

Assessment of Insulin Level, Lipid Profile, Vitamin D and Homa-IR in PCOS Women: An Observational Study

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Abstract: Background: Polycystic ovary syndrome is a common endocrine and metabolic disorder among reproductive-age women. It is associated with insulin resistance, dyslipidemia, vitamin D deficiency and increased long-term cardiometabolic risk. Aim: To assess insulin level, lipid profile, vitamin D and HOMA-IR in women with PCOS. Materials and Methods: This observational case-control study included 250 women, comprising 125 PCOS cases and 125 healthy controls. PCOS was diagnosed according to Rotterdam criteria. Clinical history, anthropometry and ultrasonographic findings were recorded. Fasting blood sugar, fasting serum insulin, lipid profile, serum vitamin D and HOMA-IR were assessed and compared between cases and controls. Results: The mean age was comparable between cases and controls. Mean BMI was significantly higher in cases than controls. Irregular menstruation, weight gain, infertility, acne and hirsutism were significantly more common among PCOS women. Mean fasting blood sugar was 113.52 $\pm$ 37.80 mg/dL in cases and 92.39 $\pm$ 24.95 mg/dL in controls. Mean fasting insulin was significantly higher in cases, 16.58 $\pm$ 5.28 uU/mL, compared to controls, 11.13 $\pm$ 4.96 uU/mL. HOMA-IR $\geq$ 2.5 was observed in 73.6% cases and 12% controls. Mean vitamin D level was significantly lower in cases, 12.15 $\pm$ 6.8 ng/mL, compared to controls, 35.6 $\pm$ 5.5 ng/mL. Total cholesterol, triglyceride and LDL cholesterol were significantly higher, while HDL cholesterol was significantly lower among cases. Conclusion: PCOS women have significantly higher insulin resistance, dyslipidemia and vitamin D deficiency compared to healthy women. Routine screening of fasting insulin, lipid profile, vitamin D and HOMA-IR is useful for early identification of metabolic risk in PCOS.

Keywords: PCOS, insulin resistance, HOMA-IR, vitamin D, lipid profile, dyslipidemia

1. Introduction

Polycystic ovary syndrome (PCOS) is one of the most common endocrine and metabolic disorders affecting women of reproductive age. It is characterized by ovulatory dysfunction, clinical or biochemical hyperandrogenism and polycystic ovarian morphology. According to Rotterdam criteria, diagnosis of PCOS is made when at least two of the following three features are present: oligo/anovulation, hyperandrogenism and polycystic ovaries on ultrasonography. PCOS has a wide clinical presentation including irregular menstruation, infertility, acne, hirsutism, obesity and metabolic abnormalities.

Apart from reproductive dysfunction, PCOS is strongly associated with insulin resistance, compensatory hyperinsulinemia, dyslipidemia, impaired glucose metabolism and increased cardiovascular risk. Insulin resistance plays a central role in the pathophysiology of PCOS by increasing ovarian androgen production and reducing sex hormone binding globulin, thereby worsening hyperandrogenism. HOMA-IR is commonly used as a simple marker for assessing insulin resistance in clinical and research settings.

Dyslipidemia is another important metabolic abnormality in PCOS. Women with PCOS commonly show increased total cholesterol, triglycerides, LDL cholesterol and reduced HDL cholesterol. These lipid disturbances may occur even in non-obese PCOS women and increase future risk of metabolic syndrome and cardiovascular disease. Vitamin D deficiency has also been increasingly linked with PCOS. Low serum vitamin D levels may contribute to insulin resistance, altered glucose homeostasis, dyslipidemia and menstrual irregularity. Therefore, assessment of vitamin D status along with insulin level, lipid profile and HOMA-IR may help in early identification of metabolic derangements in PCOS women.

2. Pathophysiology

"Polycystic ovary syndrome (PCOS) is a complex endocrine and metabolic disorder characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. Its pathophysiology involves insulin resistance and compensatory hyperinsulinemia, which stimulate ovarian theca cells to produce excess androgens while reducing hepatic sex hormone-binding globulin (SHBG) production, increasing free testosterone levels. Altered hypothalamic-pituitary-ovarian axis function, with increased luteinizing hormone (LH) secretion relative to follicle-stimulating

hormone (FSH), further enhances androgen production and impairs normal follicular maturation, leading to anovulation. Genetic predisposition, chronic low-grade inflammation, and environmental factors also contribute to the development and progression of PCOS."

3. Aim and Objectives

The aim of the present study was to assess insulin level, lipid profile, vitamin D and HOMA-IR in women with PCOS. The objectives of the study were to determine fasting insulin levels in women with PCOS and compare them with healthy controls, to assess lipid profile parameters in women with PCOS and compare them with healthy controls, to estimate serum vitamin D levels in women with PCOS and compare them with healthy controls, and to assess HOMA-IR levels in women with PCOS and compare them with healthy controls.

4. Materials and Methods

This observational case-control study was conducted among women of reproductive age group. A total of 250 subjects were included, comprising 125 women diagnosed with PCOS as cases and 125 healthy women as controls. PCOS was diagnosed according to Rotterdam criteria. Women fulfilling at least two of the following criteria were included as PCOS cases: oligo/anovulation, clinical or biochemical hyperandrogenism and polycystic ovarian morphology on ultrasonography.

Women with known diabetes mellitus, thyroid disorder, hyperprolactinemia, Cushing syndrome, congenital adrenal hyperplasia, chronic systemic illness, pregnancy or those taking hormonal therapy, vitamin D supplementation or lipid-lowering drugs were excluded from the study. Written informed consent was obtained from all participants.

Detailed history was taken regarding age, residence, religion, education, socioeconomic status, age of menarche, menstrual pattern, weight gain, infertility, acne, hirsutism and family history of PCOS. Anthropometric assessment was done, including height, weight and body mass index. Ultrasonography was performed to assess ovarian volume.

Venous blood samples were collected after overnight fasting. Fasting blood sugar, serum insulin, lipid profile including total cholesterol, triglycerides, HDL cholesterol and LDL cholesterol, serum vitamin D and hormonal parameters were measured using standard laboratory methods. HOMA-IR was calculated using fasting glucose

and fasting insulin levels. A HOMA-IR value ≥ 2.5 was considered suggestive of insulin resistance.

Data were entered and analyzed statistically. Quantitative variables were expressed as mean $\pm$ standard deviation, while categorical variables were expressed as number and percentage. Comparison between cases and controls was performed using appropriate statistical tests. A p value < 0.05 was considered statistically significant.

5. Results

A total of 250 subjects were included, with 125 PCOS cases and 125 controls. The mean age of cases was 24.56 ± 5.56 years and controls was 24.12 ± 4.51 years. Most subjects in both groups belonged to the 21-25 years age group. There was no significant difference in age distribution between groups, showing that both groups were comparable.

Most subjects belonged to urban areas in both groups. Urban residence was present in 76% cases and 71.2% controls. Religion, educational status, socioeconomic status, family history of PCOS and age of menarche were also comparable between cases and controls.

Clinical manifestations were significantly more common among PCOS cases. Irregular menstruation was present in 82.4% cases compared to 18.4% controls. Weight gain was reported in 56% cases and 32.8% controls. Infertility, acne and hirsutism were also more frequent among cases. Ovarian volume > 10 cc was present in 73.6% cases and only 3.2% controls.

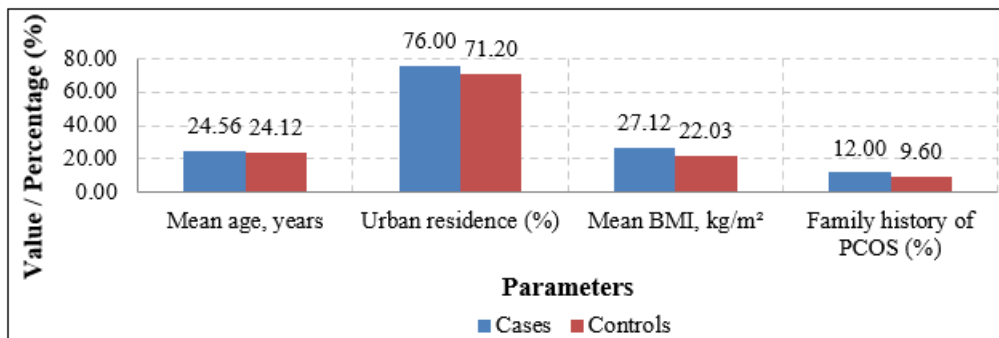
Mean BMI was significantly higher among cases, 27.12 ± 6.45 kg/m², compared to controls, 22.03 ± 2.71 kg/m². Fasting blood sugar was also significantly higher in cases, 113.52 ± 37.80 mg/dL, compared to controls, 92.39 ± 24.95 mg/dL.

Serum vitamin D levels were markedly lower in PCOS women. Vitamin D level < 8 ng/mL was seen in 76% cases and only 3.2% controls. Mean vitamin D was 12.15 ± 6.8 ng/mL in cases and 35.6 ± 5.5 ng/mL in controls.

PCOS cases had significant dyslipidemia. Mean total cholesterol, triglyceride and LDL cholesterol levels were higher in cases, whereas mean HDL cholesterol was lower. Mean fasting insulin was significantly higher in cases, 16.58 ± 5.28 uU/mL, compared to controls, 11.13 ± 4.96 uU/mL. HOMA-IR ≥ 2.5 was present in 73.6% cases and 12% controls. Mean HOMA-IR was 3.42 ± 0.86 in cases and 1.82 ± 0.54 in controls.

Table 1: Baseline characteristics of study subjects

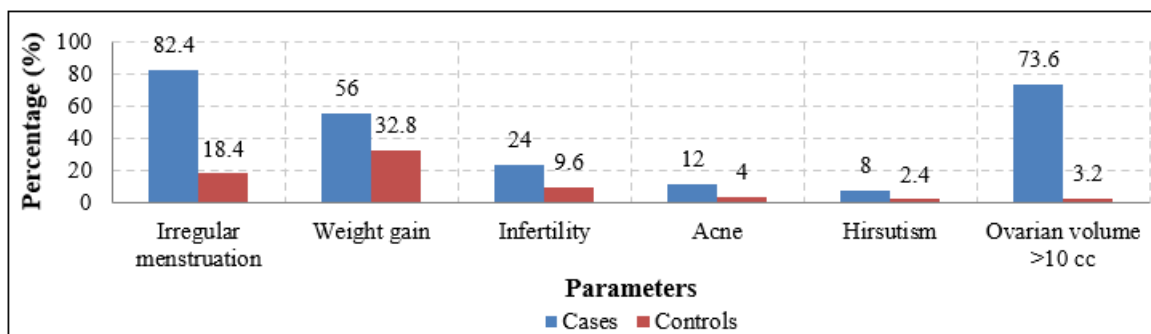
Parameters	Cases	Controls	p value
Mean age, years	24.56 ± 5.56	24.12 ± 4.51	0.869
Urban residence	95 (76.0%)	89 (71.2%)	0.602
Mean BMI, kg/m ²	27.12 ± 6.45	22.03 ± 2.71	0.0001
Family history of PCOS	15 (12.0%)	12 (9.6%)	0.684



Graph 1: Baseline characteristics of study subjects

Table 2: Clinical and ultrasonographic findings of study subjects

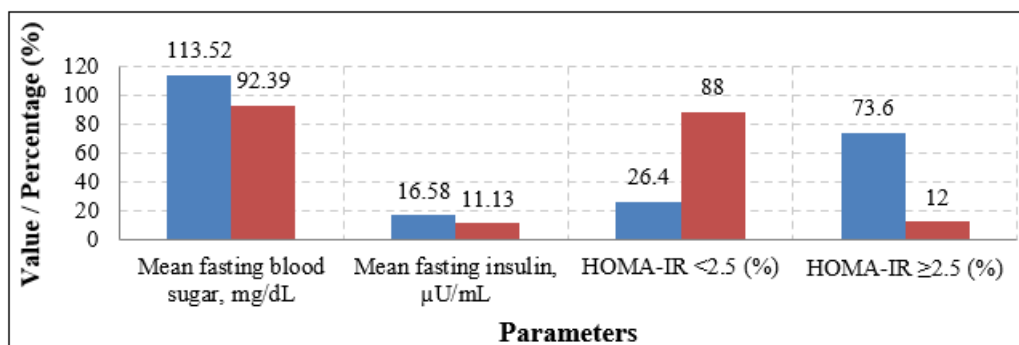
Parameters	Cases	Controls	p value
Irregular menstruation	103 (82.4%)	23 (18.4%)	0.0001
Weight gain	70 (56.0%)	41 (32.8%)	0.0001
Infertility	30 (24.0%)	12 (9.6%)	0.0001
Acne	15 (12.0%)	5 (4.0%)	0.0001
Hirsutism	10 (8.0%)	3 (2.4%)	0.0001
Ovarian volume >10 cc	92 (73.6%)	4 (3.2%)	0.0001



Graph 2: Clinical and ultrasonographic findings of study subjects

Table 3: Metabolic parameters and HOMA-IR of study subjects

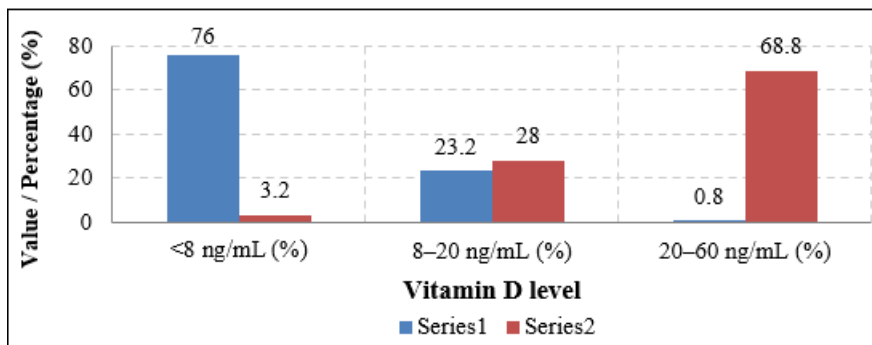
Parameter	Cases	Controls	p value
Mean fasting blood sugar, mg/dL	113.52 +/- 37.80	92.39 +/- 24.95	0.0001
Mean fasting insulin, uU/mL	16.58 +/- 5.28	11.13 +/- 4.96	0.0001
HOMA-IR <2.5	33 (26.4%)	110 (88.0%)	0.0001
HOMA-IR ≥2.5	92 (73.6%)	15 (12.0%)	0.0001



Graph 3: Metabolic parameters and HOMA-IR of study subjects

Table 4: Vitamin D status of study subjects

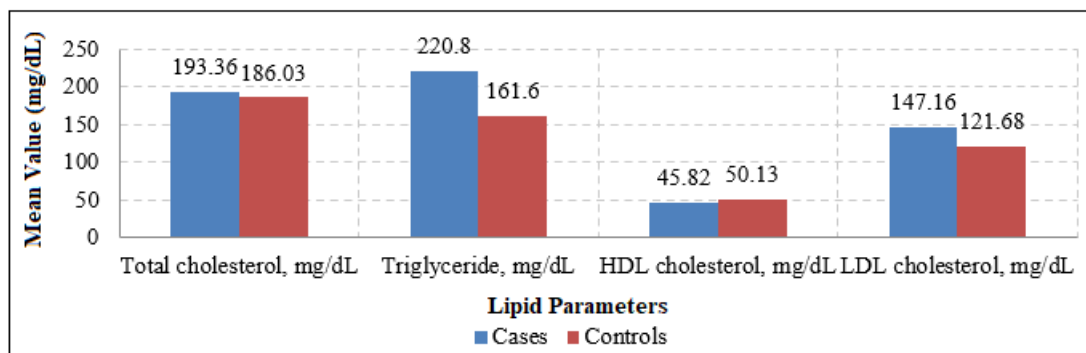
Vitamin D level	Cases	Controls	p value
<8 ng/mL	95 (76.0%)	4 (3.2%)	0.0001
8-20 ng/mL	29 (23.2%)	35 (28.0%)	0.0001
20-60 ng/mL	1 (0.8%)	86 (68.8%)	0.0001
Mean vitamin D, ng/mL	12.15 +/- 6.8	35.6 +/- 5.5	0.0001



Graph 4: Vitamin D status of study subjects

Table 5: Lipid profile comparison of study subjects

Lipid parameter	Cases	Controls	p value
Total cholesterol, mg/dL	193.36 +/- 25.29	186.03 +/- 16.79	0.028
Triglyceride, mg/dL	220.80 +/- 105.82	161.60 +/- 74.77	0.0001
HDL cholesterol, mg/dL	45.82 +/- 7.54	50.13 +/- 6.79	0.0001
LDL cholesterol, mg/dL	147.16 +/- 33.07	121.68 +/- 29.79	0.0001



Graph 5: Lipid profile comparison of study subjects

6. Discussion

In the present study, PCOS women showed significant metabolic, hormonal and biochemical differences compared to healthy controls. The mean age was comparable between cases and controls, indicating that observed metabolic differences were more likely related to PCOS status rather than age. Similar reproductive-age predominance was reported by Mukhopadhyay et al., Rahsepar et al. and other Indian studies.

The mean BMI was significantly higher among PCOS cases compared to controls. Increased BMI is an important factor in PCOS because obesity worsens insulin resistance, hyperinsulinemia and androgen excess. Mukhopadhyay et al. also reported significantly higher BMI in PCOS women compared to controls. Sethi et al. found that obese PCOS women had significantly higher insulin levels and HOMA-IR than lean PCOS women.

Clinical manifestations such as irregular menstruation, weight gain, infertility, acne and hirsutism were significantly more common among cases. This supports the classical clinical profile of PCOS, where ovulatory dysfunction and androgen excess are central features. Ovarian volume >10 cc was also significantly higher among cases, supporting the ultrasonographic component of Rotterdam criteria.

The present study found significantly higher fasting blood sugar, fasting insulin and HOMA-IR in cases. HOMA-IR

≥ 2.5 was present in 73.6% cases compared to only 12% controls. These findings indicate a strong association between PCOS and insulin resistance. Similar observations were reported by Lath et al., Patil et al., Agarwala et al. and Bharti et al., who found increased fasting insulin and HOMA-IR in PCOS women.

Vitamin D deficiency was markedly more common among PCOS women. Mean vitamin D level was much lower in cases than controls. Hahn et al., Yildizhan et al., Li et al. and Mukhopadhyay et al. also reported low vitamin D levels in PCOS women and its association with insulin resistance and metabolic risk factors.

Dyslipidemia was significantly more frequent in PCOS women. Cases had higher total cholesterol, triglyceride and LDL cholesterol, along with lower HDL cholesterol. These findings are consistent with Lath et al. and Patil et al., who reported significant lipid abnormalities in PCOS women. Thus, PCOS should be considered not only a reproductive disorder but also a metabolic disorder requiring early screening and intervention.

7. Strength of Study

- The study included a good sample size of 250 women with equal distribution of 125 PCOS cases and 125 controls, making comparison more reliable.
- The study assessed multiple important metabolic parameters, including fasting insulin, lipid profile,

vitamin D and HOMA-IR, giving a comprehensive metabolic evaluation of PCOS women.

- The study provides useful local hospital-based data regarding metabolic risk in PCOS women.

8. Limitations of Study

- This was a single-centre hospital-based study, so the findings may not represent the general population.
- The observational case-control design can show association but cannot prove causation.
- Long-term follow-up was not done, so future risk of diabetes, metabolic syndrome and cardiovascular disease could not be assessed.

9. Conclusion

The present study concludes that women with PCOS have significantly higher BMI, fasting blood sugar, fasting insulin and HOMA-IR compared to healthy controls. Insulin resistance was highly prevalent among PCOS women, with HOMA-IR ≥ 2.5 observed in 73.6% cases. This highlights the central role of insulin resistance in PCOS pathophysiology.

PCOS women also showed significant dyslipidemia, characterized by higher total cholesterol, triglycerides and LDL cholesterol, along with lower HDL cholesterol. These lipid abnormalities increase the risk of future cardiovascular complications.

Vitamin D deficiency was markedly more common among PCOS cases, suggesting its possible association with insulin resistance and metabolic dysfunction. Routine assessment of vitamin D, fasting insulin, lipid profile and HOMA-IR may help in early detection of metabolic risk in PCOS women.

Therefore, PCOS should be managed with a comprehensive approach focusing not only on reproductive symptoms but also on metabolic screening, lifestyle modification and prevention of long-term complications such as type 2 diabetes mellitus, metabolic syndrome and cardiovascular disease.

References

- [1] Stein IF, Leventhal ML. Amenorrhea associated with bilateral polycystic ovaries. *Am J Obstet Gynecol*. 1935;29:181-191.
- [2] Azziz R, Woods KS, Reyna R, Key TJ, Knochenhauer ES, Yildiz BO. The prevalence and features of polycystic ovary syndrome. *J Clin Endocrinol Metab*. 2004;89(6):2745-2749.
- [3] Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group. Revised consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. *Fertil Steril*. 2004;81(1):19-25.
- [4] March WA, Moore VM, Willson KJ, Phillips DIW, Norman RJ, Davies MJ. The prevalence of polycystic ovary syndrome in a community sample. *Hum Reprod*. 2010;25(2):544-551.
- [5] Dunaif A. Insulin resistance and polycystic ovary syndrome. *Endocr Rev*. 1997;18(6):774-800.
- [6] Wild RA. Dyslipidemia in PCOS. *Steroids*. 2012;77(4):295-299.
- [7] Diamanti-Kandarakis E, Dunaif A. Insulin resistance and polycystic ovary syndrome revisited. *Endocr Rev*. 2012;33(6):981-1030.
- [8] Franks S. Polycystic ovary syndrome. *N Engl J Med*. 1995;333(13):853-861.
- [9] Goodarzi MO, Dumesic DA, Chazenbalk G, Azziz R. Polycystic ovary syndrome: etiology, pathogenesis and diagnosis. *Nat Rev Endocrinol*. 2011;7(4):219-231.
- [10] Lath R, Shendye R, Jibhakte S. Insulin resistance and lipid profile in polycystic ovary syndrome. *Asian J Biomed Pharm Sci*. 2015;5(50):30-35.
- [11] Legro RS, Kusanman AR, Dunaif A. Prevalence and predictors of dyslipidemia in women with PCOS. *Am J Med*. 2001;111(8):607-613.
- [12] DeUgarte CM, Bartolucci AA, Azziz R. Prevalence of insulin resistance in PCOS. *Fertil Steril*. 2005;83(5):1454-1460.
- [13] Hahn S, Haselhorst U, Tan S, et al. Low serum 25-hydroxyvitamin D concentrations are associated with insulin resistance and obesity in women with PCOS. *Exp Clin Endocrinol Diabetes*. 2006;114(10):577-583.
- [14] Yildizhan R, Kurdoglu M, Adali E, et al. Serum 25-hydroxyvitamin D concentrations in obese and non-obese women with PCOS. *Arch Gynecol Obstet*. 2009;280(4):559-563.
- [15] Li HWR, Brereton RE, Anderson RA, Wallace AM, Ho CKM. Vitamin D deficiency is common and associated with metabolic risk factors in patients with PCOS. *Metabolism*. 2011;60(10):1475-1481.
- [16] Pal L, Berry A, Coraluzzi L, et al. Therapeutic implications of vitamin D and calcium in overweight women with PCOS. *Gynecol Endocrinol*. 2012;28(12):965-968.
- [17] Gupta T, Rawat M, Gupta N, Arora S. Study of effect of vitamin D supplementation on the clinical, hormonal and metabolic profile of the PCOS women. *J Obstet Gynaecol India*. 2017;67(5):349-355.
- [18] Karadag C, Yoldemir T, Yavuz DG. Effects of vitamin D supplementation on insulin sensitivity and androgen levels in vitamin-D-deficient PCOS patients. *J Obstet Gynaecol Res*. 2018;44(2):270-277.
- [19] Miao CY, Fang XJ, Chen Y, Zhang Q. Effect of vitamin D supplementation on polycystic ovary syndrome: a meta-analysis. *Exp Ther Med*. 2020;19(4):2641-2649.
- [20] Rahsepar M, Mahjoub S, Esmaelzadeh S, et al. Evaluation of vitamin D3 status and its correlation with oxidative stress markers in women with PCOS. *Int J Reprod Biomed*. 2017;15(6):345-350.
- [21] Mukhopadhyay S, et al. Investigating the relationship between vitamin D3 level and polycystic ovarian syndrome: a case control study. *J Family Med Prim Care*. 2022.
- [22] Arora S, et al. Assessment of vitamin D3 and calcium levels in women with PCOS: an observational study. *Int J Reprod Contracept Obstet Gynecol*. 2022.
- [23] Sethi N, et al. A comparative study of insulin levels in lean versus obese polycystic ovarian syndrome

- patients. *Int J Reprod Contracept Obstet Gynecol*. 2023.
- [24] Patil VD, Belwalkar G, Nagane N, Dhonde S. Study of lipid profile and insulin resistance in polycystic ovarian syndrome. *Int J Clin Biochem Res*. 2022;9(3):272-275.
- [25] Dere KAL, Djoupo AP, Menin MM, Coulibaly D, Tiahou GG. Insulin resistance and dysglycaemia in polycystic ovary syndrome patients. *Int J Clin Biochem Res*. 2020;7(4):478-483.
- [26] Agarwala BK, et al. Assessment of insulin resistance in polycystic ovary syndrome patients. 2024.
- [27] Bharti SS, et al. Evaluation of fasting insulin and HOMA-IR in PCOS patients: a cross sectional biochemistry study. *Int J Pharm Clin Res*. 2025;17(7):1720-1725.