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Assessment of Visfatin, GDF-15, and Galectin-3 as A Cardio-vascular Risk Stratification Markers among Women with Polycystic Ovary Syndrome

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ABSTRACT

Background & Objective: *Emerging evidence highlights chronic inflammation as a key mechanism underlying cardiovascular risk in Polycystic Ovary Syndrome. The objective of this study was to evaluate the inflammatory, metabolic, and cardiovascular-related biomarkers, including visfatin, GDF-15, and galectin-3 in female participants with PCOS and compare them to healthy ones.* ***Materials and methods:*** *A case-control study comprised of 65 women with PCOS and 65 subjects without PCOS (controls). The participants were aged between 20 and 40 years. Serum concentrations of visfatin, GDF-15, and galectin-3 were analyzed via the ELISA technique. Statistical analysis included comparison of clinical and metabolic indicators (BMI, lipid panel, and insulin resistance) between groups. Receiver operating characteristic (ROC) curve analysis was applied to identify the predictive ability of the investigated markers.* ***Results:*** *Serum amounts of visfatin, GDF-15, and galectin-3 were markedly raised in females with PCOS relative to healthy ones (643.67 ± 210.12 vs. 401.87 ± 69.09, 26.64 ± 9.92 vs. 10.43 ± 3.09, and 151.70 ± 55.26 vs. 101.42 ± 13.18, respectively; all $p < 0.001$). In addition, PCOS patients demonstrated greater BMI, IR, TC, TG, LDL, and VLDL levels, with notably lower HDL levels compared with controls. ROC curve analysis demonstrated good diagnostic and predictive performance of visfatin, GDF-15, and galectin-3 with AUC values ranging from 0.909 to 0.972.* ***Conclusion:*** *The findings suggest that visfatin, GDF-15, and galectin-3 may serve as promising inflammatory biomarkers linked with raised cardiovascular risk in patients with this syndrome.*

Keywords: Polycystic Ovary Syndrome, Growth Differentiation Factor 15, Galectin 3, Inflammation.

Article Information

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1. INTRODUCTION

An elevated prevalence of cardiovascular diseases(CVD) has been reported, such as asymptomatic atherosclerosis, endothelial impairment, increased arterial blood pressure (BP), and calcification of the coronary artery, which is 2-4 times higher in subjects suffered from PCOS. CVD is also the main cause of death among females, its implicated in nearly 35% of yearly deaths in the female population(1).

Polycystic ovary syndrome (PCOS) is a greatly widespread medical endocrine state which is frequently present during adolescence, characterized by hormonal imbalance, ovulatory dysfunction, and a wide spectrum of metabolic disturbances (2). Among the most significant metabolic alterations are reduced insulin sensitivity, diabetes, abnormal lipid profile, and a raised susceptibility to cardiovascular disorders (3). Affects between 5% and 18% of women. Up to 40-80% of females with this disorder have

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excess body weight/ obese (4). PCOS, in addition, is considered a major cause of reduced fertility due to ovulatory malfunction with diverse distribution according to the standards of diagnosis, Rotterdam criteria, which depends on the existence of two of three characteristics (Biochemical and/or clinical hyperandrogenism (HA), menstrual disturbances, and multiple cysts on the ovaries by ultrasound examination)(5).

Evidence from recent studies suggests that subclinical chronic inflammatory milieu and dysregulated adipokine signaling mainly affect the pathophysiology of these metabolic and cardiovascular complications of this syndrome (6). Obesity, together with androgen excess, can promote chronic inflammation. It has also been observed that persistent inflammatory conditions induce the release of additional androgens from the ovaries, which leads to a higher likelihood of CVDs (7).

Biomarkers that reflect metabolic and cardiovascular state have gained increasing attention for early detection of subclinical alterations (8). Among these, Visfatin, an important adipokine released from visceral fat, plays an essential role in inflammation, cellular stress response, lipid synthesis and accumulation, and influences the production of both anti/pro-inflammatory cytokines(9). Elevated Visfatin levels have been linked to obesity-related inflammation, CVDs, diabetes, and atherogenesis (10). Growth Differentiation Factor-15 (GDF-15) is a member of the transforming growth factor beta family, a cytokine produced by various cells as a response to cellular injury or oxidative stress. Raised levels of GDF-15 have been linked with cardiovascular stress, inflammatory stress, type 2 diabetes, myocardial injury, obesity and kidney diseases (11). The galectin family protein, Galectin-3(Gal-3), was linked to inflammation, cell adhesion, tissue fibrosis and metabolic disorders. It has been strongly associated with cardiovascular disorders such as myocardial fibrosis, cardiac remodeling, and atherosclerosis(12). Galectin-3 also contributes to regulating follicular development, steroidogenesis, and the ovulation process. Dysregulation in the expression of Galectin-3 can disturb these ovarian functions, causing progression of ovarian cysts (13).

To the available knowledge, no prior study has measured Visfatin, Galectin-3, and GDF-15 collectively within a single research, highlighting a gap in integrated evaluation (14). The assessment of these biomarkers may better show the complex connection between metabolic, inflammation and cellular stress impacts of this syndrome. Therefore, this research aims to study the circulating concentrations of these markers among the PCOS population.

2. PATIENT'S MATERIALS AND METHODS

2.1. Subjects

Among those who visited Al-Qurnah General Hospital from August 2025 to May 2026, a total of 65 females suffering from PCOS and 65 age-matched healthy ones, 20–40 years, were enrolled after strict application of inclusion and exclusion criteria. Controls had consistent ovulatory cycles and no clinical signs of HA, which include the presence of hirsutism, acne, overweight or alopecia. While PCOS patients were selected based on the Rotterdam diagnostic criteria, needing the existing at least one pair of these signs: infrequent/absence of ovulation, biochemical and/or clinical hyperandrogenism and ovarian multi-cysts on ultrasound.

2.2. Inclusion and exclusion criteria

The inclusion Criteria include women within the age range from 20 to 40 years, recognizing with PCOS as stated by Rotterdam standards, newly diagnosed and/or untreated patients and healthy age-matched controls. While the exclusion Criteria involve patients

with pregnancy or lactation, diabetes mellitus, hypertension, cardiovascular diseases, any endocrine disorders that may mimic PCOS and patients using hormonal medications.

2.3. Sample Collection and Processing

Five milliliters of venous blood sample were obtained from an enrolled subject after a 12-hour fast and left to coagulate at room temperature in gel tubes. The blood was then processed by centrifugation at 3600 g for 10 minutes to achieve separation of the serum, followed by storage at −20 °C until analysis.

2.4. Biochemical analysis

Fasting blood sugar, Lipid panel including (HDL, LDL, total cholesterol, triglycerides) were measured using Germany's Cobas Roche c111 system, while fasting insulin levels were determined using Germany's Cobas Roche E411 system.

Levels of GDF-15, Galectin-3, and Visfatin were quantified by commercially sourced kits Enzyme-Linked Immunosorbent Assay (ELISA) (BT Laboratory, China) in accordance with the manufacturer's guidelines. The analytical performance characteristics of the kits are summarized in **Table 1**.

Table (1): Characteristics of ELISA kits used for serum biomarker analysis.

Characteristic	Visfatin	GDF-15	Galectin-3
Catalog. NO	E0025Hu	E0037Hu	E19551Hu
Detection range	0.5-100ng/ml	10-3000ng/L	5-2000pg/ml
Sensitivity	0.23ng/ml	5.57ng/L	2.49pg/ml
Intra-assay CV	<8%	<8%	<8%
Inter-assay CV	<10%	<10%	<10%

Abbreviations: *GDF-15, Growth differentiation factor-15; CV, coefficient of variation; ELISA, enzyme-linked immunosorbent assay.*

2.5. Statistical Analysis

Data were analyzed by SPSS program version 26. The data were tabulated for easy presentation. Numerical parameters were expressed as means with standard deviations. The normality of variables was assessed using a histogram and a statistical test (Shapiro-Wilk). Comparisons between tested groups were performed by the Welch t-test and Mann-Whitney's test, based on the distribution of variables.

Receiver Operating Characteristic (ROC) was done for our studied markers for estimating the predictive ability to differentiate between healthy and patients, with estimation of AUC, suitable cutoff, sensitivity, specificity, and accuracy. P-value of <0.05 defined as sig.

3. RESULTS

Two groups were enrolled on the research (PCOS=65) and (healthy=65). There is no difference between the two groups in the age accordance to P.value more than 5 percent. Meanwhile, other measuring markers, particularly HOMA-IR, fasting insulin, fasting blood sugar, BMI, lipid panel involving LDL, TG, TC, and VLDL showed marked elevation in the affected group, whereas HDL levels were found to be lowered **(Table 2)**.

Table 2. Basic Clinical and Biochemical Measurements between PCOS and Control.

Variable	PCOS (Mean ± SD) (n=65)	Control (Mean ± SD) (n=65)	P value
Age	28.68 ± 6.19	28.89 ± 6.22	0.843*
BMI	28.27 ± 5.23	22.83 ± 1.84	<0.001*
HOMA-IR	7.81 ± 5.68	1.61 ± 0.17	<0.001**
TC	183.42 ± 23.71	155.80 ± 19.66	<0.001**
HDL	30.17 ± 7.46	47.92 ± 4.62	<0.001*
TG	189.63 ± 45.86	100.66 ± 22.40	<0.001**
LDL	83.49 ± 24.68	71.46 ± 13.22	0.0008**
VLDL	39.11 ± 9.03	20.13 ± 4.48	<0.001**
Fasting Insulin	32.60 ± 21.03	8.36 ± 1.07	<0.001**
FBS	92.55 ± 11.20	79.92 ± 7.30	<0.001*

**Welch t-test ** Mann Whitney's test*

***Abbreviations**: BMI, body mass index; HOMA-IR, homeostasis model assessment of insulin resistance; TC, Total cholesterol; HDL, high-density lipoprotein; TG, triglycerides; LDL, low-density lipoprotein; VLDL, very low-density lipoprotein; FBS, Fasting Blood Sugar.*

The results of the comparison of the novel cardiovascular biomarkers between the groups found an elevation in PCOS individuals, P.V below than 0.05 **(Table 3)**.

Table 3. Intergroup Comparative Analysis of Novel Cardiovascular Biomarkers between the Patients and Controls.

Variable	PCOS (Mean ± SD) (n=65)	Control (Mean ± SD) (n=65)	P value
Galectin-3	643.67 ± 210.12	401.87 ± 69.09	<0.001
Visfatin	26.64 ± 9.92	10.43 ± 3.09	<0.001
GDF-15	151.70 ± 55.26	101.42 ± 13.18	<0.001

***Mann Whitney's Test*

***Abbreviations:** SD, standard deviation, GDF-15, Growth Differentiation Factor-15.*

Receiver Operating Characteristic Curve Analysis for Prediction of PCOS demonstrated high diagnostic performance of the studied biomarkers in distinguishing women with PCOS from all participants. Visfatin exhibited the highest sensitivity (81.5%) and specificity (98.5%), followed by GDF-15 with a sensitivity (72.3%) and specificity (98.5%), while galectin-3 showed a sensitivity (66.2%) and specificity (96.9%). The AUC levels were 0.972, 0.924, and 0.909, respectively, demonstrating high differentiating ability and predictive for evaluating cardiovascular risk in women presenting with PCOS **(Table 4).**

Table 4. Receiver Operating Characteristic Curve Analysis for Prediction of PCOS.

Biomarker	AUC	P value	Cutoff	Sensitivity (%)	Specificity (%)	Accuracy (%)
Galectin-3	0.909	0.0001	507.0	66.2	96.9	81.5
Visfatin	0.972	0.0001	17.35	81.5	98.5	90.0
GDF-15	0.924	0.0001	124.5	72.3	98.5	85.4

***Abbreviations:** PCOS, Polycystic Ovary Syndrome; AUC, Area Under Curve; GDF-15, Growth Differentiation Factor-15.*

4. DISCUSSION

PCOS is often accompanied by an abnormal lipid panel, as well as BMI and IR. TG, TC, and LDL parameters were elevated while HDL was reduced (**Table 2)**. IR and obesity seems that one causes the other in a vicious cycle and contribute to the pathogenicity of this syndrome. Insulin normally helps regulate triglyceride metabolism by reducing VLDL production. In insulin resistance, this control is lost, causing increased hepatic delivery from free fatty acid, more lipid synthesis, and reduced VLDL clearance (15). These changes raise plasma VLDL and triglyceride levels. Cholesteryl ester transfer protein (CETP) is involved in TG and cholesterol esters exchange between lipoproteins. This makes HDL rich in triglycerides, leading to its rapid breakdown, which explains its decline, while VLDL becomes cholesterol-rich and is converted into LDL particles(16).

It has also been found that women who suffer from PCOS have elevated inflammatory markers, some of which are discussed in our study, such as visfatin, GDF-15 and galectin-3, which are demonstrated in **Table 3**. Several adipocytokines, which are part of inflammatory markers, are released from adipose tissue, such as visfatin, that are involved in the regulation of blood glucose and inflammatory pathways (17). Visfatin is a pro-inflammatory cytokine implicated with several cardiovascular illnesses such as endothelial dysfunction, progression of atherosclerotic plaques, and acute cardiac ischemic events, as well as obesity, insulin resistance and diabetes (18). Our research findings revealed that visfatin level is elevated in affected females, which agrees with other studies that indicate an elevated visfatin level in lean PCOS, indicating that its elevation may be linked to the metabolic and inflammatory disturbances of PCOS rather than obesity alone (19). A meta-analysis consisting of 1341 participants shows that elevated visfatin was found in affected women (20). Similar results were reported by a study, which demonstrated an elevation in this marker and a positive correlation with insulin resistance (21). However, another study disagreed with our results (22). The researchers assumed that its elevation in PCOS may occur in a state of insulin resistance, when cells become less sensitive to insulin, insulin secretion in the body increases, which in turn may stimulate the production of visfatin from fat cells as a compensatory mechanism to improve glucose uptake into cells, because visfatin has insulin-like effects on glucose metabolism (23). Furthermore, androgens are elevated in PCOS, which bind to their receptors on adipocytes, leading to disturbance in the secretion of visfatin. Hyperandrogenism also increases visceral fat, which is the main source of visfatin secretion. Chronic inflammatory mediators, particularly TNF-α and IL-6, can stimulate visfatin gene transcription and secretion from visceral adipose tissue and macrophages (24). Lower or unchanged visfatin levels in some PCOS studies may be explained by early disease stage with mild insulin resistance, along with low-grade inflammation and insufficient adipose tissue dysfunction (25).

GDF-15 belongs to the transforming growth factor β superfamily, released mainly by the placenta and various tissues in response to cellular stress. GDF-15 is associated with multiple metabolic disorders, including obesity and diabetes mellitus (26). Our findings show elevated levels of GDF-15 when comparing the groups of patients and controls, which is agree those reported increased concentrations among the group with IR, in contrast, among individuals without IR(27). However, there is no meaningful discrepancy in serum GDF-15 levels between control and patient groups in another study. The authors proposed that such discrepancies in GDF-15 levels may depend more on the severity of metabolic changes characterised by insulin

resistance, increased adiposity and inflammation rather than PCOS alone. Therefore, patients without marked metabolic abnormalities may exhibit normal serum GDF-15 levels (28). In addition to visfatin and GDF-15, galectin-3 represents an important marker in the same pathogenicity of PCOS as well as its prognostic value in various cardiovascular diseases. The investigated galectin-3 showed higher levels in the affected group compared with the healthy group, which is aligned with a study that also demonstrated an increase in levels in patients who suffered from metabolic syndrome group PCOS (29).

In the same context, a systematic review illustrated an elevation in this marker in the affected group compared with the healthy one. The association was more pronounced in participants with raised HOMA-IR (30). However, another study reported different results; gal-3 levels did not differ among subjects with hirsutism PCOS and the control group (31). Comparable results were demonstrated by other research, although there is a positive correlation with BMI, insulin levels and consequently IR (32). The conflicting results may be due to the variation in the phenotypes of PCOS, obesity, and the severity of IR. Although some studies have proposed that hyperandrogenism alone is insufficient to influence Galectin-3 levels, evidence indicates associations with BMI, glucose levels, obesity and insulin resistance. Collectively, these observations suggest that Galectin-3 may indicate the cardiometabolic alterations commonly observed in PCOS (33).

Following the assessment of biomarkers levels, the present study evaluates their diagnostic performance using ROC curve analysis, which revealed variable diagnostic abilities among the studied biomarkers, as shown in **Table 4**. The studied markers exhibited exceptional ability in differentiating the affected individuals, as reflected by their high AUC, sensitivity, and specificity values. Visfatin showed the highest discriminatory ability, followed by GDF-15 and Galectin-3, indicating their potential usefulness as predictive biomarkers for cardiometabolic disturbances in PCOS. The elevated diagnostic performance of these biomarkers may be attributed to their close association with obesity, IR, dyslipidemia, inflammation, redox imbalance, and endothelial impairment, which are major metabolic abnormalities that may be contribute the progression of cardiovascular risk in PCOS (34).

The main limitations of this study include its case-control design, which, due to the lack of follow-up, does not allow determination of causal relationships between biomarkers and PCOS, and its single-centre setting with participants recruited from a limited geographic area, which may limit generalizability.

5. CONCLUSION

The present findings suggest that galectin-3, visfatin, and GDF-15 are robustly linked with cardiovascular and metabolism-related disturbances in women with PCOS. Their high diagnostic performance indicates that they may have potential value as predictive biomarkers for early cardiovascular risk assessment in PCOS patients.

6. Declarations

Acknowledgment

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Ethics

Permission of the project was obtained by the Research Committee of Health Directorate, Basra governorate (No.547, dated 27/8/2025). Participant's consent was obtained before the sample was taken. All procedures conform the guidelines of the Declaration of Helsinki.

Author's Contribution

Abdulkareem M. Jewad was the main investigator and drafted the manuscript, whereas Fadia A. Abdulnabi, contributed to all aspects of the study.

Conflict to Interests

The authors have no conflicts of interests to declare.

Founding

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