Original Article

# Clinical Profiling of Polycystic Ovary Syndrome Patients in Kashmir Population

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## Abstract

**Background:** Polycystic ovary syndrome (PCOS) is a major endocrinopathy that affects women during their child-bearing age. PCOS women exhibit excess androgens, irregular or no ovulation, and polycystic ovaries. **Objective:** The aim of this study was to evaluate the demographic, anthropometric, physical, reproductive, metabolic, endocrine parameters, and ovarian volume (OV) of PCOS women. **Materials and Methods:** This study was case control including the clinically diagnosed PCOS women (100) and healthy women (100) as controls. Both groups were assessed for the demographic features such as age, anthropometric parameters such as height and weight, physical parameters such as body mass index (BMI), waist-Hip ratio, reproductive parameters such as menarche, and hirsutism (Ferriman Gallwey Score, acne, and alopecia), and the biochemical parameters including blood sugar fasting (BSF), hormone profile (luteinizing hormone [LH], follicle-stimulating hormone [FSH], testosterone, and prolactin), lipid profile (cholesterol, triglycerides, high-density lipoprotein [HDL], low-density lipoprotein [LDL], and very LDL [VLDL]), thyroid-stimulating hormone (TSH) using prestructured questionnaire. The OV was observed by ultrasonography. **Results:** We observed significantly higher body weight, BMI, waist/hip ratio, reproductive cycle duration, prevalence of hirsutism, LH, FSH, testosterone, prolactin, triglycerides, HDL, LDL levels, and OV in patients compared to controls. However, the average number of cycles per year and VLDL levels were significantly lower in the patient. No significant difference was found in BSF and TSH levels between the patient and control groups. **Conclusion:** The proper evaluation of the demographic, anthropometric, physical, reproductive, metabolic, endocrine parameters, and OV may help in the accurate diagnosis of PCOS that will benefit the affected women with timely therapy commencement.

**Keywords:** Body mass index, endocrinopathy, hirsutism, hyperandrogenism, polycystic ovary syndrome, ultrasonography

## Introduction

Polycystic ovary syndrome (PCOS) is a widespread premenopausal hereditary disease of reproductive women with endocrinopathy and metabolic disorders.[1-4] The characteristic features of PCOS include excess androgens, hirsutism, irregular menses, polycystic ovaries, and follicular failure making the women unproductive.[5,6] PCOS is heterogeneous disorder, lacking the knowledge of definite mechanism of pathogenesis. The Rotterdam diagnostic criteria for defining PCOS include excess androgens, irregular or no ovulation, and polycystic ovaries.[7] However, in the absence of auxiliary specific diagnostic criteria, PCOS is determined by hyperandrogenism and follicular failure.[8] In spite of contentious viewpoints on current criteria for PCOS diagnosis, a professional opinion based on blood testing, an ultrasound, and pelvic examination can corroborate the diagnosis.[9,10]

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DOI: 10.4103/mtsp.mtsp_4_22

Blood testing in PCOS mainly estimates hormonal levels and determines endocrinal activity; however, for precise diagnosis, there is still a need of PCOS specific and sensitive clinical biomarkers.[11] Investigating biomarkers may help in early diagnosis, clinical and molecular subtyping of the disorder as well as provide insights on the molecular mechanistic involved in the disorder and comorbidities, especially diabetes and cancer.[12] PCOS exhibits cross-specialty challenges that affect the patient health.[13] PCOS occurs in 5%–20% of

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**How to cite this article:** Ashraf A, Singh R, Mir S. Clinical profiling of polycystic ovary syndrome patients in Kashmir population. Matrix Sci Pharma 2022;6:23-33.

**Received:** 07-Mar-2022 **Accepted:** 08-Mar-2022 **Available Online:** 18-Jul-2022

reproductive age women globally.[14] The comorbidities that may be developed in PCOS women include insulin resistance, adiposity, cardiometabolic problems, diabetes mellitus, and cancer.[15,16] Insulin resistance, obesity, and hyperandrogenemia may affect the receptivity of PCOS endometrium, explaining the poor implantation of embryo and clinical pregnancy outcome.[17] In addition, PCOS demonstrates dysfunction in adipose tissue,[18,19] increase in the levels of serum inflammatory biomarkers, and alterations in endometrium.[20-22]

PCOS-affected tissues have been shown carrying altered levels of micro-RNAs and long noncoding RNAs.[23-26] PCOS phenotypic expression could occur due to the changes in histone acetylation and specifically the DNA methylation.[27-29] The risk of PCOS is associated with many susceptible genes that regulate the production and action of androgens and insulin as well as the activity of gonads.[30] These genes, however, could not alone explain the PCOS phenotype. The phenotypic expression seems to involve modified epigenetics of one or more risk genes through their interaction with environmental factors during the prenatal stage, altering the maternal endometabolic functions that continue in postnatal to stage to reproductive age, increasing the genetic propensity to PCOS phenotype.[31-35] The pathogenesis of PCOS has been correlated with the serum concentration of certain trace elements. Higher levels of Fe, Cu, Cr, and Co and lower levels of Mg and Se have been reported in the serum of PCOS women.[36] The changes in the concentration of Cu and Mg augment the secretion from β cells of the pancreas, leading to insulin resistance,[37,38] and the PCOS women with insulin resistance in their skeletal musculature are highly susceptible to develop Type 2 diabetes. On the other hand, aberrant levels of Se, Fe, and Zn impede follicular development, causing their atresia and resulting in infertility.[39] Most recently, PCOS has been correlated with decreased levels of adropin in peripheral blood abnormal follicular angiogenesis associated with dysregulation in angiogenesis-linked genes involvement of Prevotella_9 (gut bacteria) and estrone sulfate (metabolite).[40-42] This disorder also exhibits increased levels of interleukin-6 (IL-6), IL-18, TNFα, monocytes chemotactic protein-1, and C-reactive protein and decreased IL-10 levels.[43-47] Infertility increases 15 times in PCOS women, and pregnancy is commonly obtained through fertility therapies.[48] PCOS has life-long impacts on the health and well-being of women.

PCOS phenotype changes over time, necessitating the tailored diagnosis and therapeutic strategy.[49] Different PCOS phenotypes resulting from the combinations of different features can be treated through different treatment interventions. The metabolic phenotype treated with improved dietary habits, exercise, weight management, and medicines such as statins, insulin sensitizers, and liraglutide.[50] While treatments of reproductive phenotype include weight management, laparoscopic ovarian drilling and use of drugs such as gonadotropins, oral contraceptives, clomiphene citrate, and letrozole. Similarly, the therapeutic interventions for hyperanderogenism include cosmetic procedures, oral contraceptives, eflornithine hydrochloride, gonadotropin-releasing hormone agonists, and antiandrogens.

Dietary habits appear to have an important role in the prevention and treatment of PCOS.[51,52] Based on global practices, weight management can be adopted as a key therapeutic strategy for PCOS, because the clinical signs of the disorder are worsened with obesity.[53] Dietary therapies for PCOS patients that could improve metabolic activities, insulin resistance, and reproductive functions include intake of hypocaloric diets for weight management, restricted consumption of simple and refined carbohydrates, and consumption of diets with hypoglycemic index. Moreover, reducing saturated and transfats and paying attention to chromium, omega-3, and Vitamin D deficiencies. Furthermore, Mediterranean diet might be an effective nutritional intervention for PCOS owing to its anti-inflammatory properties and link to weight loss.[54] Barren women with PCOS when treated with Myoinositol exhibit improvement in metabolic, hormonal, and reproductive outcomes.[55] The study of different clinical parameters in PCOS patients may help in accurate diagnosis, phenotypic categorization, and application of personalized therapeutic regimens.

## Materials and Methods

### Study design

This study was case control, and the participants were equally distributed including 100 PCOS women and 100 normal women. The study was conducted at the outpatient department of Endocrinology, Government Medical College (GMC), Srinagar, India, after proper approval from Institutional Ethical Committee, GMC under ref. no. 142/ETH/GMC/ICM, 2019. PCOS patients were selected after proper diagnosis using Rotterdam criteria. (2004) Both groups were assessed for demographic features such as age, anthropometric parameters such as height and weight, physiological parameters such as body mass index (BMI), waist-hip ratio (W/H ratio), reproductive parameters such as menarche, and hirsutism (Ferriman Gallwey Score [FG score], acne, and alopecia) and the biochemical parameters including blood sugar fasting (BSF), hormone profile (luteinizing hormone [LH], follicle-stimulating hormone [FSH], testosterone, and prolactin), lipid profile (cholesterol, triglycerides, high-density lipoprotein [HDL], low-density lipoprotein [LDL], and very LDL [VLDL]), thyroid-stimulating hormone (TSH) using a prestructured questionnaire. The ovarian volume (OV) was observed by ultrasonography (USG) with expert assistance. Written consents were taken from all the participants.

### Patient inclusion criteria

The Kashmiri women clinically diagnosed for PCOS with age between 18 and 45 years, either bachelor or marital were included in the study.

### Patient exclusion criteria

The patients that were excluded from the study include non-Kashmiri patients, cancer patients, patients with other metabolic disorders such as thyroid, diabetes, etc., patients

with other hereditary diseases and those patients who showed reluctance to participation.

### Control inclusion criteria

Kashmiri healthy women aged between 18 and 45 years either bachelor or marital with no metabolic disorders were included in the control group.

### Control exclusion criteria

Non-Kashmiri women, pregnant women, women with any metabolic disorder or other health issue, familial history of PCOS, and the women who declined to participate were excluded from the control group.

## Results

In our study, the mean age of patients was 22.45 ± 3.53 years while that of controls was 25.89 ± 4.99 years. Both the groups were evaluated for different parameters.

### Height, weight and body mass index

The patients and controls were evaluated and compared for height, weight, and BMI. The average height (157.9 ± 6.12) of patient group was not significantly different from the average height (156.2 ± 6.07) of control group. On the other hand, the average body weight exhibited a statistically significant difference ($P = 0.0001$) between patient group (61.86 ± 10.27) and control group (57.12 ± 6.15). Similarly, there was a statistically significant difference ($P = 0.0012$) observed between the BMI of patient group (24.77 ± 3.84) and that of control group (23.4 ± 1.62) [Table 1 and Figure 1]. The BMI distribution demonstrated the nearly similar percentage of patients (36%) and controls (35%) in 18.5–22.9 BMI range while the percentage of patients (19%) were lower compared to controls (43%) in 23–24.9 BMI range. However, the majority of patients (45%) and less number of controls (22%) had BMI frequency ≥25 [Table 2 and Figure 2]. The statistical difference in body weight and BMI between the patients and controls suggests their association with PCOS.

### Waist, hip, and waist/hip ratio

Waist size exhibited no significant difference between the patient group (87.23 ± 9.22) and the control group (87 ± 6.02). However, we observed higher hip size in the control group (100.8 ± 6.2) compared to the patient group (94.45 ± 8.39) with highly significant difference ($P = 0.0001$) between the two groups. We also found higher waist/hip ratio in the patient group (0.91 ± 0.053) as compared to the control group (0.85 ± 0.041). The two study groups demonstrated highly significant difference ($P = 0.0001$) in their waist/hip ratio [Table 3 and Figure 3], suggesting the waist/hip ratio as a physical marker for PCOS diagnosis.

### Characteristics of menarche

The average age of menarche was same for the patients (13.3 ± 1.47) and the controls (13.41 ± 1.32).

**Table 1: Comparison of height, weight, and body mass index between test and control groups**

| Parameter | Mean±SD | | *P* |
|---|---|---|---|
| | Test | Control | |
| Height | 157.9±6.12 | 156.2±6.07 | 0.0507 |
| Weight | 61.86±10.27 | 57.12±6.15 | <0.0001* |
| BMI | 24.77±3.84 | 23.4±1.62 | 0.0012* |

BMI: Body mass index, SD: Standard deviation, *Significant

**Table 2: Distribution of body mass index among test and control groups**

| BMI | Test, *n* (%) | Control, *n* (%) | *P* |
|---|---|---|---|
| 18.5-22.9 | 36.00 (36.00) | 35.00 (35.00) | 0.0012* |
| 23-24.9 | 19.00 (19.00) | 43.00 (43.00) | |
| ≥25 | 45.00 (45.00) | 22.00 (22.00) | |
| Total | 100 (100.00) | 100 (100.00) | |
| Mean±SD | 24.77±3.84 | 23.4±1.62 | |

BMI: Body mass index, SD: Standard deviation, *Significant

**Table 3: Comparison of waist, hip, and w/h ratio between test and control groups**

| Parameter | Mean±SD | | *P* |
|---|---|---|---|
| | Test | Control | |
| Waist | 87.23±9.22 | 87±6.02 | 0.8384 |
| Hip | 94.45±8.39 | 100.8±6.2 | <0.0001* |
| W/H ratio | 0.91±0.053 | 0.85±0.041 | <0.0001* |

SD: Standard deviation, *Significant

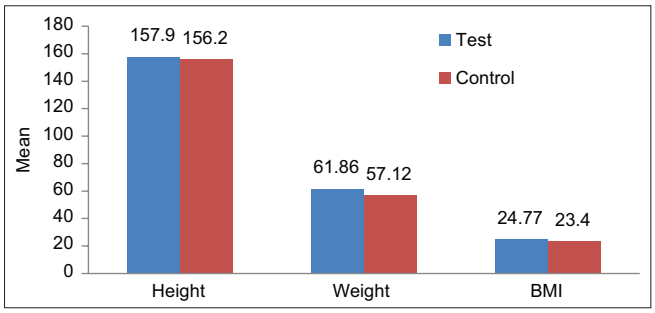


**Figure 1:** Showing comparison of height, weight and body mass index between test and control group

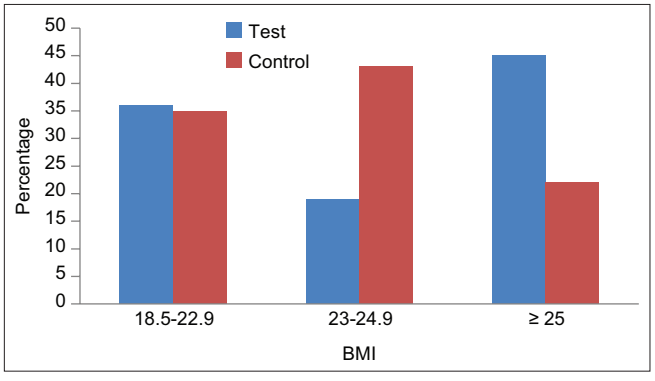


**Figure 2:** Distribution of body mass index among test and control groups

The mean duration of reproductive cycles was higher in the patient group (4.78 ± 1.8) compared to the control group (3.74 ± 0.06) with significant difference ($P = 0.0001$). However, the average number of cycles per year observed was less in the patient group (7.76 ± 2.25) compared to the control group (10.26 ± 0.97). The difference in the number of cycles per year between the two groups was highly significant ($P = 0.0001$) [Table 4 and Figure 4].

## Hirsutism

The hirsutism status was assessed on the basis of FG score, acne, and alopecia.

### *Ferriman gallwey score*

On the basis of FG score majority of controls (93%) were exclusive of hirsutism and only 7% controls exhibited mild hirsutism. However, no moderate to very severe case was found in control group. On the other hand, PCOS patients were categorized into different categories ranging from normal to very severe depending on the severity of hirsutism. Among the PCOS patients 9% were exclusive of hirsutism, 20% had mild, 37% were moderate, and 24% and 10% patients exhibited severe and very severe hirsutism respectively [Table 5 and Figure 5]. A highly significant difference ($P = 0.0001$) was observed in FG score between the patient and control groups with higher prevalence of hirsutism in patient group, suggesting association between hirsutism and PCOS.

### *Acne*

The majority of healthy controls (88%) were exclusive of acne. However, mild and moderate acne were observed in 8% and 4% controls respectively. No severe case was reported in from controls. In case of patient group most of the patients (30%) were mildly affected by acne followed by moderate (27%), and severe (25%) categories. However, least of the patients (18%) were exclusive of acne [Table 6 and Figure 6]. The status of acne exhibited a highly significant difference ($P = 0.0001$) between the patient and control groups with higher prevalence frequency in patients, signifying the correlation between acne and PCOS.

### *Alopecia*

The alopecia affected both patient and control groups with varying severity ranging from mild to moderate. However, 20% and 43% cases were exclusive of alopecia in patient and control groups respectively. Majority of controls (53%) were mildly affected and least proportion (4%) had moderate alopecia. On the other hand, most PCOS patients had moderate

**Table 4: Comparison of reproductive characteristics between test and control group**

| Parameter | Mean±SD | | *P* |
|---|---|---|---|
| | Test | Control | |
| Age of menarche (years) | 13.3±1.47 | 13.41±1.32 | 0.5797 |
| Duration of cycle | 4.78±1.8 | 3.74±0.06 | <0.0001* |
| Number of cycles/year | 7.76±2.25 | 10.26±0.97 | <0.0001* |

SD: Standard deviation, *Significant

**Table 5: Status of hirsutism with respect to FG score among test and control group**

| Status | Test, *n* (%) | Control, *n* (%) | *P* |
|---|---|---|---|
| Normal | 9 (9) | 93 (93) | <0.0001* |
| Mild | 20 (20) | 7 (7) | |
| Moderate | 37 (37) | 0 | |
| Severe | 24 (24) | 0 | |
| Very severe | 10 (10) | 0 | |
| Total | 100 (100) | 100 (100) | |

*Significant

**Table 6: Status of hirsutism with respect to acne among test and control group**

| Status | Test, *n* (%) | Control, *n* (%) | *P* |
|---|---|---|---|
| Normal | 18 (18) | 88 (88) | <0.0001* |
| Mild | 30 (30) | 8 (8) | |
| Moderate | 27 (27) | 4 (4) | |
| Severe | 25 (25) | 0 | |
| Total | 100 (100) | 100 (100) | |

*Significant

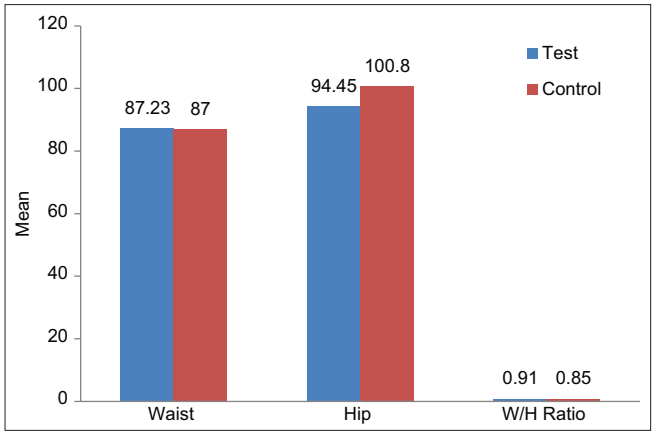


**Figure 3:** Showing comparison of waist, hip and ratio between test and control groups

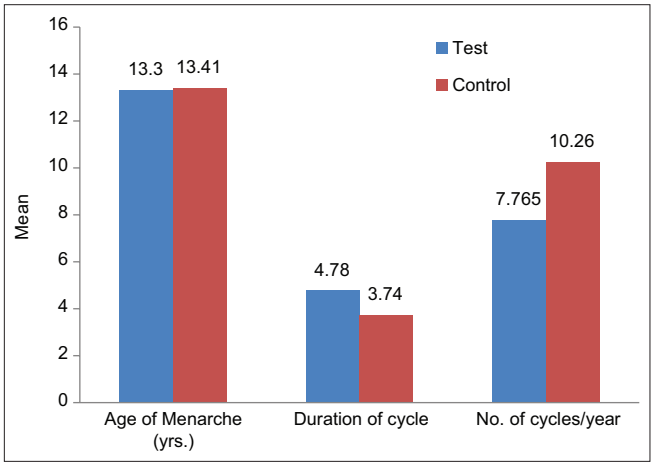


**Figure 4:** Showing comparison of reproductive characteristics between test and control group

alopecia (43%) while 37% exhibited mild alopecia. However, none of the patients and controls demonstrated severe alopecia [Table 7 and Figure 7]. The difference in alopecia prevalence frequency between the patient and control group was highly significant ($P$ = 0.0001) with higher moderate frequency in patients than controls, suggestive of association of alopecia with PCOS.

## Biochemical and hormonal parameters

The patient and control groups were evaluated for different biochemical parameters including BSF, and lipid profile (Cholesterol, Triglycerides, HDL, LDL, and VLDL), and hormonal profile (LH, FSH, Testosterone, Prolactin, and TSH).

The levels of BSF exhibited no significant difference between the patient (91.37 ± 8.1) and control (90.55 ± 4.87). Triglycerides, HDL, and LDL levels were higher in patient group compared to control group with highly significant difference between the two groups ($P$ < 0.01). However, VLDL levels were low (8.21 ± 1.14) in patient group compared to control group (23.29 ± 4.53). The difference in VLDL levels between the two groups were highly significant ($P$ = 0.0001) [Table 8 and Figure 8]. Similarly, the levels of LH, FSH, Testosterone, and Prolactin were higher in patient group compared to control group. The hormone profile exhibited highly significant difference ($P$ < 0.01) between the two groups. However, no significant difference was reported in TSH levels between the patient and control groups [Figure 9]. The significant difference in hormone and lipid profile between the patient and control groups depicts a close association of these parameters with PCOS.

## Ultrasonography

The USG images depicted higher mean right OV (ROV) (cc) in the patient group (11.96 ± 2.99) compared to the control group (6.85 ± 1.45). ROV exhibited highly significant

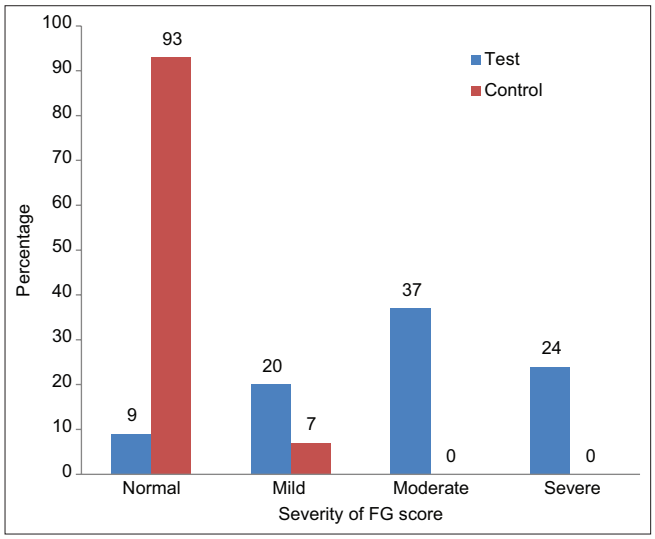


**Figure 5:** Showing status of hirsutism with respect to Ferriman Gallwey Score among test and control groups

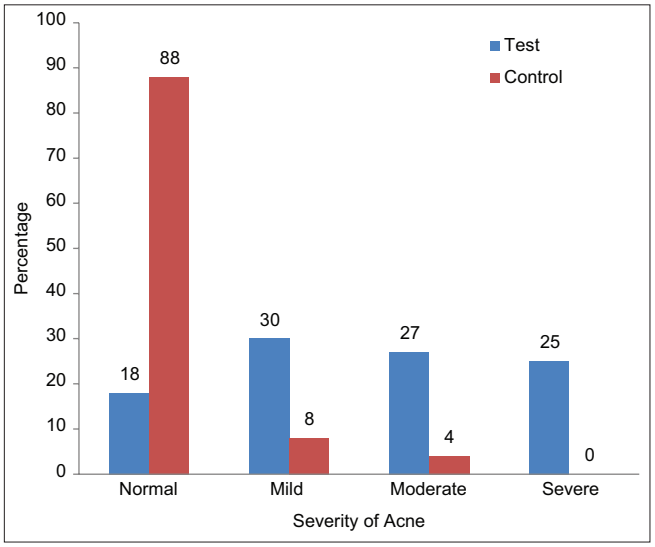


**Figure 6:** Showing status of hirsutism with respect to acne among test and control groups

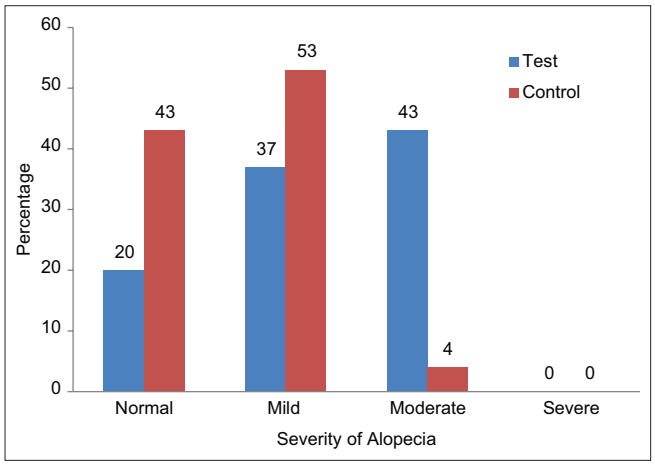


**Figure 7:** Showing status of hirsutism with respect to alopecia among test and control groups

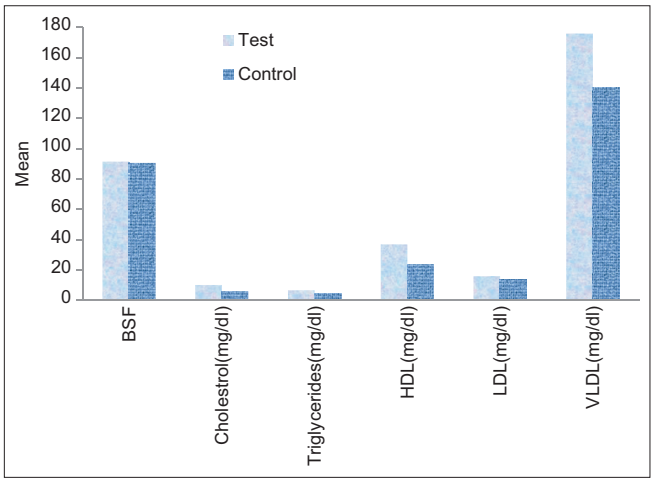


**Figure 8:** Showing comparison of biochemical between test and control groups

difference ($P$ = 0.0001) between the two groups. Similarly, we observed higher mean left ovarian volume (LOV) (cc) in the patient group (11.02 ± 3.13) compared to the control group (6.98 ± 1.38). LOV also exhibited highly significant difference ($P$ = 0.0001) between the two groups [Table 9 and Figure 10]. The statistically highly significant difference in ROV and LOV between the patient and control groups depicts strong correlation between abnormal OV and PCOS.

**Table 7: Status of hirsutism with respect to alopecia among test and control group**

| Status | Test, *n* (%) | Control, *n* (%) | *P* |
|---|---|---|---|
| Normal | 20 (20) | 43 (43) | <0.0001* |
| Mild | 37 (37) | 53 (53) | |
| Moderate | 43 (43) | 4 (4) | |
| Severe | 0 | 0 | |
| Total | 100 (100) | 100 (100) | |

*Significant

**Table 8: Comparison of biochemical and hormonal profile between test and control group**

| Parameter | Mean±SD | | *P* |
|---|---|---|---|
| | Test | Control | |
| BSF | 91.37±8.1 | 90.55±4.87 | 0.39 |
| LH (µIU/ml) | 10.16±5.13 | 6.10±1.63 | <0.0001* |
| FSH (µIU/ml) | 6.7±3.26 | 4.52±1.33 | <0.0001* |
| Testosterone (ng/dl) | 36.91±32.65 | 23.91±6.75 | <0.0001* |
| Prolactin (ng/dl) | 15.95±6.39 | 13.99±3.3 | 0.0071* |
| Cholesterol (mg/dl) | 175.8±42.38 | 140±20.34 | <0.0001* |
| Triglycerides (mg/dl) | 134.7±33.4 | 116.5±22.67 | <0.0001* |
| HDL (mg/dl) | 46.97±10.95 | 41.07±5.74 | <0.0001* |
| LDL (mg/dl) | 97.52±23.44 | 90.48±10.16 | 0.0064* |
| TSH (µIU/ml) | 2.76±1.08 | 2.75±1.05 | 0.9521 |

SD: Standard deviation, FSH: Follicle-stimulating hormone, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TSH: Thyroid-stimulating hormone, BSF: Blood sugar fasting, LH: Luteinizing hormone, *Significant

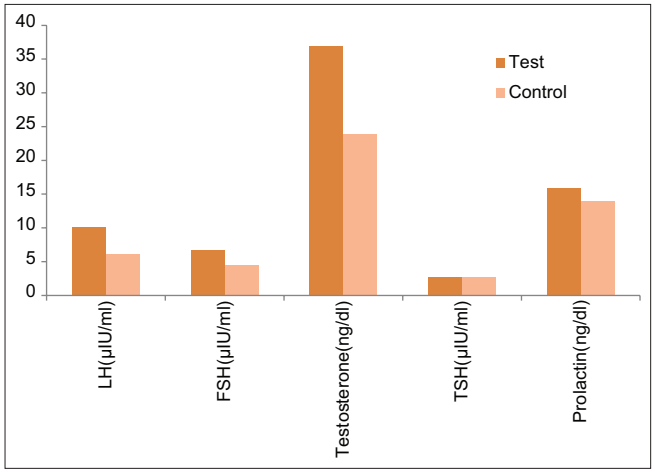


**Figure 9:** Showing comparison of hormonal profile between test and control group

## Discussion

The mean age of patients in our study was 22.45 ± 3.53 years while that of controls was 25.89 ± 4.99 years. However, in a study the mean age of PCOS patients was 28.71 ± 5.237 years.[56] Another study reported the mean age of 31 ± 5 years in PCOS patients.[57] However, the patient mean age in our study coincide with the study.[58] In the present study the mean BMI of PCOS patients was 24.77 ± 3.84 and the women with BMI ≥25 kg/m$^2$ were considered obese. Usmani, 2014 reported mean BMI >25 kg/m$^2$ in all the PCOS patients included in their study.[59] Similarly another study reported the mean BMI of 28.45 ± 4.178 in PCOS patients. Also reported the mean BMI of 28.9 ± 5.3 in PCOS patients. However, in our study 45% PCOS patients and 22% controls were obese (BMI ≥25 kg/m$^2$). Our findings were coinciding with the results of research who reported obesity or overweight in 40%–70% PCOS patients.[60] BMI ≥25 kg/m$^2$ in 76% of PCOS patients. We observed significant difference in the body weight and the BMI between the patient and control groups. Obese or overweight women exhibit fourfold PCOS incidence than normal weight women.[61] Obesity has been found linked with PCOS and poor pregnancy outcome.[62-64] One among three PCOS Chinese women have BMI >23 kg/m$^2$.[65] In PCOS patients the endo-metabolic disorders exacerbate with truncal/abdominal adiposity.[66,67] In our study the mean waist circumference (cm), hip circumference (cm) and the W/H Ratio of PCOS patients were 87.23 ± 9.22, 94.45 ± 8.39, and 0.91 ± 0.053. However, in a previous study the mean waist circumference (cm), hip circumference (cm) and the W/H Ratio of PCOS patients reported were 92.05 ± 12.831, 109.11 ± 10.044 and 0.84 ± 0.0517. In another study the mean abdominal circumference (AC) (cm) of PCOS was found 96.0 ± 13.5 (Sales *et al*., 2015). Our study demonstrated highly significant difference ($P$ = 0.0001) in the Waist/Hip ratio between the patient and control groups suggesting the Waist/

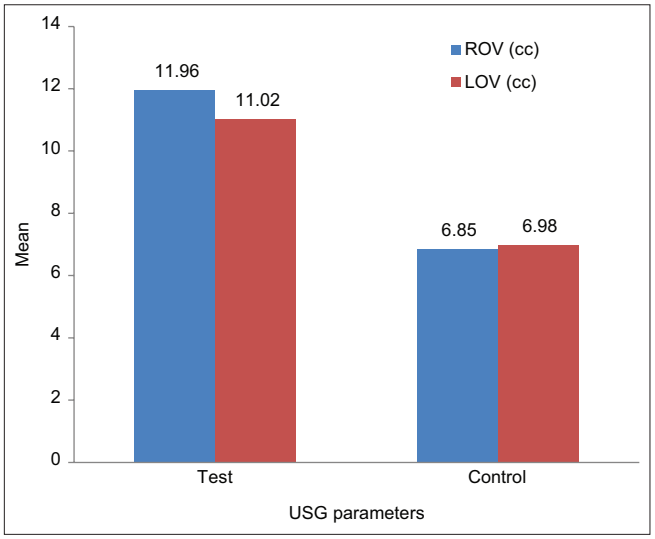


**Figure 10:** Showing the comparison of ultrasonography parameters between test and control groups

**Table 9: Comparison of ultrasonography parameters between test and control groups**

| Parameter | Mean±SD | | *P* |
|---|---|---|---|
| | Test | Control | |
| ROV (cc) | 11.96±2.99 | 6.85±1.45 | <0.0001* |
| LOV (cc) | 11.02±3.13 | 6.98±1.38 | <0.0001* |

SD: Standard deviation, ROV: Right ovarian volume, LOV: Left ovarian volume, *Significant

Hip ratio as one of the physical markers for PCOS diagnosis. It has been reported that obesity increases the risk of PCOS.[68]

Our findings reported significantly higher ($P = 0.0001$) mean duration of reproductive cycles in the patient group (4.78 ± 1.8) compared to the control group (3.74 ± 0.06). However, the average number of cycles per year observed was less in the patient group (7.76 ± 2.25) compared to the control group (10.26 ± 0.97). Similarly the difference in the number of cycles per year between the two groups was highly significant ($P = 0.0001$). Our findings reported cyclic pattern irregularity with oligomenorrhea in majority (57.14%) of PCOS patients. Infertility in 70% PCOS patients due to anovulation.[69] Our study on the basis of FG score observed mild to very severe hirsutism in majority (91%) of PCOS patients compared to mild hirsutism in 7% healthy controls. On the basis of acne we also reported mild to severe hirsutism in 82% PCOS patients compared to mild to moderate hirsutism in 12% normal controls. Similarly this study found mild to moderate hirsutism in 80% patients and 57% controls with respect to alopecia. Our results were in harmony who reported hirsutism in 85% PCOS patients. In our study FG score, acne and alopecia demonstrated highly significant difference ($P = 0.0001$) between the patient and control groups with higher prevalence in patient group, suggesting association between hirsutism and PCOS. FG score of 11 ± 7 in PCOS patients. Hirsutism assessed with FG score has been positively correlated with body weight, BMI, waist circumference, hip circumference and the W/H Ratio in PCOS women. Recent finding also positively correlated FG score with BMI and AC indicating the association of obesity and abdominal adiposity with high degree of hirsutism in PCOS patients.

In the present study the mean level of BSF observed in PCOS patients was 91.37 ± 8.1. However, in few previous studies the mean BSF level reported is 87 ± 9.7 and 99.31 ± 8.823. The levels of BSF exhibited no significant difference between the patient and control in our study. However, the difference in BSF levels was nonsignificant between PCOS patients and healthy controls while the levels of glucose were higher in PCOS patients than healthy controls (Rashidi *et al*., 2018). In our study levels of Cholesterol (175.8 ± 42.38), Triglycerides (134.7 ± 33.4), HDL (46.97 ± 10.95), and LDL (97.52 ± 23.44) levels were higher in patient group compared to control group with highly significant difference between the two groups ($P < 0.01$). A previous study reported different levels of Triglycerides (162.97 ± 52.88), and LDL (111.74 ± 24.63) levels but Cholesterol (178.46 ± 32.07), and HDL (42.74 ± 2.019) levels were comparable to our study. Higher levels of triglycerides and total cholesterol were reported in PCOS women as compared to healthy controls.[70] HDL and LDL levels demonstrated no significant difference between PCOS and control groups. The results of another previous study were different for cholesterol (189.7 ± 31.8) and LDL (116.6 ± 30.09) levels but the HDL levels (46.7 ± 13.1) coincide with our study. We also observed lower VLDL (8.21 ± 1.14) levels in patient group compared to control group (23.29 ± 4.53). The difference in VLDL levels between the two groups were highly significant ($P = 0.0001$). However, our findings contradict with the previous study which reported higher VLDL levels (36.61 ± 18.70) in PCOS patients compared to normal range. Higher levels of Triglycerides, LDL, and cholesterol in PCOS patients that may lead to cardiovascular disorders.[71] Similarly, we found higher levels of LH (10.16 ± 5.13), FSH (6.7 ± 3.26), Testosterone (36.91 ± 32.65), and Prolactin (15.95 ± 6.39) in patient group compared to control group. The hormone profile exhibited highly significant difference ($P < 0.01$) between the two groups. The results of a previous study were similar for LH (10.81 ± 2.805) and comparable for Prolactin (17.99 ± 9.276) levels to our findings, however different for FSH (3.974 ± 1.248) and Testosterone (78.57 ± 18.27) levels. However, no significant difference was reported in TSH levels between the patient (2.76 ± 1.08) and control (2.75 ± 1.05) groups. However, the previous study reported lower mean TSH level (1.898 ± 0.9675) compared to our study. No significant difference in FSH and Prolactin while significant difference in LH and Testosterone between PCOS patients and control group. Lipid profile (Triglycerides, Cholesterol, HDL, and LDL) exhibited no significant difference between the PCOS and control group.[72] The significant difference in hormone and lipid profile between the patient and control groups depicts a close association of these parameters with PCOS. Drug-induced inhibition of hyperandrogenism improves the function of hypothalamic-pituitary-ovarian axis which reinstates folliculogenesis and prevents the development of ovarian cysts in PCOS rats depicts the association of excess androgens with PCOS development.[73]

In the present study trans-vaginal USG images depicted higher mean ROV (cc) (11.96 ± 2.99) and LOV (cc) (11.02 ± 3.13) in the patient group compared to the control group with highly significant difference ($P = 0.0001$) which suggests the strong correlation between abnormal OV and PCOS. Our findings were supported by the previous study which estimated OV by pelvic and abdominal scan in two groups, one with BMI = 25.6 ± 4.7 kg/m$^2$ and the other with BMI = 28.6 ± 5.7 kg/m$^2$. The transabdominal scan demonstrated the OV of 10.87 ± 2.49 cm$^3$ (BMI = 25.6 ± 4.7 kg/m$^2$) and 14.33 ± 3.17 (BMI = 28.6 ± 5.7 kg/m$^2$) while the OV estimated by ultrasound scan was 11.44 ± 2.36 cm$^3$ (BMI = 25.6 ± 4.7 kg/m$^2$) and 14.79 ± 2.19 cm$^3$ (BMI = 28.6 ± 5.7 kg/m$^2$). The increase in BMI, Anti-Mullerian hormone, and production of oocytes

results in decreased size of oocytes.[74] PCOS women are more likely to produce higher number of oocytes. Body weight of PCOS patients has been correlated with the size of oocyte.[75] The oocytes with considerably smaller size have been found in non-PCOS obese women compared to women with normal body weight.[76] A study on obese, diabetic, and insulin resistant mice demonstrated lower rate of ovulation and altered oocyte maturation.[77] PCOS patients with higher BMI exhibit an increased thickness of endometrium, OV, and uterine size while as decreased follicular size and count. Therefore, PCOS patients show altered reproductive, hormonal, and lipid profiles and other parameters. Early diagnosis of PCOS pathology may help to improve the physical and mental health of patients through the implication of proper therapies.

## Conclusion

PCOS women exhibit altered BMI, W/H Ratio, cyclic pattern, biochemical profile, and OV. Proper evaluation of the demographic, anthropometric, physical, reproductive, metabolic, endocrine parameters and OV may help in accurate diagnosis of PCOS that will benefit the affected women with timely therapy commencement. However, further large-scale studies may increase the understanding of PCOS pathology.

### Perseverance and limitations of the present study

Being multifactorial and a heterogenic one, this particular syndrome till now does not have a proper diagnosis and the diagnostic features are only symptom based, hence its always the point of interest to find out the accurate pathology and complete diagnosis which yet are not found completely. Their also have been certain clinical finding like some patients only have any one features of this syndrome which does not classify them PCOS as according to the Rotterdam diagnostic criteria of PCOS, but the symptom does exist, and henceforth it can be researched out if there are any further reasons for the pathophysiology of this disease or any genetic or epigenetic factors may be responsible even. Also in another part of this study, including the genetic and epigenetic study of PCOS patients are yet to be evaluated which can also lead to better conclusive factors of the disease. Thus, the on going as well as future studies and research on this particular syndrome can ahead be helpful in understanding the accurate diagnosis of PCOS.

Besides being a topic of great interest there occur certain limitations during this study. Due to the heterogeneity and incomplete diagnosis, the study analysis demanded a great time which timely wasn't sufficient to maintain over only in 2 years of time period. We evaluated all physical, clinical and biochemical parameters of PCOS patients but on the other hand, the hereditary characters seems somehow play a role, thus it may be linked to genetic and epigenetic factors as well, which are yet to be evaluated on the broader aspects. Also the patients not following the Rotterdam diagnostic criteria but still exhibiting any single criteria result in dropping the overall disease frequency and subject collection in our study. As the study was not supported by any funding agency, so every time it went difficult to manage the expenses. In the future, the disease yet is needed to be evaluated more on clinico-pathological details as well as the genetic and epigenetic factors in the Kashmir population as well as in world-wide population in understanding the exact causations and diagnosis of the disease.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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## Questionnaire

**Questionnaire for Polycystic Ovary Syndrome**

S. No……. Dated…….

**Personal Information:**

Name: ……. Age: …….

D/o, W/o: …….

Address: …….

**Physical Parameters:**

Height:……. Weight:……. BMI:…….

Waist:…… Hip:……. Waist/Hip Ratio….

**Clinical Parameters:**

Age of Menarche:…… Oligomenorrhea…… No. of cycles/year:…….

Hirsutism:

Ferriman-Gallway Score:…… Acne Grade:…… Alopecia:……

Family History- …….

**Biochemical Parameters:**

Investigations: - BSF:…… Vitamin D……..

Hormone Profile: LH…….…… FSH……..…

Testosterone…….……. Prolactin……..…

TSH……

Lipid Profile: Cholesterol……. Triglycerides……

HDL…… LDL…… VLDL……

Ultra-Sonography Scan:……

Medication:……

- Metformin…….
- Aldactone + Metformin.…….
- Aldactone…….…….……
- OCP……
- PIOZ + Aldactone…….……
- PIOZ……