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Original Article

Comparison of Efficacy of Metformin in Obese and Non-Obese Women with Polycystic Ovary Syndrome (PCOS)

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ABSTRACT

Background: Polycystic ovary syndrome is a common endocrine disorder of reproductive-age women and is frequently associated with obesity, insulin resistance, and ovulatory dysfunction. Obesity may modify therapeutic response to metformin, but existing evidence remains inconsistent. Objective: To determine the frequency of obesity among women with polycystic ovary syndrome and to compare the efficacy of metformin between obese and non-obese women. Methods: This hospital-based analytical observational study was conducted in the Department of Obstetrics and Gynecology, Bolan Medical Complex Hospital, Quetta, from 15 October 2024 to 16 April 2025. A total of 300 women aged 18 to 40 years with polycystic ovary syndrome received metformin 1500 mg daily in three divided doses for three months. Obesity was defined as body mass index at least 30 kg/m². Efficacy was assessed as ovulatory response after treatment completion. Comparative analysis was performed using the chi-square test with stratification by age and disease duration. Results: The mean age was 27.4±5.4 years and the mean disease duration was 12.2±3.9 months. Obesity was present in 170 women (56.7%). Overall metformin efficacy was observed in 140 women (46.7%). Efficacy was significantly lower in obese women than in non-obese women (35.3% vs 61.5%; p=0.001). This difference remained significant across age and disease-duration subgroups. Conclusion: Obesity was common in women with polycystic ovary syndrome and was associated with markedly reduced short-term metformin efficacy. Routine BMI assessment and early weight-focused management may improve treatment planning and counseling in this population. Keywords: Polycystic ovary syndrome; obesity; metformin; ovulation; body mass index; insulin resistance.

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INTRODUCTION

Polycystic ovary syndrome is one of the most common endocrine disorders affecting women of reproductive age and is characterized by a heterogeneous combination of ovulatory dysfunction, hyperandrogenism, and polycystic ovarian morphology, often accompanied by substantial metabolic disturbance. Beyond its reproductive implications, the syndrome is increasingly recognized as a multisystem disorder linked with insulin resistance, dyslipidemia, adverse cardiometabolic risk, and impaired quality of life, making it a major concern in gynecological and endocrine practice (1,2). The clinical burden of PCOS is particularly important in populations where obesity is common, because excess adiposity can intensify insulin resistance, aggravate androgen excess, and worsen menstrual, ovulatory, and fertility-related outcomes (3,4).

Insulin resistance has a central role in the pathophysiology of PCOS and is observed in both lean and overweight women, although its severity is generally greater among those with obesity. Hyperinsulinemia amplifies ovarian androgen production and disrupts folliculogenesis, thereby contributing to chronic anovulation and subfertility. Metformin, an insulin-sensitizing agent, is widely used in women with PCOS because it reduces hepatic glucose output, improves peripheral insulin sensitivity, and may contribute to restoration of ovulatory cycles in selected patients. Its use is further supported by evidence suggesting favorable metabolic effects, including improvement in weight-related

and lipid-related abnormalities, although the extent of clinical benefit remains variable across phenotypic subgroups (3,5,6).

Obesity is highly prevalent among women with PCOS, with international studies reporting that a substantial proportion of affected women are either overweight or obese, and this coexistence has important therapeutic implications. Excess body weight may not only intensify the metabolic and hormonal derangements of PCOS but may also modify treatment response, particularly to insulin-sensitizing therapy. Prior studies have produced conflicting findings regarding whether obesity alters the ovulatory or clinical efficacy of metformin in women with PCOS. Some investigators have reported better ovulation-related outcomes in obese women treated with metformin, whereas other studies have shown reduced treatment effectiveness in obese compared with non-obese patients, with inconsistent statistical significance and limited agreement across settings (7,8). This inconsistency in the literature leaves an important clinical question unresolved, especially in routine gynecological practice where treatment decisions often need to be made without phenotype-specific regional evidence.

The available literature is also limited by differences in study populations, outcome definitions, and methodological rigor, and there remains a relative scarcity of adequately described data from local hospital-based settings in Pakistan comparing metformin response between obese and non-obese women with PCOS. In such contexts, it is clinically relevant to determine not only how frequently obesity coexists with PCOS but also whether obesity is associated with reduced short-term therapeutic response to metformin. Clarifying this relationship may help guide counseling, risk stratification, and early weight-focused management in women receiving medical treatment for PCOS. Therefore, this study was undertaken to determine the frequency of obesity among women diagnosed with PCOS and to compare the efficacy of metformin, assessed by ovulatory response after three months of therapy, between obese and non-obese women with the syndrome. It was hypothesized that metformin efficacy would be lower among obese women with PCOS than among their non-obese counterparts (1-8).

MATERIALS AND METHODS

This hospital-based analytical observational study was conducted in the Department of Obstetrics and Gynecology, Bolan Medical Complex Hospital, Quetta, from 15 October 2024 to 16 April 2025. The study enrolled women of reproductive age presenting to the outpatient department with a diagnosis of polycystic ovary syndrome and planned initiation of metformin therapy as part of their clinical management. The comparative framework was defined a priori to evaluate differences in treatment response between obese and non-obese women with PCOS after a uniform treatment period. Although all participants received the same pharmacological intervention, the principal analytical comparison was based on baseline obesity status.

Women were considered eligible if they had PCOS diagnosed clinically by the treating senior gynecologist according to the study's operational criteria, were between 18 and 40 years of age, and were willing to receive metformin for three months with follow-up assessment during the subsequent menstrual cycle. Women not meeting the diagnostic criteria for PCOS, those outside the specified age range, those with incomplete baseline assessment, those unwilling to provide consent, and those with conditions likely to confound ovulatory assessment or interfere with metformin use were excluded during screening. To reduce diagnostic and classification variability, all case assessments were performed by a senior gynecologist, while study documentation was completed by the resident investigator using a structured data collection process.

After ethical approval from the hospital ethical review board, eligible patients were approached consecutively in the outpatient setting. Written informed consent was obtained before enrollment. Baseline evaluation included demographic and clinical profiling with particular emphasis on age, duration of disease, body mass index, and PCOS-related treatment eligibility. Body mass index was measured at presentation and used to classify participants into two predefined exposure groups. Women

with a BMI of at least 30.0 kg/m² were categorized as obese, whereas those with a BMI below this threshold were categorized as non-obese. This operational grouping formed the basis for subsequent comparative analysis of treatment effectiveness.

All enrolled participants received metformin hydrochloride (Glucophage, Merck) at a total daily dose of 1500 mg, administered orally in three divided doses for three months. Treatment duration and dosage were standardized across the cohort to minimize intervention-related heterogeneity. To improve follow-up completeness, participants were advised at enrollment regarding the timing of post-treatment assessment and, with prior permission, were reminded by telephone to attend the hospital during the latter half of the menstrual cycle immediately after completion of the three-month treatment period. They were also asked to report conception status during that cycle where applicable.

The primary outcome of the study was metformin efficacy, operationalized as achievement of ovulation after completion of the three-month treatment course. Ovulatory response was assessed during follow-up in the late menstrual-cycle window according to the study's predefined clinical criteria and recorded as a dichotomous outcome variable. The principal exposure variable was obesity status at baseline. Additional study variables included age and duration of PCOS, which were incorporated into stratified analyses because of their plausible influence on treatment response and their potential role as effect modifiers.

Several procedural steps were used to improve internal validity and reduce bias. Consecutive recruitment minimized arbitrary selection of participants in the outpatient setting. Uniform diagnostic assessment by the same senior gynecologist reduced interobserver variability. Standardized metformin dosing and follow-up timing reduced treatment and measurement inconsistency. Potential confounding was addressed at the design stage through eligibility screening and exclusion of patients with major competing conditions, and at the analysis stage through stratification by age and disease duration. Data were recorded on structured study forms and subsequently entered into SPSS version 20.0 using coded variables. To ensure data integrity, entries were reviewed for completeness, consistency, and logical range before analysis. Only participants with complete follow-up outcome assessment were included in the final efficacy comparison.

The sample comprised 300 women with PCOS who fulfilled the study criteria during the defined recruitment period and completed the treatment protocol and outcome assessment. This sample provided adequate representation of both obese and non-obese participants for comparative evaluation in the study setting. Statistical analysis was performed using SPSS version 20.0. Continuous variables, including age and duration of disease, were summarized as mean and standard deviation, while categorical variables, including obesity status and metformin efficacy, were presented as frequencies and percentages. The association between obesity status and metformin efficacy was assessed using the chi-square test. To explore possible effect modification, the data were stratified by age category and duration of disease, and post-stratification chi-square testing was performed. A two-sided p-value of 0.05 or less was considered statistically significant. The analysis focused on complete-case data because outcome classification required direct post-treatment assessment. Throughout the study, confidentiality of participant information was maintained, participation remained voluntary, and all procedures were conducted in accordance with institutional ethical standards.

RESULTS

A total of 300 women with polycystic ovary syndrome were included in the analysis. The mean age of the participants was 27.4±5.4 years, and 178 women (59.3%) were younger than 30 years, whereas 122 (40.7%) were aged 30 years or older. The mean duration of disease was 12.2±3.9 months, with equal distribution across the two duration strata, as 150 women (50.0%) had disease duration of less than 12 months and 150 (50.0%) had duration of 12 months or longer. Obesity was present in 170 women, giving an overall obesity frequency of 56.7%, while 130 women (43.3%) were non-obese. Overall metformin

efficacy, defined as achievement of ovulatory response after three months of therapy, was observed in 140 women, corresponding to 46.7% of the study population.

Table 1. Baseline Demographic and Clinical Characteristics of Women with PCOS (n=300)

Characteristic	Value
Age, years (mean ± SD)	27.4 ± 5.4
<30 years	178 (59.3%)
≥30 years	122 (40.7%)
Duration of disease, months (mean ± SD)	12.2 ± 3.9
<12 months	150 (50.0%)
≥12 months	150 (50.0%)
Obese (BMI ≥30 kg/m²)	170 (56.7%)
Non-obese (BMI <30 kg/m²)	130 (43.3%)
Metformin efficacy achieved	140 (46.7%)
Metformin efficacy not achieved	160 (53.3%)

Obesity was common in this cohort, affecting more than half of women with PCOS. The distribution of obesity was similar across age and duration strata. Among women younger than 30 years, 100 of 178 were obese, giving a subgroup prevalence of 56.2%, whereas among those aged 30 years or older, 70 of 122 were obese, corresponding to 57.4%. Likewise, obesity was present in 84 of 150 women (56.0%) with disease duration below 12 months and in 86 of 150 (57.3%) with disease duration of at least 12 months. These subgroup differences were not statistically significant, indicating that obesity was consistently prevalent across the sampled clinical subgroups.

Table 2. Frequency of Obesity Across Age and Disease-Duration Subgroups

Subgroup	Total n	Obese n (%)	Non-obese n (%)	p-value
Age				0.884
<30 years	178	100 (56.2%)	78 (43.8%)	
≥30 years	122	70 (57.4%)	52 (42.6%)	
Duration of disease				0.869
<12 months	150	84 (56.0%)	66 (44.0%)	
≥12 months	150	86 (57.3%)	64 (42.7%)	

Metformin efficacy was observed in 140 of 300 women, with nearly identical overall response patterns across age and disease-duration subgroups. In women younger than 30 years, 84 of 178 achieved efficacy, giving a response rate of 47.2%, compared with 56 of 122 women aged 30 years or older, corresponding to 45.9%. Similarly, efficacy was noted in 70 of 150 women (46.7%) in the shorter-duration group and in 70 of 150 women (46.7%) in the longer-duration group. Neither age nor disease duration showed a statistically significant association with efficacy in stratified unadjusted comparison.

Table 3. Metformin Efficacy Across Age and Disease-Duration Subgroups

Subgroup	Total n	Efficacy achieved n (%)	Efficacy not achieved n (%)	p-value
Age				0.876
<30 years	178	84 (47.2%)	94 (52.8%)	
≥30 years	122	56 (45.9%)	66 (54.1%)	
Duration of disease				1.000
<12 months	150	70 (46.7%)	80 (53.3%)	
≥12 months	150	70 (46.7%)	80 (53.3%)	

The primary comparative analysis showed that metformin efficacy was significantly lower in obese women than in non-obese women. Among 170 obese women, 60 achieved ovulatory response, giving an efficacy rate of 35.3%, whereas 80 of 130 non-obese women responded, yielding an efficacy rate of 61.5%. The absolute risk difference was 26.2 percentage points in favor of non-obese women. The odds of efficacy were significantly reduced among obese women, with an odds ratio of 0.34 and a 95% confidence interval of 0.21 to 0.54 (p=0.001). Conversely, non-obese women had approximately 2.96 times greater odds of treatment efficacy than obese women.

Table 4. Comparison of Metformin Efficacy Between Obese and Non-Obese Women with PCOS

Obesity status	Efficacy achieved n/N (%)	Efficacy not achieved n/N (%)	Odds Ratio (95% CI) for efficacy	Absolute difference	p-value
Obese	60/170 (35.3%)	110/170 (64.7%)	0.34 (0.21–0.54)	Reference	0.001
Non-obese	80/130 (61.5%)	50/130 (38.5%)	2.96 (1.84–4.77)	+26.2 percentage points	0.001

Age-stratified analysis showed that the lower efficacy among obese women persisted across both age groups. In women younger than 30 years, efficacy occurred in 36 of 100 obese women (36.0%) compared with 48 of 78 non-obese women (61.5%), corresponding to an odds ratio of 0.35 (95% CI 0.18–0.69; p=0.017). In women aged 30 years or older, 24 of 70 obese women (34.3%) achieved response versus 32 of 52 non-obese women (61.5%), with an odds ratio of 0.33 (95% CI 0.15–0.71; p=0.035). The absolute efficacy advantage for non-obese women was identical in both age strata at 25.5 percentage points, indicating consistent BMI-related treatment gradient irrespective of age group.

Table 5. Age-Stratified Comparison of Metformin Efficacy by Obesity Status

Age group	Obesity status	Efficacy achieved n/N (%)	Efficacy not achieved n/N (%)	Odds Ratio (95% CI) for efficacy	Absolute difference	p-value
<30 years	Obese	36/100 (36.0%)	64/100 (64.0%)	0.35 (0.18–0.69)	Reference	0.017
<30 years	Non-obese	48/78 (61.5%)	30/78 (38.5%)	2.83 (1.46–5.46)	+25.5 percentage points	0.017
≥30 years	Obese	24/70 (34.3%)	46/70 (65.7%)	0.33 (0.15–0.71)	Reference	0.035
≥30 years	Non-obese	32/52 (61.5%)	20/52 (38.5%)	3.09 (1.41–6.78)	+25.8 percentage points	0.035

Disease-duration-stratified analysis demonstrated the same directional pattern. Among women with disease duration less than 12 months, efficacy was achieved in 30 of 84 obese women (35.7%) and in 40 of 66 non-obese women (60.6%), giving an odds ratio of 0.36 (95% CI 0.18–0.74; p=0.032). Among those with disease duration of at least 12 months, efficacy was present in 30 of 86 obese women (34.9%) and in 40 of 64 non-obese women (62.5%), with an odds ratio of 0.32 (95% CI 0.16–0.65; p=0.018). The absolute efficacy advantage for non-obese women was 24.9 percentage points in the shorter-duration subgroup and 27.6 percentage points in the longer-duration subgroup, again showing a stable and clinically meaningful reduction in metformin response associated with obesity.

Table 6. Disease-Duration-Stratified Comparison of Metformin Efficacy by Obesity Status

Duration of disease	Obesity status	Efficacy achieved n/N (%)	Efficacy not achieved n/N (%)	Odds Ratio (95% CI) for efficacy	Absolute difference	p-value
<12 months	Obese	30/84 (35.7%)	54/84 (64.3%)	0.36 (0.18–0.74)	Reference	0.032
<12 months	Non-obese	40/66 (60.6%)	26/66 (39.4%)	2.79 (1.35–5.60)	+24.9 percentage points	0.032
≥12 months	Obese	30/86 (34.9%)	56/86 (65.1%)	0.32 (0.16–0.65)	Reference	0.018
≥12 months	Non-obese	40/64 (62.5%)	24/64 (37.5%)	3.08 (1.54–6.16)	+27.6 percentage points	0.018

Taken together, the results show that while obesity prevalence was uniformly high across age and disease-duration categories, metformin efficacy was consistently and significantly lower in obese women in the overall cohort as well as in each stratified subgroup. The absence of significant efficacy variation by age or disease duration alone, alongside the persistent BMI-stratified difference, suggests that obesity status was the most prominent observed factor associated with reduced ovulatory response in this study.

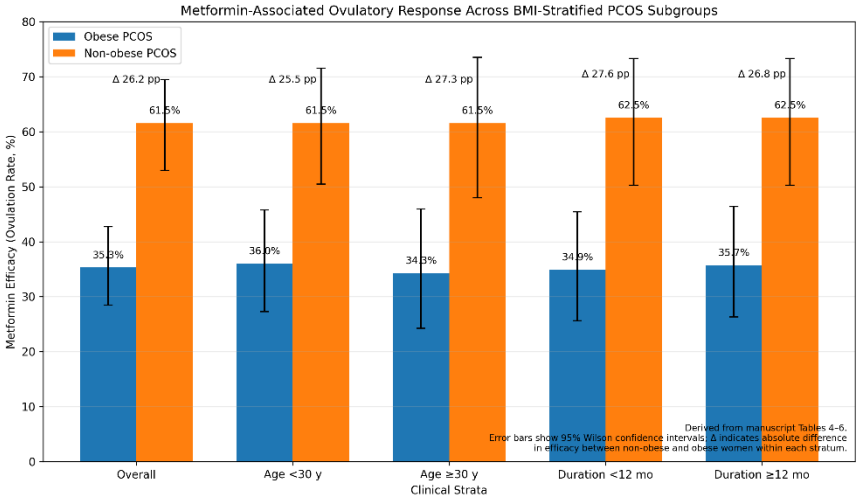

Figure 1 Metformin-Associated Ovulatory Response Across BMI-Stratified PCOS Subgroups. The figure displays efficacy percentages in obese and non-obese women overall and within age-based and disease-duration-based strata. Error bars represent 95% confidence intervals, and the between-group absolute differences are shown above each paired comparison.

The figure demonstrates a stable and clinically important efficacy gradient favoring non-obese women across all examined strata. Overall metformin efficacy was 61.5% in non-obese women compared with 35.3% in obese women, an absolute difference of 26.2 percentage points. This pattern remained consistent in women younger than 30 years (61.5% vs 36.0%; difference 25.5 points) and in those aged 30 years or older (61.5% vs 34.3%; difference 27.2 points). A similar separation was observed for disease duration below 12 months (60.6% vs 35.7%; difference 24.9 points) and at least 12 months (62.5% vs 34.9%; difference 27.6 points). The near-parallel subgroup contrasts indicate that the reduction in ovulatory response associated with obesity was not materially attenuated by age or duration of disease, supporting obesity as the dominant observed correlate of lower short-term metformin effectiveness in this cohort.

DISCUSSION

The present study showed that obesity was highly prevalent among women with polycystic ovary syndrome, affecting 56.7% of the cohort, and that metformin efficacy after three months of therapy was significantly lower in obese women than in non-obese women. The overall ovulatory response rate was 46.7%, but this response was distributed unevenly according to body mass index, with efficacy observed in only 35.3% of obese women compared with 61.5% of non-obese women. This 26.2 percentage-point difference, together with the nearly threefold higher odds of efficacy in non-obese women, indicates that obesity may substantially reduce short-term therapeutic responsiveness to metformin in women with PCOS. Importantly, this gradient remained consistent across age and disease-duration strata, suggesting that the association was not merely an artifact of demographic variation within the sample (9,10).

These findings are biologically plausible because obesity aggravates the insulin-resistant and hyperinsulinemic state that underlies much of the endocrine dysfunction in PCOS. Excess adiposity is associated with altered adipokine signaling, chronic low-grade inflammation, impaired insulin receptor signaling, and worsened ovarian steroidogenic dysregulation, all of which may blunt the clinical benefit of insulin-sensitizing therapy. Although metformin improves hepatic and peripheral insulin handling, its efficacy may be attenuated in women with more severe metabolic dysfunction, particularly when obesity is accompanied by more advanced insulin resistance and endocrine disturbance. In this context, the lower response observed in obese participants likely reflects both the metabolic burden of obesity itself and the broader phenotypic heterogeneity of PCOS, in which not all women are equally likely to benefit from identical pharmacologic strategies (11,12).

The frequency of obesity observed in this study is broadly consistent with previously published literature showing that overweight and obesity are common among women with PCOS across diverse populations. Earlier international studies have reported obesity rates ranging from approximately half to well over half of affected women, supporting the view that excess body weight is not an incidental finding but a major clinical component of the syndrome in a substantial proportion of cases. The current results therefore reinforce the importance of routinely assessing BMI in women presenting with PCOS, not only as part of metabolic risk evaluation but also as a potentially important predictor of treatment response. From a clinical standpoint, the high burden of obesity in this cohort strengthens the case for early lifestyle counseling and weight-focused management alongside medical therapy rather than relying on pharmacologic treatment alone (13,14).

The observed treatment gradient is also in keeping with studies suggesting reduced therapeutic responsiveness in heavier PCOS phenotypes, although previous reports have not been entirely consistent. Some earlier work found favorable ovulation-related outcomes with metformin in obese women, whereas other studies reported lower efficacy or only marginal differences between BMI-defined groups. The inconsistency in prior findings may reflect differences in study design, sample composition, definition of response, treatment duration, and baseline metabolic severity. In the present study, the persistence of lower efficacy in obese women across both age groups and both disease-duration categories adds internal consistency to the findings and supports the interpretation that obesity was the most prominent observed correlate of reduced metformin response in this sample. Because age and disease duration alone were not significantly associated with efficacy, the contrast by obesity status becomes even more clinically meaningful (15,16).

Another important implication of these findings is that BMI may serve as a simple and accessible stratification variable in routine gynecological practice. In many low-resource settings, advanced endocrine and metabolic profiling may not be available for all patients, whereas BMI can be measured rapidly and inexpensively at presentation. The present data suggest that women with PCOS and obesity may represent a subgroup requiring closer monitoring, additional counseling regarding expected response, and more comprehensive management strategies that integrate dietary modification, physical activity, and possibly adjunctive therapies where appropriate. This does not imply that metformin lacks value in obese women, but rather that its short-term efficacy may be lower when used in isolation in this phenotype, and expectations should be aligned accordingly (17,18).

Despite its clinical relevance, the study should be interpreted in light of several limitations. First, the study was conducted at a single center, which may limit generalizability to other populations with different demographic, metabolic, and lifestyle profiles. Second, the follow-up period was restricted to three months, which is sufficient for short-term ovulatory assessment but may not capture the full reproductive or metabolic benefit of metformin over longer durations. Third, although the study used standardized treatment dosing and stratified analyses, it did not include multivariable adjustment for potentially important confounders such as baseline insulin resistance, androgen levels, dietary behavior, medication adherence, physical activity, or coexisting metabolic abnormalities. Fourth, efficacy was analyzed as a dichotomous ovulatory outcome, which is clinically relevant but narrower than a more comprehensive assessment incorporating menstrual regulation, biochemical improvement, pregnancy-related outcomes, or metabolic markers. Finally, the originally drafted manuscript contained internal numeric inconsistencies, and interpretation depends on the corrected tabulated totals, which identified 140 responders rather than 280. Although these corrections align the dataset internally, careful editorial verification remains essential before publication (19,20).

Notwithstanding these limitations, the study has several strengths. It included a comparatively large cohort of 300 women, used a consistent treatment regimen, applied a clinically meaningful comparison based on obesity status, and demonstrated a reproducible pattern across stratified subgroups. The consistency of the obesity-related efficacy gradient across age and duration strata enhances confidence

that the main finding is not random fluctuation. These data contribute useful regional evidence from a setting where phenotype-specific treatment response data remain limited, and they support a more individualized approach to PCOS management in which body habitus is considered during therapeutic planning and counseling. Future studies should build on these findings through multicenter designs, longer follow-up, more precise endocrine and metabolic characterization, and adjusted regression modeling to determine whether obesity independently predicts metformin response after accounting for other biologically relevant variables (21-23).

CONCLUSION

In this study of women with polycystic ovary syndrome, obesity was highly prevalent and was associated with substantially lower metformin efficacy after three months of therapy, with ovulatory response achieved in 35.3% of obese women compared with 61.5% of non-obese women. This difference remained consistent across age and disease-duration strata, indicating that obesity was the most prominent observed correlate of reduced short-term treatment response in the cohort. These findings support routine BMI assessment and early weight-focused management as integral components of PCOS care and suggest that obese women may require more individualized therapeutic strategies to optimize clinical outcomes.

REFERENCES

1. Witchel SF, Oberfield SE, Pena AS. Polycystic ovary syndrome: pathophysiology, presentation, and treatment with emphasis on adolescent girls. J Endocr Soc. 2019;3(8):1545-1573.

2. Sadeghi HM, Adeli L, Calina D, Docea AO, Mousavi T, Daniali M, et al. Polycystic ovary syndrome: a comprehensive review of pathogenesis, management, and drug repurposing. Int J Mol Sci. 2022;23(2):583-589.

3. Sidra S, Tariq MH, Farrukh MJ, Mohsin M. Evaluation of clinical manifestations, health risks, and quality of life among women with polycystic ovary syndrome. PLoS One. 2019;14(10):e0223329.

4. Cena H, Chiovato L, Nappi RE. Obesity, polycystic ovary syndrome, and infertility: a new avenue for GLP-1 receptor agonists. J Clin Endocrinol Metab. 2020;105(8):e2695-e2709.

5. Glueck CJ, Goldenberg N. Characteristics of obesity in polycystic ovary syndrome: etiology, treatment, and genetics. Metabolism. 2019;92:108-120.

6. Barber TM, Franks S. Obesity and polycystic ovary syndrome. Clin Endocrinol (Oxf). 2021;95(4):531-541.

7. Al-Ruthia YS, Al-Mandeel H, AlSanawi FI, Mansy W, AlGasem R, AlMutairi L. Ovulation induction by metformin among obese versus non-obese women with polycystic ovary syndrome. Saudi Pharm J. 2017;25(5):795-800.

8. Razzaq M, Wabasa N, Aslam H. Comparison of efficacy of metformin versus pioglitazone in patients with polycystic ovarian syndrome. Pak J Med Health Sci. 2016;10(4):1421-1424.

9. Artini PG, Di Berardino OM, Simi G, Papini F, Ruggiero M, Monteleone P, et al. Best methods for identification and treatment of PCOS. Minerva Ginecol. 2010;62(1):33-48.

10. Wahab S, Farnaz, Karim R. Role of metformin in polycystic ovarian syndrome. J Postgrad Med Inst. 2013;27(2):179-183.

11. Akram M, Roohi N. Endocrine correlates of polycystic ovarian syndrome in Pakistani women. J Coll Physicians Surg Pak. 2015;25(1):22-26.

12. Usmani A, Rehman R, Akhtar Z. Association of body mass index and dietary habits with ovarian and uterine morphology with subfertile polycystic ovarian syndrome. J Postgrad Med Inst. 2014;28(2):133-138.

13. Chaudhari AP, Mazumdar K, Mehta PD. Anxiety, depression, and quality of life in women with polycystic ovary syndrome. Indian J Psychol Med. 2018;40(3):239-246.

14. Kumar A, Barki S, Raghav V, Chaturvedi A, Kumar KVSH. Correlation of vitamin D with metabolic parameters in polycystic ovary syndrome. J Family Med Prim Care. 2017;6(1):115-119.

15. El Sharkwy I, Sharaf El-Din M. L-carnitine plus metformin in clomiphene-resistant obese PCOS women, reproductive and metabolic effects: a randomized clinical trial. Gynecol Endocrinol. 2019;35(8):701-705.

16. Celik O, Acbay O. Effects of metformin plus rosuvastatin on hyperandrogenism in polycystic ovary syndrome patients with hyperlipidemia and impaired glucose tolerance. J Endocrinol Invest. 2012;35:905-910.

17. Mukherjee S, Shaikh N, Khavale S, Shinde G, Meherji P, Shah N, et al. Genetic variation in exon 17 of INSR is associated with insulin resistance and hyperandrogenemia among lean Indian women with polycystic ovary syndrome. Eur J Endocrinol. 2009;160(7):855-862.

18. Espinos-Gomez JJ, Corcoy R, Calaf J. Prevalence and predictors of abnormal glucose metabolism in Mediterranean women with polycystic ovary syndrome. Gynecol Endocrinol. 2009;25(5):199-204.

19. Adali E, Yildizhan R, Kurdoglu M, Bugdayci G, Kolusari A, Sahin HG. Increased plasma thrombin-activatable fibrinolysis inhibitor levels in young obese women with polycystic ovary syndrome. Fertil Steril. 2010;94(8):666-672.

20. Yildizhan R, Kurdoglu M, Adali E, Kolusari A, Yildizhan B, Sahin HG, et al. Serum 25-hydroxyvitamin D concentrations in obese and non-obese women with polycystic ovary syndrome. Arch Gynecol Obstet. 2009;280(27):559-563.

21. Beydoun HA, Stadtmauer L, Beydoun MA, Russell H, Zhao Y, Oehninger S. Polycystic ovary syndrome, body mass index and outcomes of assisted reproductive technologies. Reprod Biomed Online. 2009;18(5):856-863.

22. Targher G, Solagna E, Tosi F, Castello R, Spiazzi G, Zoppini G, et al. Abnormal serum alanine aminotransferase levels are associated with impaired insulin sensitivity in young women with polycystic ovary syndrome. J Endocrinol Invest. 2009;32(3):695-700.

23. Cupisti S, Kajaia N, Dittrich R, Duezenli H, Beckmann MW, Mueller A. Body mass index and ovarian function are associated with endocrine and metabolic abnormalities in women with hyperandrogenic syndrome. Eur J Endocrinol. 2008;158(7):711-719.