

## COMPARATIVE STUDY

# A Comparative Study of Clinical, Radiological, Hormonal, and Metabolic Parameters between Nonobese and Overweight Polycystic Ovarian Syndrome (PCOS) Patients

Dipansha Bajpai<sup>1</sup>, Deepa Shanmugham<sup>2</sup>, Prithviraj Nagarajan<sup>3</sup>, Leena Rajathy P Louis<sup>4</sup>

Received on: 16 April 2023; Accepted on: 20 July 2023; Published on: 29 September 2023

### ABSTRACT

**Background:** One in five women of reproductive age-group is affected by polycystic ovarian syndrome (PCOS). The high prevalence of PCOS makes it of immense clinical and public health importance. This study is aimed to compare the clinical, radiological, hormonal, and metabolic parameters of nonobese and overweight PCOS patients.

**Aim:** This prospective observational study is aimed to compare the clinical, radiological, hormonal, and metabolic parameters of nonobese and overweight PCOS patients.

**Materials and methods:** This prospective observational study is conducted among the patients attending the outpatient department (OPD) diagnosed with PCOS according to Rotterdam's criteria among females aged 15–45 years (reproductive age-group). A total of 57 participants are included in the study. All participants fulfilled the inclusion criteria and informed consent was obtained.

**Results:** The mean age of participants was found to be  $22.3 \pm 4.4$  years of age. There was a significantly higher mean weight and waist-hip ratio among the group II participants compared to group I ( $p < 0.05$ ). The mean level of luteinizing hormones (LH) among group II was  $11.81 \pm 4.67$  and group I was  $10.58 \pm 4.47$  ( $p > 0.05$ ) and thyroid-stimulating hormone (TSH) levels were  $2.93 \pm 1.91$  among group II and  $3.07 \pm 2.12$  among group I participants ( $p > 0.05$ ). The mean stromal volume of the right ovary in group II was  $13.5 \pm 4.2$  and in group I was  $12.2 \pm 3.4$  and of the left ovaries, it was  $12.05 \pm 3.05$  in group II and  $11.30 \pm 2.78$  in group I participants ( $p > 0.05$ ). The significantly higher mean of total cholesterol among group II ( $170.7 \pm 22.7$  mg/dL) compared to group I participants ( $155.8 \pm 21.1$  mg/dL) ( $p < 0.05$ ). Hirsutism was significantly higher among group II participants (27.8%) compared to the participants in group I ( $p < 0.05$ ).

**Conclusion:** It was found that there is a significant difference in the metabolic parameters and clinical characteristics in the PCOS women of both groups and also a significantly higher incidence of hirsutism among the obese PCOS participants, as well as a higher incidence of other clinical parameters.

**Keywords:** Acne, Hirsutism, Luteinizing hormones, Obese, Polycystic ovarian syndrome.

Donald School Journal of Ultrasound in Obstetrics and Gynecology (2023): 10.5005/jp-journals-10009-1983

### INTRODUCTION

One in five women of reproductive age-group is affected by polycystic ovary syndrome (PCOS), thus making it of immense clinical and public health importance.<sup>1</sup> PCOS has a spectrum of clinical presentation in which patients come with reproductive complaints like infertility and hyperandrogenism; metabolic complaints like insulin resistance (IR), impaired glucose tolerance (IGT), type 2 diabetes mellitus, adverse cardiovascular risk profile, increased chances of psychological symptoms like anxiety, depression, and worsened quality of life. PCOS is the most frequently encountered endocrinopathy. PCOS is categorized under normogonadotropic normoestrogenic anovulation (World Health Organization).<sup>2</sup> The prevalence of PCOS is found to be 18% ( $17.8 \pm 2.8\%$ ) based on Rotterdam's diagnostic criteria.<sup>3</sup> Evidently, 70% of women

<sup>1,2</sup>Department of Obstetrics and Gynecology, Aarupadai Veedu Medical College, Vinayaka Mission's Research Foundation (Deemed to be University), Puducherry, India

<sup>3</sup>Department of Medical Biotechnology, Aarupadai Veedu Medical College, Vinayaka Mission's Research Foundation (Deemed to be University), Puducherry, India

<sup>4</sup>Department of Pharmacology, Aarupadai Veedu Medical College, Puducherry, India

**Corresponding Author:** Deepa Shanmugham, Department of Obstetrics and Gynecology, Aarupadai Veedu Medical College, Vinayaka Mission's Research Foundation (Deemed to be University), Puducherry, India, Phone: +91 8012081902, e-mails: drdeepabalamurugan@gmail.com; deepa.shanmugam@avmc.edu.in

**How to cite this article:** Bajpai D, Shanmugham D, Nagarajan P, et al. A Comparative Study of Clinical, Radiological, Hormonal,

© The Author(s). 2023 Open Access. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.

remain undiagnosed.<sup>4</sup> It has been debated over the years that PCOS is more prevalent in overweight patients as compared to lean patients. But recently it has been found that obesity is not the sine qua non of PCOS. The study of clinical, hormonal, radiological, and metabolic parameters based on their body mass index (BMI) can help us in the appropriate treatment of these patients in the future. This can help us frame protocols for the management of patients with PCOS based on their clinical symptoms. So, in this study, we evaluated the clinical, hormonal, and metabolic profile of PCOS patients with normal BMI, which is on the rise nowadays.

## MATERIALS AND METHODS

This prospective observational study was done after getting Institutional Ethical Clearance for 2-year period in a hospital attached to Aarupadai Veedu Medical College and Hospital from November 2019 to November 2021. The study participants included patients attending the outpatient department (OPD) diagnosed with PCOS of the reproductive age-group (15–45 years) who were willing to give informed and written consent. The diagnosis of PCOS is made based on Rotterdam's criteria in patients aged 18–45 years and National Institute of Health's (NIHs) strict criteria for the adolescent age-group (15–17 years). Based on Rotterdam's criteria, PCOS was diagnosed if at least two of the following criteria were present:

- Oligomenorrhea/anovulation (defined as delaying of menses >35 days or <8 spontaneous hemorrhagic episodes/year).
- Clinical hyperandrogenism.
- Polycystic ovary on ultrasonography ( $\geq 12$  small follicles measuring 2–9 mm in at least one ovary and or ovarian volume >10 cm).<sup>3–5</sup>

The NIH's strict criteria include menstrual irregularity/anovulation and hyperandrogenism with the exclusion of other causes of above said symptoms.<sup>6</sup> The study excluded women on the oral contraceptive pill since its use changes the morphology of the ovary in normal women and presumably in women with PCOS<sup>7</sup> and the presence of any abnormal ovarian cyst or ovarian asymmetry. Informed consent was obtained from all 57 participants who fulfilled the inclusion criteria. On the basis of BMI, participants were divided into two groups: group I—nonobese, PCOS, BMI  $\leq 23$ ; group II—overweight PCOS,

and Metabolic Parameters between Nonobese and Overweight Polycystic Ovarian Syndrome (PCOS) Patients. Donald School J Ultrasound Obstet Gynecol 2023;17(3):197–201.

**Source of support:** Nil

**Conflict of interest:** None

BMI > 23. Of the 57 participants in the study, 21 participants were in group I and 36 in group II. Clinical parameters like age, family history of diabetes, menstrual irregularities, infertility, acne, hirsutism, acanthosis nigricans, and waist-hip ratio were observed in all the patients. The hormonal parameters like serum luteinizing hormones (LH) tested by electrochemiluminescent immunoassay (ECLIA) on day 2 of the menstrual cycle and thyroid-stimulating hormone (TSH) tested by ECLIA were recorded for all study patients. Transvaginal sonography and transabdominal sonography in selected patients (unmarried) were done to record the ovarian stromal volume and endometrial thickness. The metabolic parameters like glucose tolerance test with an estimation of glucose by glucose oxidase/peroxidase method (GOD/POD) method and lipid profile were recorded. The above parameters were recorded on a data collection proforma. The results were compared between both the groups. The data was entered in the Excel sheet and analyzed using Statistical Package for the Social Sciences version 21 operating on Windows 10. The quantitative continuous variables were analyzed using an unpaired *t*-test. The categorical variables were analyzed using the Chi-square test to measure the statistical difference. A *p*-value of <0.05 was considered statistically significant.

## RESULTS

Out of 57 participants included in the study, 21 participants were in group I and 36 participants in group II. **Table 1** demonstrates the comparison of anthropometric parameters like height, weight, and waist-hip ratio between both the groups, a significant difference was noted in weight and waist-hip ratio between groups I and II. **Table 2** demonstrates the comparison of clinical parameters between the groups. PCOS patients presented with complaints of infertility and menstrual irregularities, we did not find statistically significant differences between the groups. The clinical parameters like acne, hirsutism, galactorrhea, acanthosis nigricans, clitoromegaly, and family history of diabetes were compared between both

**Table 1:** Comparison of anthropometric parameters between the groups

| Anthropometric parameters | Group I (N = 21) |                    | Group II (N = 36) |                    | p-value |
|---------------------------|------------------|--------------------|-------------------|--------------------|---------|
|                           | Mean             | Standard deviation | Mean              | Standard deviation |         |
| Height in m               | 1.59             | 0.06               | 1.57              | 0.04               | 0.270   |
| Weight in kg              | 52.0             | 7.5                | 68.1              | 7.3                | 0.001** |
| Waist-hip ratio           | 0.73             | 0.11               | 0.88              | 0.11               | 0.001** |

\*\*Statistical significance of *p* = 0.001

**Table 2:** Comparison of clinical parameters between the groups

| Clinical parameters        | Group I (N = 21) |           | Group II (N = 36) |           | p-value        |
|----------------------------|------------------|-----------|-------------------|-----------|----------------|
|                            | Count            | Column N% | Count             | Column N% |                |
| Infertility                | 2                | 9.5%      | 5                 | 13.9%     | 3.68           |
| Menstrual irregularities   | 3                | 14.2%     | 10                | 27.8%     | 1.28           |
| Acne                       | 4                | 19.0%     | 11                | 30.6%     | 0.906 (0.341)  |
| Hirsutism                  | 1                | 4.8%      | 10                | 27.8%     | 4.511 (0.034)* |
| Galactorrhea               | 0                | 0.0%      | 1                 | 2.8%      | 0.594 (0.441)  |
| Acanthosis nigricans       | 1                | 4.8%      | 5                 | 13.9%     | 1.173 (0.273)  |
| Clitoromegaly              | 0                | 0.0%      | 0                 | 0.0%      | –              |
| Family history of diabetes | 3                | 14.3%     | 7                 | 19.4%     | 0.244 (0.621)  |

**Table 3:** Comparison of hormonal parameters between the groups

| Hormonal parameters | Group I |                    | Group II |                    | t-test (p-value) |
|---------------------|---------|--------------------|----------|--------------------|------------------|
|                     | Mean    | Standard deviation | Mean     | Standard deviation |                  |
| LH                  | 10.58   | 4.47               | 11.81    | 4.67               | 0.332            |
| TSH uIU/mL          | 3.07    | 2.12               | 2.93     | 1.91               | 0.808            |

LH, Luteinizing Hormone; TSH, Thyroid Stimulating Hormone

**Table 4:** Comparison of radiological parameters between the groups

| Radiological parameters      | Group I |                    | Group II |                    | t-test (p-value) |
|------------------------------|---------|--------------------|----------|--------------------|------------------|
|                              | Mean    | Standard deviation | Mean     | Standard deviation |                  |
| Right ovarian stromal volume | 12.2    | 3.4                | 13.5     | 4.2                | 0.224            |
| Left ovarian stromal volume  | 11.30   | 2.78               | 12.05    | 3.05               | 0.360            |
| Endometrial thickness in mm  | 6.4     | 1.8                | 6.2      | 2.5                | 0.847            |

**Table 5:** Comparison of metabolic parameters between the groups

| Metabolic parameters       | Group I |                    | Group II |                    | t-test (p-value) |
|----------------------------|---------|--------------------|----------|--------------------|------------------|
|                            | Mean    | Standard deviation | Mean     | Standard deviation |                  |
| FBS in mg/dL               | 96.6    | 7.8                | 103.5    | 22.5               | 0.181            |
| At 2 hours PPBS in mg/dL   | 119.8   | 17.7               | 129.3    | 24.4               | 0.124            |
| Total cholesterol in mg/dL | 155.8   | 21.1               | 170.7    | 22.7               | 0.01*            |
| Triglycerides in mg/dL     | 92.5    | 17.0               | 100.7    | 29.5               | 0.248            |

PPBS, Postprandial Blood Sugar; \*Statistical significance of  $p = 0.001$

the groups and hirsutism was found to be statistically significantly high in group II. Table 3 demonstrates the comparison of hormonal parameters between the groups. There was no significant difference in LH and TSH levels in both groups.

Table 4 demonstrates the comparison of radiological parameters between the groups. The radiological parameters like ovarian stromal volume and endometrial thickness were compared between both the groups, and there was no significant difference in the radiological parameters in groups I and II. Table 5 demonstrates the comparison of metabolic parameters between the groups. The metabolic parameters like blood sugar levels and fasting lipid profile were compared between both groups. No significant difference in the blood sugar level was found in both groups. A significantly higher total cholesterol level was found in group II, there was no

significant difference noted in triglyceride and high density lipoprotein (HDL) levels in both groups.

## DISCUSSION

The prevalence of obesity in PCOS women is reported to be 30–75%.<sup>8</sup> There is a bidirectional relationship between obesity and PCOS. The association of obesity with IR/hyperinsulinemia and metabolic syndrome is well established. In our study, there was not much difference in the clinical parameters except hirsutism and hormonal parameters which shows that even lean PCOS also manifests with all the features of PCOS. There was a significantly higher mean weight and waist-hip ratio among the group II participants compared to group I ( $p < 0.05$ ). In a study by Boumosleh et al. the total body fat percentage was found to

be the same in obese PCOS women and non-PCOS patients (41.4 and 41.4%, respectively).<sup>3</sup> Both obese groups exhibited comparable levels of intraperitoneal fat (1.4% of total body mass in PCOS vs 1.4% in non-PCOS). The ratio of truncal/lower body fat was found to be lower in nonobese PCOS women (1.42 vs 1.27;  $p < 0.016$ ).<sup>9</sup>

The present study assessed the clinical parameters like infertility, acne, hirsutism, galactorrhea, acanthosis nigricans, clitoromegaly, and family history of diabetes mellitus. In the present study, the presence of hirsutism was significantly higher among group II participants (27.8%) compared to the participants in group I ( $p < 0.05$ ). However other clinical parameters distribution was higher among the group II participants compared to group I but was not statistically significant. In a study by Akshaya and Bhattacharya on a comparison between both lean and obese PCOS, there was no statistically significant difference in the clinical presentation of patients with reproductive complaints like menstrual abnormalities and symptoms of excessive androgenism like hirsutism, infertility, acne, alopecia, and clitoromegaly.<sup>4</sup> Irrespective of the BMI most of the PCOS patients will have menstrual irregularities, infertility, and features of hyperandrogenism.<sup>10</sup> On the assessment of the metabolic parameters between the groups, we found a significantly higher mean of total cholesterol among group II compared to group I participants. In a study by Gupta et al., features of IR like mean fasting blood sugar, IGT, and clinical hyperandrogenism were statistically equivalent between groups I and II.<sup>11</sup> Metabolic syndrome in group I (20%) against group II (8%) was not statistically significant and the degree of IR in group I against group II (44 vs 36%) was almost statistically equal.<sup>12</sup> On the assessment of the hormonal parameters between the groups, we found no significant difference in the mean level of LH and TSH. In a study by Daghestani et al., it was found that BMI, waist-hip ratio, total cholesterol, triglycerides, HDL, low density lipoprotein (LDL), and insulin level had significant associations between ghrelin and leptin levels in the PCOS group.<sup>9</sup> On the assessment of the radiological parameters between the groups, we found no significant difference in the ovarian stromal volume between the groups on the right and left ovaries ( $p > 0.05$ ) and endometrial thickness between the groups. However, the mean value of the ovarian stromal volume among group II was higher than in the group I participants on both ovaries. The increase in the stromal volume of the ovary may contribute to the androgenic microenvironment in these obese PCOS patients resulting in anovulation.

## CONCLUSION

In the present study, the clinical features of PCOS like menstrual irregularities, infertility, acne, and acanthosis nigricans were present in most of the PCOS women irrespective of weight. However, hirsutism was significantly higher in obese PCOS patients. Central obesity indicated by waist-hip ratio was more in obese PCOS than in lean PCOS. Ovarian stromal volume was

significantly higher in obese PCOS women resulting in poor folliculogenesis and chronic anovulation in these women. Hence lifestyle modification can help them in follicular growth and ovulation and prevent infertility.

## Clinical Significance

This study found a significant difference in the metabolic parameters and clinical characteristics in the PCOS women of both obese and nonobese groups and also a significantly higher incidence of hirsutism among the obese PCOS participants. These results will guide clinicians to decide the course of treatment.

## ACKNOWLEDGMENT

The authors are thankful to the Management, Dean, Director of Medical Research and IRC of Aarupadai Veedu Medical College and Hospital, Puducherry, India for their support.

## STATEMENT

It is stated that the material contained in the manuscript has not been previously published and is not being concurrently submitted elsewhere.

## DATA AVAILABILITY STATEMENT

The datasets included in this study are available upon request from the corresponding author.

## REFERENCES

1. Teede H, Deeks A, Moran L. Polycystic ovary syndrome: a complex condition with psychological, reproductive and metabolic manifestations that impacts on health across the lifespan. *BMC Med* 2010;8(1):41. DOI: 10.1186/1741-7015-8-41
2. Azziz R, Woods KS, Reyna R, et al. The prevalence and features of the polycystic ovary syndrome in an unselected population. *J Clin Endocrinol Metab* 2004;89(6):2745–2749. DOI: 10.1210/jc.2003-032046
3. Boumosleh JM, Grundy SM, Phan J, et al. Metabolic concomitants of obese and nonobese women with features of polycystic ovarian syndrome. *J Endocr Soc* 2017;1(12):1417–1427. DOI: 10.1210/js.2017-00323
4. Akshaya S, Bhattacharya R. Comparative study of clinical profile of lean and obese polycystic ovary syndrome women. *Int J Reprod Contracept Obstet Gynecol* 2016;5(8):2530–2533. DOI: 10.18203/2320-1770.ijrcog20162173
5. Rotterdam ESHRE/ASRM-sponsored PCOS consensus workshop group. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS). *Hum Reprod* 2004;19(1):41–47. DOI: 10.1093/humrep/deh098
6. National Institutes of Health. Evidence-based Methodology. Workshop on Polycystic Ovary Syndrome. 2012. <https://www.nichd.nih.gov/news/resources/spotlight/Pages/112112-pcos.aspx>
7. Coviello AD, Zhuang WV, Lunetta KL, et al. Circulating testosterone and SHBG concentrations are heritable in women: the Framingham Heart Study. *J Clin Endocrinol Metab* 2011;96(9):E1491–1495. DOI: 10.1210/jc.2011-0050



8. Essah PA, Nestler JE. The metabolic syndrome in polycystic ovary syndrome. *J Endocrinol Invest* 2006;29(3):270–280. DOI: 10.1007/BF03345554
9. Daghestani MH, Daghestani M, Daghistani M, et al. A study of ghrelin and leptin levels and their relationship to metabolic profiles in obese and lean Saudi women with polycystic ovary syndrome (PCOS). *Lipids Health Dis* 2018;17(1):195. DOI: 10.1186/s12944-018-0839-9
10. Sam S, Legro RS, Essah PA, et al. Evidence for metabolic and reproductive phenotypes in mothers of women with polycystic ovary syndrome. *Proc Natl Acad Sci USA* 2006;103(18):7030–7035. DOI: 10.1073/pnas.0602025103
11. Gupta N, Radhakrishnan G, Madhu SV, et al. Comparison of metabolic and endocrinal parameters in obese and nonobese women of polycystic ovarian syndrome with normal controls. *Fertil Sci Res* 2015;2(1):19. DOI: 10.4103/2394-4285.180491
12. Leibel NI, Baumann EE, Kocherginsky M, et al. Relationship of adolescent polycystic ovary syndrome to parental metabolic syndrome. *J Clin Endocrinol Metab* 2006;91(4):1275–1283. DOI: 10.1210/jc.2005-1707