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# Evaluate The Burden of Cardiometabolic Disorders in Patients with Polycystic Ovary Syndrome

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**Abstract**

PCOS or Poly cystic ovarian syndrome is a condition in which numerous small rounded sacs filled with fluid grow on the ovaries in women of reproductive age. The manifestations of PCOS are Insulin resistance, Obesity, Hyperandrogenism, Hyper prolactinoma, Amenorrhea or Oligomenorrhea, Hirsutism, Acanthosis Nigricans, Infertility, Type 2 diabetes mellitus, Metabolic syndrome, Cardiovascular diseases.

A cross-sectional study was conducted among 120 females from Karachi aged 18–40 years, comprising 60 diagnosed cases of PCOS and 60 healthy controls. Anthropometric indices including body mass index (BMI), waist-to-hip ratio (WHR), and percent body fat were assessed along with blood pressure, fasting plasma glucose (FPG), lipid profile, and fasting plasma insulin levels. Insulin resistance was evaluated using the HOMA-IR model, and β-cell function and insulin sensitivity were assessed using HOMA2 calculator version 2.2.3. Pregnant and menopausal females were excluded from the study. The mean age of participants was 28.4 years, with no statistically significant difference between PCOS and control groups ($p = 0.061$). Anthropometric analysis revealed that BMI and percent body fat were significantly higher in PCOS patients ($p < 0.001$), whereas no significant difference was observed in waist-to-hip ratio ($p = 0.704$). Among hemodynamic parameters, diastolic blood pressure was significantly elevated in PCOS patients ($p < 0.001$), while systolic blood pressure showed no significant difference ($p = 0.168$). Biochemical parameters including cholesterol, triglycerides, fasting plasma glucose, and fasting plasma insulin were significantly higher in PCOS patients compared to controls ($p < 0.01$). HOMA-IR analysis indicated significantly increased insulin resistance in PCOS patients ($p < 0.001$). Additionally, percent β-cell function was significantly elevated ($p = 0.003$), whereas β-cell sensitivity was significantly reduced ($p < 0.001$) in the PCOS group.

It is concluded that obesity, type 2 diabetes, cardiovascular disease, insulin resistance and hypertension is prevailing in PCOS patient. The polycystic ovary syndrome patients show symptoms like obesity, acne, Hirsutism, diabetes, menstrual irregularity, insulin resistance and sedentary life style. Polycystic ovary syndrome is very critical condition and its long-term consequences have devastating effects on life in this regard further research should be done to provide more awareness about this disease. The study was aimed to create awareness about polycystic ovary syndrome in our population and to educate people about the complications of polycystic ovary syndrome. The guideline developed from the study will help the proper diagnosis and treatment of PCOS in Pakistani population.

## INTRODUCTION

Polycystic ovary syndrome (PCOS) is a common endocrinopathy occurring in reproductive-age women. Hyperandrogenism, polycystic ovaries, chronic anovulation, and metabolic aberrations are the common features in PCOS. Hormonal changes are causing pathological symptoms in women with PCOS. The various hormone alterations in PCOS have been demonstrated. Hormones, such as insulin, growth hormones (GH), ghrelin, LEAP-2, gonadotropin-releasing hormone (GnRH), insulin, the luteinizing hormone/follicle-stimulating hormone (LH/FSH) ratio, androgens, and estrogens, are all abnormal in PCOS women. These hormones are related to metabolic disorders, such as diabetes and insulin resistance, overweight and obesity, infertility, and disturbed menstrual cycle in PCOS patients. The pathological changes of these hormones, such as increased insulin, reduced GH, increased ghrelin, and leptin resistance, result in an increased prevalence of diabetes and obesity in PCOS women. A reduced GH, increased LEAP-2 levels, high LH basal, increased LH/FSH ratio, high androgens, and low estrogen are demonstrated in PCOS and linked to infertility. This narrative review aims to clarify the changes of hormone profiles, such as insulin, GH, LH, FSH, androgens, estrogen, progesterone, ghrelin, LEAP-2, asprosin, and subfatin, in PCOS, which may reveal novel targets for better diagnosis and treatment of PCOS. (Yang & Chen, 2024)

The two American gynecologists Irving F. Stein, Sr. and Michael L. Leventhal first time describe the term PCOS or poly cystic ovary syndrome in 1935 this disease also called as Stein-Leventhal syndrome (Lucidi.R.S,. 2011). The consequences of this syndrome are an ovulation, Hirsutism, oily skin which leads to acne, and infertility (Siraj A et.all.,2009). PCOS is a very ancient disorder in Italy a patient's description with the disease of PCO was first published in 1721 and in the year 1844 changes in the ovaries which is related to cyst development were described (Kovacs, G et.all.2007). The connection between PCOS and hyperinsulinemia and impaired glucose tolerance were detected in the early years of 1980 and the link of insulin post receptor defect in the patient with PCOS was recognized in the year 1990 (MARILYN R. RICHARDSON, 2003)

The recent diagnostic criteria followed are Rotterdam criteria (2003). According to this criterion a woman has two of the following three symptoms may be diagnosed with PCOS, Absence of ovulation, High level of androgen, Cyst on one or both ovaries. (Shriver E.K,. 2008)

Metabolic syndrome, insulin resistance, dyslipidemia, and hyperandrogenism are risk factors for polycystic ovarian syndrome (PCOS), making early identification essential for initiating effective cardioprotective treatments. This research highlights the need for PCOS women to understand their cardiovascular risks and treatment options. Additionally, it emphasizes that carotid intima-media thickness (CIMT), measures the early atherosclerosis risk in women over 40. Many individuals expose themselves to cardiovascular disease risk due to obesity, dyslipidemia, insulin resistance, or diabetes. PCOS and elevated testosterone levels are indicators of systemic cardiovascular disease, suggesting that PCOS poses a greater cardiovascular risk than previously thought.

Different PCOS phenotypes carry varying degrees of risk, indicating that current approaches may be too broad. Women with PCOS are at higher risk for cardiovascular complications, including preeclampsia and eclampsia, particularly after hospital births. To reduce cardiovascular risk, it is vital to enhance awareness of PCOS, develop evidence-based guidelines, and provide thorough treatment for affected women. (Asif et al., 2024)

## METHODOLOGY

This study was carried out during March 2024 to October 2024. It includes 120 subjects of 60 PCOS patients and 60 controls, 18-40 years of age from University of Karachi. Mostly Patients are taken from Australian Concept Medical Center with diagnosed PCOS.

**INCLUSION AND EXCLUSION CRITERIA**

| **INCLUSION CRITERIA** | **EXCLUSION CRITERIA** |
|---|---|
| **FOR CONTROL** | **FOR CONTROL** |
| Women at reproductive age (18-40) years | Pregnant women |
| Women with regular menstrual cycle | Post-menopausal women |
| Women with normal BMI (18.5-22.9) kg/m2 | Women who's BMI less than 16.5 kg/m2 |
| Women without PCOS | Women age greater than 40 years and below 18 years |
| No hormonal or insulin sensitizing medication for at least 3 months have taken | |
| **FOR PATIENTS** | **FOR PATIENTS** |
| Women with PCOS | Women with other gynecological problem |
| Women who are suffering from menstrual irregularities, obesity, CVD, diabetes, acne and Hirsutism problem | Diseases causing similar disorder must be excluded e.g. Cushing syndrome, thyroid disease, congenital adrenal hyperplasia etc. |
| Presence of cyst on ovaries | |

**Study Design:** Cross-sectional Study

**Sample Size Calculation:** The Sample Size Was Calculated for the Study by using total number of subjects at the age of 18 to 40 years in the city (2,14000), we keep the 95% confidence level. WHO 2009 software was Use for sample size calculation.

**Population Interest:** The Study was carried out on human subject.

**Sampling Technique:** It was a convenient sampling Technique.

**Data Collection:** The data were collected from 120 participants (60 PCOS patients and 60 controls) belonging to different areas of Karachi (Clifton, Glulistan-e-Johar, and Gulshan-e-Iqbal). The data of PCOS patients were collected from Australian Concept Medical Center during the month of June and July 2024, the subject was asked about their personal profile than Anthropometric measurements (BMI, waist to hip Ratio and body fat percentage) and the vitals and the (Blood Pressure) were measured. The specimens were collected on Thursday at Australian Concept Medical Center to determine the blood tests including fasting plasma glucose, fasting plasma insulin, cholesterol, triglycerides, Followed by HOMA analysis to find out insulin resistance, Percent beta cell and beta cell sensitivity. Then the subjects were asked about her family's medical history. The similar procedure was followed in controls during the month of March to August 2024 and specimens were collected at university of Karachi, Gulistan-e-Jouhar, and Gulshan-e-Iqbal.

**Anthropometric Measurements:** Anthropometric measurements are non-invasive, quantitative measurement of human body including weight, height, circumferences and

skinfold thickness which is used to assess body size, shape and composition. During the study different measurements was taken in order to evaluate the nutritional and health status, helpful for monitoring health risks associated with body composition. Measurement of body mass index (BMI) and Waist to Hip Ratio (WHR) was recorded of each participant under standard guidelines.

**Blood Pressure Measurement:** There are two methods to measure blood pressure. In this study the indirect method to measure arterial blood pressure was adopted and that is auscultatory method. The two sounds are termed as systolic and diastolic which are the upper pressure and lower pressure respectively

**Blood Samples Collection**: Diagnostic approach for the subjects as recommended by WHO followed by ADA, was followed to screen the subjects including plasma glucose, cholesterol, triglyceride, plasma insulin level of selected control and patients was measure using ELISA technique. At the time of blood collection, all participants were asked to provide consent for blood tests for FPG, cholesterol, triglyceride, plasma insulin. All blood samples were collected in serum tubes. A total of 2.5ml of blood was taken from each patient and control. Within one hour of collection the blood was centrifuged and the serum was separated. The blood was centrifuged at 4000rmp and the serum was serrated and kept in the Eppendorf tube for the analysis FPG, cholesterol, triglyceride, plasma insulin. FPG was estimated by enzymatic method and fasting plasma insulin was determined by ELISA.

**Data Analysis:** Standardized statistical programs including test of significance, regression analysis of coefficient correction was applied to correlate various variables among different groups**.**

Data was stored and analyze using SPSS 22.0, Mean and standard deviation computed for all quantitative parameters, like age, BMI, W/H Ratio, Cholesterol, Triglyceride, FPG, Fasting Plasma insulin, Percent Beta Cell, Beta cell Sensitivity etc. for qualitative parameters, Count and percentage reported using frequency tables.

Pearson chi square test used to see the association between qualitative parameters, with PCOS and control, while independent sample t-test performed to compare the means of all quantitative parameters, of PCOS and control.

Spearman rank correlation used to see the correlations among parameters, then binary logistic regression analysis run on the data to estimates the odds of increasing FPG, Fasting plasma insulin, Cholesterol, TG, HOMA IR, Percent beta cell and Percent beta cell sensitivity in PCOS with respect to controls, univariate and multivariate analysis gives the estimated odds with 95% confidence intervals. All statistical tests were performed after testing the normality of data, at 5% level of significance. P-value less than 0.05 considered as the evidence of statistical significance.

## RESULTS

All of the subjects under study were between 18 to 40 years of age, with a mean age of 28.4 years. BMI was found to be 28.72±8.4 in overall population. The overall mean values of anthropometric, blood pressure, cholesterol, triglycerides, FPG, Fasting plasma insulin and HOMA analysis are given in the table # 03. As discussed in methodology, in our data there were two types of parameters the quantitative and qualitative. The qualitative parameters include sign and symptoms of PCOS, family history of diabetes, cardiovascular disease and daily habits. The quantitative parameters include, Anthropometric measurements (BMI, W/H ratio and percent body fats), Blood pressure (systolic and diastolic blood pressure), Blood tests (Cholesterol, Triglycerides, Fasting plasma glucose, Fasting plasma insulin) and HOMA analysis (HOMA IR, percent beta cells and percent sensitivity of the beta cell). The quantitative as well as qualitative parameters were compared between control and PCOS patients.

### Age and Anthropometric Indices

The mean age along with standard deviation in the overall data is shown in figure 1. The mean BMI was 28.72±8.4. More participants of our study show the BMI valued

30. The mean W/H ratio was 0.77±0.10. Maximum participants of our study show the W/H ratio of 0.80. The data of percent body fats shows the mean value of 34.5±11.0. Most of the participants were having 40 percent body fats.

**Blood pressure, Cholesterol, TG, FPG, FPI**

The mean value of systolic blood pressure in overall data is 75.3±8.4 and the mean value of diastolic blood pressure in overall data is 114.8±8.5. The mean value of cholesterol was found to be 163 mg/dl with standard deviation of 25.1. The minimum value 75 mg/dl was found in overall data for Cholesterol while maximum value found remains 160 mg/dl. The mean value of Triglycerides was found to be 97.4 with standard deviation of 32.6. The minimum value 40 mg/dl was found in overall data for TG while maximum value found remains 75 mg/dl. The mean value of FPG was found to be 99.6 with standard deviation of 15. The minimum value 75 mg/dl was found in overall data for FPG while maximum value found remains 100 mg/dl.

The average value of Fasting plasma insulin was found to be 15.5 with standard deviation of 8.9 (Figure#02). The minimum value 2 µU/ml was found in overall data for Fasting plasma insulin while maximum value found remains 40µU/ml.

**HOMA Analysis**

The mean value of HOMA IR was found to be 2.07 with standard deviation of 1.19. The minimum value of HOMA IR was 0.5 while maximum of HOMA IR was 5 in overall participants. The mean value of percent beta cell was found to be 124.8 with standard deviation of 53.2. The minimum value of percent beta cell was 30 while maximum of percent beta cell was 300 in overall participants (Figure#05). The average value of percent sensitivity of the beta was found to be 74.9 with the standard deviation of 55.2. The minimum value of percent sensitivity of beta was found to be 30 while maximum of percent sensitivity of the beta was found to be 250 in overall participants of our study. (Figure#04)

**Table 2: Mean Value Along with Standard Deviation of Anthropometric Indices, B.P, FPG, CHOL, TG, FPI, HOMA Analysis**

| PARAMETERS | MEAN | MEDIAN | STD.DEVIATION | MINIMUM | MAXIMUM |
|---|---|---|---|---|---|
| **AGE** | 28.40 | 28.0 | 5.3 | 18.0 | 40.0 |
| **BMI** | 28.72 | 27.45 | 8.4 | 14.5 | 55.5 |
| **WHR** | 0.77 | 0.78 | 0.10 | 0.00 | 0.95 |
| **Percent Body Fat** | 34.5 | 34.2 | 11.0 | 6.3 | 66.5 |
| **Systolic Blood Pressure** | 75.3 | 75.0 | 8.4 | 60 | 125 |
| **Diastolic Blood Pressure** | 114.8 | 120 | 8.5 | 90 | 130 |
| **CHOLESTEROL mg/dl** | 163 | 165 | 25.1 | 68.2 | 200 |
| **TRIGLYCERIDES mg/dl** | 97.4 | 81.8 | 32.6 | 32.6 | 153 |
| **FPG mg/dl** | 99.6 | 98 | 15 | 74 | 200 |
| **Fasting plasma insulin µU/ml** | 15.5 | 14.1 | 8.9 | 1.70 | 37.7 |
| **HOMA IR** | 2.07 | 1.97 | 1.19 | 0.43 | 5.21 |
| **PERCENT BETA CELL** | 124.8 | 119.5 | 53.2 | 15 | 290.5 |
| **BETA CELL SENSITIVITY** | 74.9 | 55 | 55.2 | 19.2 | 234 |

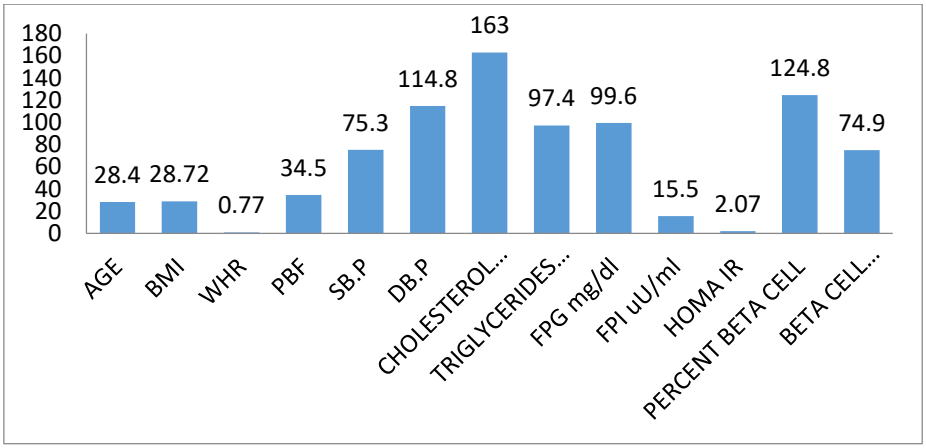


**Figure 1: Mean Value of Anthropometric Indices, B.P, FPG, CHOL, TG AND HOMA Analysis**

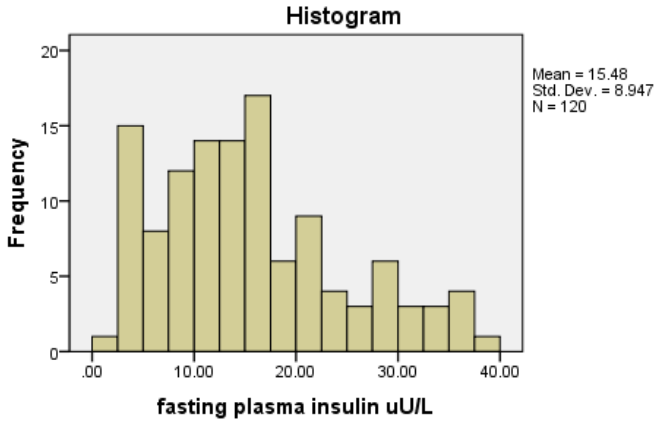


**Figure 2: Fasting Plasma Insulin**

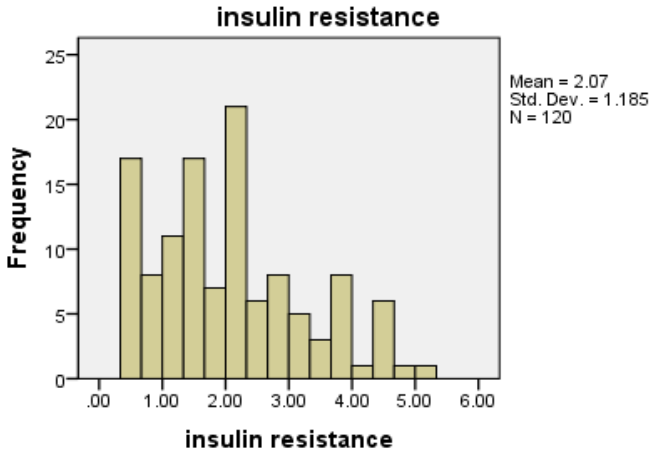


**Figure 3: Insulin Resistance**

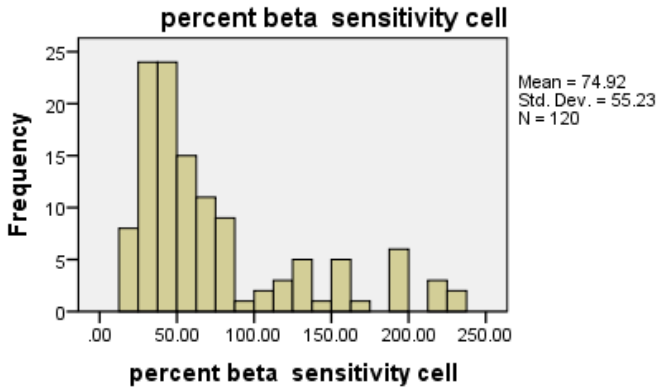


**Figure 4: Percent Beta Sensitivity**

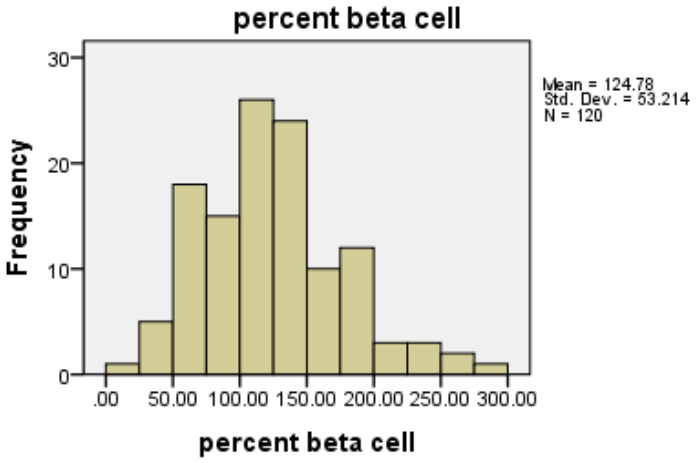


**Figure 5: Percent Beta Cell**

**COMPARISION OF PCOS SIGN AND SYMPTOMS BETWEEN CONTROL AND PATIENTS**

Using Pearson chi-square test of independence, the PCOS sign and symptoms such as obesity, acne, numbness, miscarriages shows a significant difference between the PCOS patients and control at P value 0.05. In PCOS patients 81% shows obesity and 3.8% show Hirsutism, 50.0% patients have acne problem, 22.5% patients show increase thirst, 25% with blurring of vision, 40.0% show numbness, and 8.8% has skin, bladder and gum infection and 7.5% patients are suffering from angina, 2.5% patients are smoker, 71.3% has regular menstrual cycles. 31.3% patients have family history of PCOS, 41.3% has family history of diabetes and 33.8% has family history of heart disease. The sign and symptoms were seen in PCOS patients while in control except for few these sign and symptoms were not observed. Comparison between control and patients is given in table#03

**Table# 03: PCOS Sign and Symptoms in Control and PCOS Patients**

| CHARATERISICS | YES | Group | | | | P value |
|---|---|---|---|---|---|---|
| | | Controls | | PCOS | | |
| | | n | % | n | % | |
| **Obesity** | YES | 4 | 10.0% | 55 | 81% | 0.00* |
| **Hirsutism** | YES | 2 | 5.0% | 3 | 3.8% | 0.747 |
| **Acne** | YES | 10 | 25% | 40 | 50.0% | 0.009* |
| **Miscarriages** | YES | 0 | 0% | 8 | 10.0% | 0.038* |
| **Thirst** | YES | 12 | 30% | 18 | 22.5% | 0.371 |
| **Blurry Vision** | YES | 8 | 20% | 20 | 25% | 0.542 |
| **Numbness** | YES | 6 | 15% | 32 | 40.0% | 0.006* |
| **Skin, Bladder, Gum Infection** | YES | 5 | 12.5% | 7 | 8.8% | 0.519 |
| **Angina (Chest Pain)** | YES | 4 | 10.0% | 6 | 7.5% | 0.64 |
| **Smoking** | YES | 0 | 0% | 2 | 2.5% | 0.313 |
| **Urination** | mild | 3 | 7.50% | 5 | 6.3% | 0.858 |
| | Moderate | 34 | 85.0% | 56 | 82.5% | |
| | severe | 3 | 7.50% | 8 | 10.0% | |
| **Intensity of Pain** | mild | 14 | 35.0% | 21 | 26.3% | 0.534 |
| | moderate | 17 | 42.5% | 35 | 43.8% | |
| | severe | 9 | 22.5% | 24 | 30.0% | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Regularity of Menstrual Cycle** | YES | 36 | 90.0% | 57 | 71.3% | 0.020* |
| **Family History of PCOS** | YES | 0 | 0% | 25 | 31.3% | 0.00* |
| **Family History of Diabetes** | YES | 27 | 67.5% | 33 | 41.3% | 0.007* |
| **History Of Heart Disease** | YES | 15 | 37.5 | 27 | 33.8% | 0.685 |
| *P-value <0.05 considered as significant using Pearson chi-square test of independence | | | | | | |

**COMPARISION OF ANTHROPOMETRIC INDICES, BLOOD PRESSURE, FPG, CHOLESTEROL, TG,FASTING PLASMA INSULIN,HOMA ANALYSIS BETWEEN CONTROL AND PATIENTS**

Anthropometric indices show a significant difference in PCOS patients with p value 0.05. BMI, Percent body fat and Diastolic blood pressure show significance difference among PCOS patients while there is no significant difference between W/H ratio and Systolic blood pressure in PCOS patients and control. Blood parameters such as Cholesterol, TG, FPG and Fasting plasma insulin were higher in PCOS patient at p value 0.05 which shows the significance difference.

HOMA analysis in PCOS patients also shows the significant difference marked insulin resistance and percent beta cell was found in PCOS patients beta cell sensitivity was found to be decrease in PCOS patients.

Comparison between control and patients is given in table#04. Comparison of age and anthropometric indices such as BMI, W/H ratio and Percent body fat are given in figure 06. While comparison between systolic and diastolic blood pressure in PCOS patients and control is shown in figure 7 & 8 exhibit the control-PCOS patients' comparison between Cholesterol, TG, FPG and figure 9 shows fasting plasma insulin, HOMA IR, percent beta cell and percent beta cell sensitivity.

**Table#04: Comparison of Anthropometric, B.P, CHOL, TG, FPG Between Control and Patients**

| **Variables** | **Control (n=60) Mean ± SD** | **PCOS (n=60) Mean ± SD** | **p-value** |
|---|---|---|---|
| Age (years) | 27.1 ± 6.2 | 29.0 ± 4.7 | 0.061 |
| Body Mass Index (kg/m²) | 21.3 ± 4.2 | 32.4 ± 7.5 | <0.001* |
| Waist–Hip Ratio | 0.773 ± 0.07 | 0.767 ± 0.10 | 0.704 |
| Percent Body Fat (%) | 25.3 ± 5.2 | 39.7 ± 10.0 | <0.001* |
| Systolic BP (mmHg) | 76.6 ± 10.8 | 74.3 ± 6.9 | 0.168 |
| Diastolic BP (mmHg) | 110.2 ± 9.5 | 117.0 ± 7.0 | <0.001* |
| Cholesterol (mg/dl) | 146.5 ± 33.2 | 171.2 ± 14.1 | <0.001* |
| Triglycerides (mg/dl) | 84.8 ± 27.1 | 103.7 ± 33.5 | 0.001* |
| Fasting Plasma Glucose (mg/dl) | 91.77 ± 9.4 | 103.6 ± 15.7 | <0.001* |
| Fasting Insulin (µU/ml) | 9.88 ± 4.8 | 18.2 ± 9.2 | <0.001* |
| Percent Beta Cell (%) | 107.1 ± 36.0 | 133.6 ± 58.1 | 0.003* |
| Beta Cell Sensitivity | 102.3 ± 58.3 | 61.1 ± 48.3 | <0.001* |
| HOMA-IR | 1.28 ± 0.63 | 2.46 ± 1.20 | <0.001* |

A total of 120 participants were included in the study, with 60 individuals in the control group and 60 diagnosed with PCOS. The mean age of participants did not differ significantly between the two groups (27.1 ± 6.2 vs 29.0 ± 4.7 years; p = 0.061), indicating comparable baseline characteristics.

Anthropometric analysis revealed that body mass index (BMI) and percent body fat were significantly higher in the PCOS group compared to controls (32.4 ± 7.5 vs 21.3 ± 4.2 kg/m² and 39.7 ± 10.0% vs 25.3 ± 5.2%, respectively; p < 0.001 for both). However, waist-to-hip ratio showed no statistically significant difference between groups (p = 0.704).

Regarding hemodynamic parameters, systolic blood pressure did not differ significantly between groups ($p = 0.168$), whereas diastolic blood pressure was significantly elevated in the PCOS group ($117.0 \pm 7.0$ vs $110.2 \pm 9.5$ mmHg; $p < 0.001$).

Biochemical analysis demonstrated significantly higher levels of total cholesterol and triglycerides in PCOS subjects compared to controls ($p < 0.001$ and $p = 0.001$, respectively). Similarly, fasting plasma glucose and fasting insulin levels were markedly elevated in the PCOS group ($p < 0.001$), indicating impaired glucose metabolism.

Markers of insulin resistance and β-cell function further supported these findings. HOMA-IR was significantly higher in the PCOS group ($2.46 \pm 1.20$ vs $1.28 \pm 0.63$; $p < 0.001$), while percent β-cell function was also increased ($p = 0.003$). In contrast, β-cell sensitivity was significantly reduced in PCOS patients compared to controls ($61.1 \pm 48.3$ vs $102.3 \pm 58.3$; $p < 0.001$).

Overall, these findings indicate that women with PCOS exhibit significant alterations in anthropometric, metabolic, and endocrine parameters, particularly reflecting increased adiposity, dyslipidemia, insulin resistance, and impaired β-cell responsiveness.

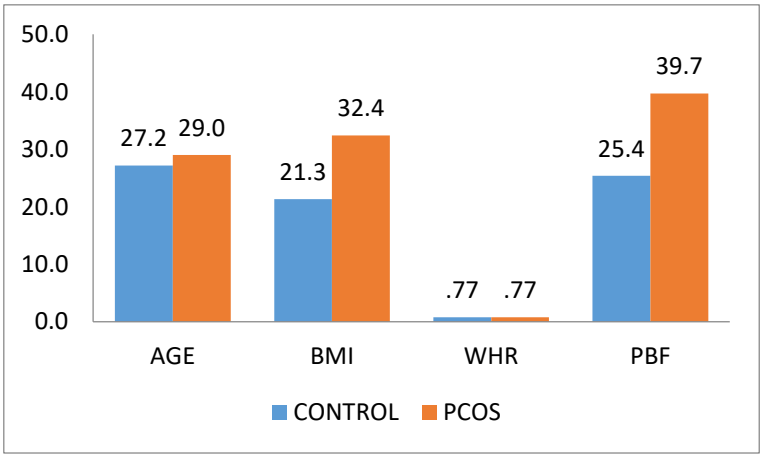


**Figure 6: Age and Antnhropometric Indices Comparison in Control And PCOS Patients**

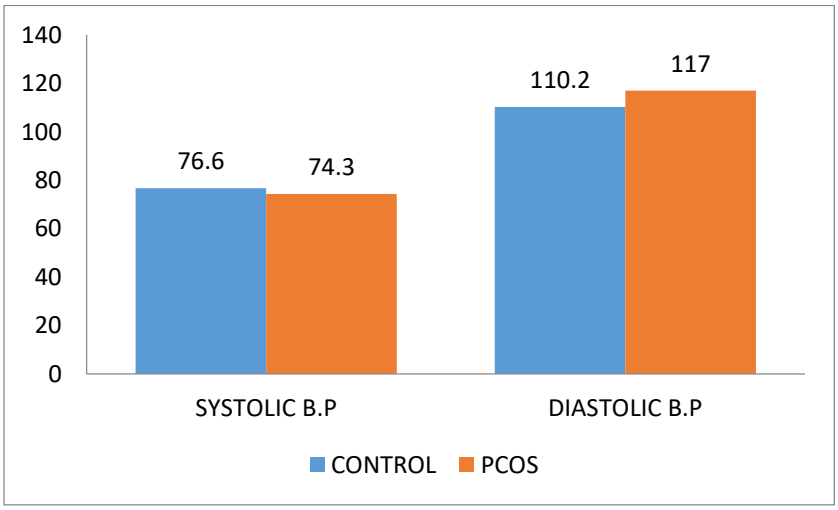


**Figure 7: Comparison of Blood Pressure in Control and PCOS Patients**

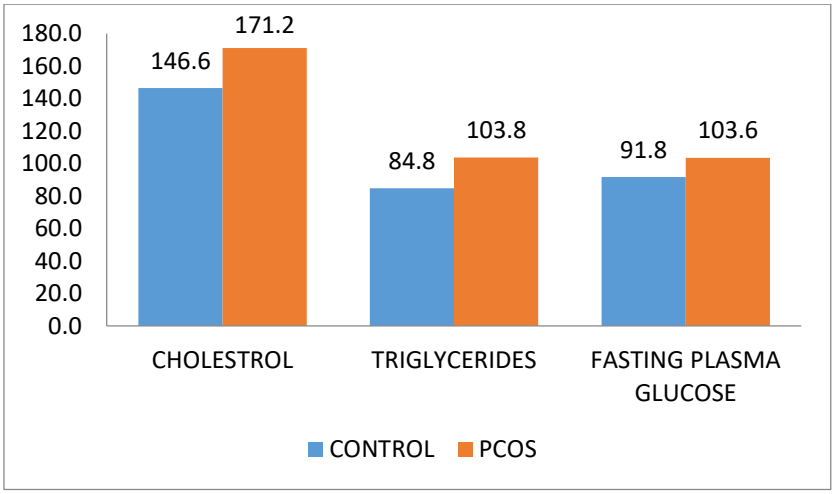


**Figure 08: Comparison of Cholesterol, Triglycerides, Fasting Plasma Glucose in Control and PCOS Patients**

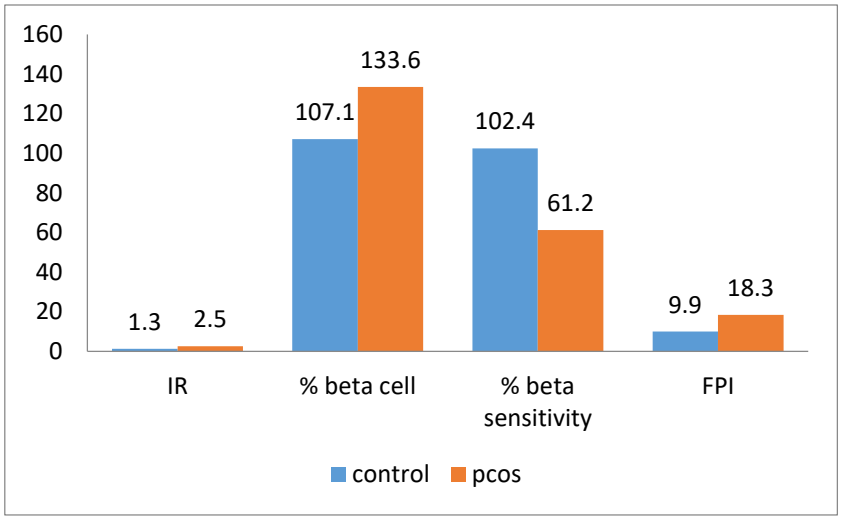


**Figure 09: Comparison of FPI and HOMA Analysis in Control and PCOS Patients**

**CORRELATION BETWEEN AGE AND ANTHROPOMETRY, BLOOD PRESSURE, CHOLESTEROL, TG, FPG, FASTING PLASMA INSULIN AND HOMA ANALYSIS**

Age show positive correlation with BMI ($r = 0.229$, $p = 0.012$), W/H ratio ($r = 0.252$, $p = 0.005$), PBF ($r = 0.283$, $p = 0.002$). BMI show positive correlation with age ($r = 0.229$, $p = 0.012$), Percent body fats ($r = 0.940$, $p = 0.000$), Diastolic Blood pressure ($r = 0.325$, $p = 0.000$), Cholesterol ($r = 0.479$, $p = 0.000$), TG ($r = 0.449$, $p = 0.000$), FPG ($r = 0.561$, $p = 0.000$), Fasting plasma insulin ($r = 0.290$, $p = 0.001$), HOMA IR ($r = 0.353$, $p = 0.000$). BMI show negative correlation with percent beta cell sensitivity ($r = -0.287$, $p = 0.002$). W/H ratio show positive correlation with age ($r = 0.252$, $p = 0.005$).

Percent body fat show positive correlation with age($r = 0.283$, $p = 0.002$), BMI ($r = 0.940$, $p = 0.000$), Diastolic blood pressure ($r = 0.310$, $p = 0.001$), Cholesterol ($r = 0.434$, $p = 0.000$), TG ($r = 0.388$, $p = 0.000$), FPG ($r = 0.546$, $p = 0.000$), Fasting plasma insulin ($r = 0.304$, $p = 0.001$), HOMA IR ($r = 0.337$, $p = 0.000$). Percent body fats show negative correlation with percent beta cell sensitivity ($r = -0.299$, $p = 0.001$). Systolic blood pressure shows positive correlation with diastolic blood pressure ($r = 0.341$, $p = 0.000$). Diastolic blood pressure shows positive correlation with BMI ($r = 0.325$, $p = 0.000$), Percent body fats ($r = 0.310$, $p = 0.001$), Systolic blood pressure ($r = 0.341$, $p = 0.000$), FPG ($r = 0.325$, $p = 0.012$).

Cholesterol show positive correlation with BMI ($r = 0.479$, $p = 0.000$), Percent body fats ($r = 0.434$, $p = 0.000$), TG ($r = 0.440$, $p = 0.000$), FPG ($r = 0.240$, $p = 0.008$).

Triglycerides show positive correlation with BMI (r = 0.449, p = 0.000), Percent body fats (r = 0.388, p = 0.000), cholesterol (r = 0.440, p = 0.000), FPG (r = 0.327, p = 0.000). Fasting plasma glucose show positive correlation with BMI (r = 0.561, p = 0.000), Percent body fats (r = 0.546, p = 0.000), TG (r = 0.327, p = 0.000), cholesterol (r = 0.240, p = 0.008), Diastolic blood pressure (r = 0.228, p = 0.012), HOMA IR (r = 0.326, p = 0.000). FPG show negative correlation with percent beta cell sensitivity (r = -0.312, p = 0.001). Fasting plasma insulin show positive correlation with BMI (r = 0.290, p = 0.001), Percent body fats (r = 0.304, p = 0.001), percent beta cell (r = 0.462, p = 0.000), HOMA IR (r = 0.541, p = 0.000). Fasting plasma insulin show negative correlation with percent beta cell sensitivity (r = -0.511, p = 0.000).

Percent beta cell show positive correlation with Fasting plasma insulin (r = 0.462, p = 0.001), HOMA IR (r = 0.367, p = 0.000). Percent beta cell show negative correlation with percent beta cell sensitivity (r = -0.371, p = 0.000). Percent beta cell sensitivity show negative correlation with BMI (r = - 0.287, p = 0.002), Percent body fats (r = -0.299, p = 0.001), FPG (r = -0.312, p = 0.001), Fasting plasma insulin (r = -0.511, p = 0.000), percent beta cell (r = -0.371, p = 0.000), HOMA IR (r = 0.452, p = 0.000). HOMA IR show positive correlation with BMI (r = 0.353, p = 0.000), Percent body fats (r = 0.337, p = 0.000), FPG (r = 0.326, p = 0.000), Fasting plasma insulin (r = 0.541, p = 0.000), percent beta cell (r = 0.367, p = 0.000). HOMA IR show negative correlation with percent beta cell sensitivity (r = -0.452, p = 0.000).

**Table#05: Correlation Between Anthropometric Indices, Blood Pressure, Cholesterol, TG FPG, Fasting Plasma Insulin and HOMA Analysis**

| | AGE | BMI | W/H | PBF | SB.P | DB.P | CHOL | TG | FPG | FPI | %B | %S | IR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AGE Correlation Coefficient** | 1.000 | .229* | .252* | .283* | .115 | .143 | .122 | .178 | .160 | .033 | -.034 | .068 | .092 |
| **Sig (2tailed)** | | .012 | .005 | .002 | .211 | .120 | .185 | .052 | .081 | .719 | .716 | .457 | .319 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **BMI Correlation Coefficient** | .229* | 1.000 | .094 | .940* | .148 | .325* | .479* | .449* | .561* | .290* | .150 | -.28* | .35* |
| **Sig (2tailed)** | .012 | | .309 | .000 | .107 | .000 | .000 | .000 | .000 | .001 | .103 | .002 | .000 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **W/H Correlation Coefficient** | .252* | .094 | 1.000 | .098 | .079 | -.033 | .074 | .092 | -.004 | .076 | .137 | -.01 | .065 |
| **Sig (2tailed)** | .005 | .309 | | .288 | .392 | .724 | .423 | .320 | .967 | .407 | .135 | .837 | .479 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **Percent body fats Correlation Coefficient** | .283* | .940* | .098 | 1.000 | .106 | .310* | .434* | .388* | .546* | .304* | .149 | -.29 | .33* |
| **Sig (2tailed)** | .002 | .000 | .288 | | .251 | .001 | .000 | .000 | .000 | .001 | .104 | .001 | .000 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **Systolic** | | | | | 1.000 | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **blood pressure** | | | | | | | | | | | | | |
| **Correlation Coefficient** | .115 | .148 | .079 | .106 | | .341* | .075 | .014 | .088 | -.014 | -.124 | .056 | -.04 |
| **Sig (2tailed)** | .211 | .107 | .392 | .251 | | .000 | .417 | .881 | .341 | .878 | .176 | .545 | .646 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **Diastolic blood pressure** | | | | | | 1.000 | | | | | | | |
| **Correlation Coefficient** | .143 | .325* | -.033 | .310* | .341* | | .127 | .139 | .228* | .131 | .047 | -.12 | .124 |
| **Sig (2tailed)** | .120 | .000 | .724 | .001 | .000 | 120 | .166 | .130 | .000 | .153 | .609 | .184 | .177 |
| **N** | 120 | 120 | 120 | 120 | 120 | | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **Cholesterol** | | | | | | | 1.000 | | | | | | |
| **Correlation Coefficient** | .122 | .479* | .074 | .434* | .075 | .127 | | .440* | .240* | .031 | -.002 | -.05 | .056 |
| **Sig (2tailed)** | .185 | .000 | .423 | .000 | .417 | .166 | | .000 | .008 | .739 | .985 | .567 | .544 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **Triglycerides** | | | | | | | | 1.000 | | | | | |
| **Correlation Coefficient** | .178 | .449* | .092 | .388* | .014 | .139 | .440* | | .327* | -.020 | .084 | -.031 | .031 |
| **Sig (2tailed)** | .052 | .000 | .320 | .000 | .881 | .130 | .000 | | .000 | .827 | .364 | .739 | .734 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **FPG** | | | | | | | | | 1.000 | | | | |
| **Correlation Coefficient** | .160 | .561* | -.004 | .546* | .088 | .228* | .240* | .327* | | .166 | -.004 | -.31 | .32* |
| **Sig (2tailed)** | .081 | .000 | .967 | .000 | .341 | .012 | .008 | .000 | | .070 | .970 | .001 | .000 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **Fasting plasma insulin** | | | | | | | | | | 1.000 | | | |
| **Correlation Coefficient** | .033 | .290* | .076 | .304* | -.014 | .031 | -.020 | .166 | .101 | | .426* | -.51 | .54* |
| **Sig (2tailed)** | .718 | .001 | .407 | .001 | .878 | .739 | .827 | .070 | .272 | | .000 | .000 | .000 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **% Beta cell** | | | | | | | | | | | 1.000 | | |
| **Correlation** | -.034 | .150 | .137 | .149 | -.124 | -.002 | .084 | -.004 | .077 | .426* | | -.37* | .36* |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Coefficient** | | | | | | | | | | | | | |
| **Sig (2tailed)** | .716 | .103 | .135 | .104 | .176 | .985 | .364 | .970 | .401 | .000 | | .000 | .000 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **% Beta sensitivity** | | | | | | | | | | | | 1.000 | |
| **Correlation** | .068 | -.28* | -.019 | -.29* | .056 | .122 | -.053 | -.031 | -.31* | -.51* | -.37* | | -.45* |
| **Coefficient** | | | | | | | | | | | | | |
| **Sig (2tailed)** | .457 | .002 | .837 | .001 | .545 | .184 | .567 | .739 | .001 | .000 | .000 | | .000 |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| **HOMA IR** | | | | | | | | | | | | | 1.000 |
| **Correlation** | 0.92 | .353* | .065 | .337* | -.042 | .124 | .056 | .031 | .326* | .541* | .367* | -.45* | |
| **Coefficient** | | | | | | | | | | | | | |
| **Sig (2tailed)** | .319 | .000 | .479 | .000 | .646 | .177 | .544 | .734 | .000 | .000 | .000 | .000 | |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |

## DISCUSSION

The present study demonstrates that anthropometric indices, particularly body mass index (BMI) and percent body fat, were significantly higher in PCOS patients compared to controls ($p < 0.001$), confirming the strong association between PCOS and obesity. In contrast, waist-to-hip ratio did not differ significantly between groups, suggesting that generalized adiposity rather than fat distribution may be more prominent in this cohort. These findings are consistent with the systematic review and meta-analysis by S. S. Lim et al. (2012), which reported a significantly higher prevalence of obesity, central obesity, and overweight status among women with PCOS. The variation in obesity prevalence across populations further emphasizes the influence of age, ethnicity, and geographic factors.

In the present study, age did not show a statistically significant difference between groups ($p = 0.061$), indicating that both groups were comparable at baseline. This strengthens the validity of observed metabolic differences as being associated with PCOS rather than age-related confounding.

Regarding blood pressure, diastolic blood pressure was significantly elevated in PCOS patients ($p < 0.001$), whereas systolic blood pressure showed no significant difference. Although the mean diastolic values were not critically high, they were on the upper side, indicating a potential predisposition to future cardiovascular complications. Similar findings were reported in a large retrospective study by Yuhua Shi et al. (2013), which demonstrated a higher prevalence of hypertension in PCOS women compared to controls, along with elevated glucose, insulin, and lipid parameters.

Biochemical analysis in this study revealed significantly elevated levels of cholesterol, triglycerides, fasting plasma glucose (FPG), fasting plasma insulin (FPI), and HOMA-IR in PCOS patients ($p < 0.01$). These findings indicate the presence of dyslipidemia and impaired glucose metabolism, both of which are key contributors to cardiovascular risk. Furthermore, correlation analysis showed that lipid parameters were positively

associated with BMI, percent body fat, and glycemic indices, reinforcing the link between obesity and metabolic dysfunction. A cohort study by H. Mani et al. (2013) also reported an increased incidence of cardiovascular events, including myocardial infarction and angina, in women with PCOS, particularly with advancing age and presence of comorbid risk factors.

The observed elevation in fasting glucose and insulin levels, along with increased HOMA-IR, confirms the presence of insulin resistance in PCOS patients. Additionally, percent β-cell function was increased, whereas β-cell sensitivity was significantly reduced, suggesting compensatory hyperinsulinemia in response to decreased insulin sensitivity. These findings support the concept that insulin resistance is a central feature in the pathophysiology of PCOS. Similar trends in metabolic and cardiovascular risk factors were reported by J. K. Hillman et al. (2013), who demonstrated increased BMI, blood pressure, and adverse lipid profiles in PCOS women.

Mechanistically, insulin resistance leads to decreased cellular glucose uptake, resulting in hyperglycemia and compensatory hyperinsulinemia. Elevated insulin levels stimulate ovarian theca cells to produce excess androgens, which disrupt follicular development and ovulation. Moreover, hyperinsulinemia reduces sex hormone-binding globulin (SHBG), increasing circulating free androgens and contributing to clinical manifestations such as hirsutism and acne. These mechanisms have been well documented, including findings from population-based analyses such as those by S. Lindheim et al. (2012).

The present study also highlights the long-term metabolic risks associated with PCOS. Increased prevalence of impaired glucose tolerance (IGT) and type 2 diabetes mellitus has been reported in PCOS populations, as demonstrated by H. Kuang et al. (2013), where PCOS women showed significantly higher rates of IGT and diabetes compared to controls. These findings align with the current results, indicating that obesity and insulin resistance in PCOS may predispose individuals to future metabolic disorders.

Genetic and familial predisposition also appear to play a significant role in PCOS. A considerable proportion of patients in this study reported a family history of PCOS, diabetes, and cardiovascular disease, suggesting hereditary influence. Studies such as those by Elisabeth Lerchbaum et al. (2014) and M. Kahsar-Miller et al. (1998) support the association between family history and increased risk of PCOS and related metabolic conditions.

Lifestyle factors were also notable in this study, with a proportion of PCOS patients exhibiting sedentary behavior and overeating habits. Physical inactivity is known to exacerbate obesity and insulin resistance, thereby increasing the risk of type 2 diabetes and cardiovascular disease. Regular physical activity improves insulin sensitivity and promotes better glucose utilization, highlighting its importance in the management of PCOS.

Overall, the findings of this study confirm that PCOS is strongly associated with obesity, insulin resistance, dyslipidemia, and early cardiovascular risk factors. These results emphasize the need for early screening and lifestyle interventions to prevent long-term metabolic and reproductive complications in women with PCOS.

## CONCLUSION

PCOS is considered one of the important causes of female sub fertility and the most common endocrine problem in women of reproductive age. Polycystic ovary syndrome is prevailing in Pakistan and obesity; type 2 diabetes, cardiovascular disease is prevailing in PCOS patient. The risk factors of PCOS are obesity, type 2 diabetes, insulin resistance, hormonal imbalance, menstrual disturbance and family history of polycystic ovary syndrome. In order to control the prevalence of polycystic ovary syndrome and its long-term consequences (type-2 diabetes, cardiovascular disease and endometrial cancer) life style modification (healthy diet and regular exercise) are necessary and should adopt the healthier lifestyle and limit sedentary habits. Learning

programs are considered necessary in public as well as in national setting in order to resolve the causes in Pakistan.

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