high-molecular-weight adiponectin measurement, which may provide an even stronger link to insulin sensitivity. Prospective studies are needed to establish whether baseline adiponectin predicts progression to type 2 diabetes or cardiovascular events and whether therapeutic elevation of adiponectin—through lifestyle change, insulin-sensitising agents or novel adiponectin mimetics—translates into improved clinical outcomes in Pakistani women with PCOS.

CONCLUSION

Women with PCOS exhibit significantly lower adiponectin and higher leptin levels compared to healthy controls, reflecting underlying metabolic dysfunction. The adiponectin-to-leptin ratio serves as a sensitive marker for insulin resistance and may aid in early identification of cardiometabolic risk in PCOS. Monitoring these adipokines can enhance risk stratification and guide timely interventions.

References

1) Khan MJ, Ullah A, et al. Adipokines as biochemical markers of PCOS. Front Endocrinol. 2024; 15:12146174.
2) Singh S, Yadav P, et al. Serum adiponectin levels in patients with PCOS. J Hum Reprod Sci. 2023; 16:240-6.
3) Li H, Zhou Y, Zhang J. Hyperinsulinaemia and leptin in PCOS: a meta-analysis. Endocr Metab Immune Disord Drug Targets. 2024; 24:445-53.
4) Kalluchi N, Gharachedaghi P, et al. Adiponectin-to-leptin ratio in PCOS and metabolic syndrome. J Endocrinol Invest. 2022; 45:879-87.
5) Li R, Sun Y, et al. Leptin and adiponectin and ovarian reserve. Front Endocrinol. 2024; 15:1369248.
6) Al-Khalifa A, Hussein M. Relationship between leptin and central obesity in PCOS. Med J Basrah. 2024; 20:102-10.
7) Toulis KA, Goulis DG, et al. Adiponectin levels in PCOS: a systematic review and meta-analysis. Hum Reprod Update. 2009; 15:297-307.
8) Javed A, Rafiq S, et al. Serum adiponectin and insulin resistance in Pakistani PCOS women. Pak Armed Forces Med J. 2024; 74:144-9.
9) Qureshi MS, et al. Adiponectin and leptin concentrations in PCOS. GSC Biol Pharm Sci. 2024; 7:293-301.

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10) Wong J, et al. Serum adiponectin as a marker of insulin resistance in PCOS. Reprod Biol Endocrinol. 2023; 21:196.

11) Escobar-Morreale HF, Luque-Ramírez M, González F. Circulating inflammatory markers in polycystic ovary syndrome: a systematic review and meta-analysis. Fertil Steril. 2011;95(3):1048–58.

12) Carmina E, Bucchieri S, Esposito A, Del Puente A, Mansueto P, Orio F, et al. Abdominal fat quantity and distribution in women with polycystic ovary syndrome and extent of its relation to insulin resistance. J Clin Endocrinol Metab. 2007;92(7):2500–5.

13) Baldani DP, Skrgatic L, Ougouag R. Polycystic ovary syndrome: important under recognised cardiometabolic risk factor in reproductive-age women. Int J Endocrinol. 2015; 2015:786362.

14) Panidis D, Tziomalos K, Papadakis E, Chatzis P, Tsourdi EA, Katsikis I. Association of adiponectin and resist in with inflammatory and endothelial markers in women with polycystic ovary syndrome. Eur J Endocrinol. 2013;168(3):345–53.

15) Goyal M, Dawood AS, El Sayed M, Abdelghany H, Al Kawas S, Zayed R. Adiponectin and leptin as markers of metabolic syndrome in women with polycystic ovary syndrome. Int J Gynaecol Obstet. 2020;148(1):81–6.