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Correlation of Clinical, Hormonal and Ultrasonography Features of Polycystic Ovarian Syndrome among Women of Reproductive Age

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Abstract:

Background: *Polycystic ovarian syndrome (PCOS) is the most common endocrine disorder among women of reproductive age. This study aimed to assess the correlation of clinical, hormonal and ultrasonography features of polycystic ovarian syndrome among women of reproductive age.*

Methods: *This cross-sectional study was conducted at the Department of Obstetrics & Gynaecology, Dhaka Medical College Hospital, Dhaka., Bangladesh from January 2015 to December 2016.This study included 51 women with polycystic ovarian syndrome (PCOS) in the case group, while the control group consisted of 51 healthy women of the same age. A purposive sampling technique was used for sample selection, and data analysis was performed using MS Office tools and SPSS Version 23.0.*

Results: *The mean age, BMI, waist-hip ratio, total cholesterol, and HDL differences were not statistically significant ($p>0.05$) between the groups. The s. LH/FSH ratio was increased in 58.8% of the patients in the case group, while it was only seen in 7.8% of the control group; the difference was statistically significant ($p<0.05$). Case group patients had impaired fasting blood sugar levels, significantly higher fasting insulin levels and HOMA-IR than the controls. Regarding the ultrasonography, in the case group, 39.2% had polycystic ovaries and 27.5% had enlarged ovaries. In contrast, all patients in the control group had normal USG findings. The difference between the groups was statistically significant ($p<0.05$). PCOS patients with HOMA-IR >3.2 had higher testosterone, LH, and insulin levels compared to those with HOMA-IR <3.2. FSH levels did not differ significantly ($p>0.05$).*

Conclusion: *Women with PCOS are at a significantly higher risk of developing insulin resistance compared to those without PCOS. A higher LH/FSH ratio, insulin resistance, cystic ovaries, and elevated serum testosterone levels may predict polycystic ovarian syndrome in reproductive-age women.*

Keywords: *Polycystic ovarian syndrome, PCOS, Reproductive age, Clinicalfeature, Hormonal, Ultrasonography*

1. INTRODUCTION

Polycystic ovary syndrome (PCOS) is the most prevalent reproductive disorder, with significant health consequences for women. It can lead to infertility and other endocrine disorders that require more complex management compared to the non-PCOS population, ultimately affecting the quality of life and increasing morbidity [1,2]. The Rotterdam criteria, established as one of the diagnostic criteria for PCOS, are now internationally accepted. These criteria recognize different phenotypes with varying clinical presentations and risk profiles. To be diagnosed with PCOS according to the Rotterdam criteria, a patient must have at least two of the following features: oligo- or anovulation, clinical and/or biochemical hyperandrogenism, and polycystic ovaries [3]. Polycystic ovarian syndrome (PCOS) is a complex and heterogeneous disorder and represents the most common endocrine

abnormality among women of reproductive age [4]. The prevalence of PCOS can range from 3% to 11%, depending on the diagnostic criteria used and the population being studied [5,6]. Polycystic ovary syndrome (PCOS) is characterized by ovarian dysfunction, with its primary features being hyperandrogenism and polycystic ovarian morphology (PCOM), often accompanied by chronic anovulation [7]. In 2003, ultrasonographic evidence of polycystic ovaries was added as the third diagnostic criterion. This addition was based on substantial global evidence supporting PCOM as a consistent finding in women exhibiting clinical and endocrine features of PCOS [8]. The presence of high levels of anti-mullerian hormone (AMH) and increased ovarian volume may be attributed to the excessive number of small follicles in polycystic ovaries, as suggested by Giampaolino et al. [9]. Recent studies have indicated that ovarian volume is significantly higher in patients with metabolic syndrome who also have PCOS compared to metabolic syndrome patients without PCOS [9,10]. The mechanism behind the increased ovarian volume is as follows: Androgens are typically found at elevated levels in PCOS patients due to ovarian stromal hypertrophy, and hyperinsulinemia amplifies androgen production by having a mitogenic effect on ovarian theca cells [11]. The association between ovarian volume and various parameters of PCOS remains inconclusive. Reid et al. [12] have highlighted the significance of ovarian volume as a factor related to metabolic risk in women with PCOS. Conversely, Han et al. [13] have concluded that ovarian volume does not appear to be correlated with patient weight, height, body mass index, and other hormonal parameters, except for AMH levels. These conflicting findings underscore the need for further research to establish a clear understanding of the relationship between ovarian volume and PCOS. Achieving this clarity is essential to develop more effective, individualized treatment strategies that address the critical metabolic aspects of this complex disorder for PCOS patients. The objective of this current study was to assess the correlation of clinical, hormonal and ultrasonography features of polycystic ovarian syndrome among women of reproductive age.

2. METHODOLOGY

This cross-sectional study was carried out at the Department of Obstetrics & Gynaecology, Dhaka Medical College Hospital, Dhaka, Bangladesh, from January 2015 to December 2016. The case group comprised 51 women diagnosed with polycystic ovarian syndrome (PCOS), while the control group consisted of 51 healthy women of similar ages. The researchers utilized a purposive sampling technique to select participants for this study.The study received approval from the ethical committee of the hospital mentioned. All participants provided written consent before participating in the study.The research included the collection of menstrual history and anthropometric measurements. Additionally, clinical assessments for acne and hirsutism were conducted. Transvaginal ultrasonography and biochemical analysis for free testosterone were performed. Participants eligible for this study were women attending the gynecology outpatient department who had oligo-ovulatory cycles and showed evidence of polycystic ovaries (PCO) through transvaginal sonography (TVS).Exclusion criteria for this study encompassed women with clinical indications of thyroid disorders, those suspected of having Cushing's syndrome, androgen-secreting neoplasms, congenital adrenal hyperplasia, and women with hyperprolactinemia. Demographic and clinical information of the participants was meticulously recorded, and data analysis was conducted using MS Office and SPSS version 23.0 software, as necessary.

3. RESULT

In this study, the mean age did not significantly differ between the case and control groups, with mean ages of 25.0±32 years and 26.5±4.7 years, respectively. Similarly, the mean BMI in the case group (27.0±3.1 kg/m2) and control group (26.1±2.1 kg/m2) did not show a significant statistical difference ($p>0.05$) between the two groups. The mean waist circumference was 82.4±6.7 cm in individuals with HOMA-IR <3.2 and 86.6±3.9 cm in those with HOMA-IR >3.2. The mean hip circumference measured 99.4±4.6 cm for individuals with HOMA-IR <3.2 and 101.4±5.6 cm for those with HOMA-IR >3.2. Additionally, the mean Waist-to-Hip Ratio (W/H Ratio) was 0.80±0.38 in individuals with HOMA-IR <3.2 and 0.83±0.18 in individuals with HOMA-IR >3.2. Notably, PCOS patients with HOMA-IR >3.2 exhibited a higher waist circumference compared to those with HOMA-IR <3.2.When analyzing the clinical parameters of the study population, a higher percentage of

hirsutism, acne, acanthosis nigricans, oligomenorrhea, amenorrhea, and hypertension were observed in the case group compared to the control group. PCOS patients with HOMA-IR >3.2 exhibited more severe symptoms of hirsutism, acanthosis nigricans, and oligomenorrhea than those with HOMA-IR levels <3.2. In the control group, patients with insulin resistance showed symptoms of acanthosis nigricans and hirsutism (75.0%) and acne (50.0%). Regarding the ultrasound findings, 39.2% of cases in the case group had polycystic ovaries, 27.5% had enlarged ovaries, and 33.3% had normal ovarian findings. In contrast, all patients in the control group had normal ultrasound findings, and this difference was statistically significant ($p<0.05$) between the two groups.The mean serum testosterone was significantly higher in the case group (1.8±0.9 ng/ml) compared to the control group (0.9±0.2 ng/ml). Similarly, the mean D2 serum LH level was significantly elevated in the case group (12.7±6.7 mIU/mL) compared to the control group (5.9±1.4 mIU/mL). It was observed that PCOS patients with HOMA-IR >3.2 had higher serum testosterone, D2 serum LH, and fasting serum insulin levels than PCOS patients with HOMA-IR <3.2. However, there was no statistically significant difference in D2 serum FSH ($p>0.05$). In the control group, 4 patients with insulin resistance exhibited increased fasting serum insulin, while serum testosterone, D2 serum LH, and D2 serum FSH remained within the normal range. Regarding the serum LH/FSH ratio in study population, it was notably higher in the case group (58.8%) compared to the control group (7.8%), and this difference was statistically significant ($p<0.05$). Furthermore, the case group exhibited significantly higher mean levels of fasting insulin (27.3±10.7 μU/ml) compared to the control group (14.3±6.0 μU/ml). Similarly, the case group had a higher mean fasting blood sugar (5.1±0.8 mmol/L) compared to the control group (4.6±0.6 mmol/L). The mean HOMA IR was also significantly higher in the case group (4.1±1.3) compared to the control group (2.4±1.2). These differences in fasting insulin, fasting blood sugar, and HOMA IR were statistically significant ($p<0.05$) between the two groups. When comparing BMI with HOMA-IR in the case group, it was noted that although the number of patients with a BMI ≥25 kg/m2 was higher (55.6%) than those in the BMI 18.5-24.9 kg/m2 group (53.3%), the difference was not statistically significant ($P>0.05$) between the two groups. Regarding the comparison of fasting lipid profiles, the case group exhibited lower HDL levels and higher LDL levels than the control group. However, total cholesterol and triglyceride levels were similar in both groups. It was found that PCOS patients with HOMA-IR >3.2 had higher levels of triglycerides and LDL than PCOS patients with HOMA-IR <3.2. However, the total cholesterol and HDL levels did not show statistically significant differences ($p>0.05$) between the two groups. Among the 4 control patients with insulin resistance, triglycerides and LDL were elevated, while total cholesterol and HDL levels remained within the normal range.

Table1. *Comparison of the study population by age.(N=102)*

Age (Years)	Cases (n=51)		Control (n=51)	
	n	%	n	%
20-25 yrs.	29	56.90%	24	47.1%
26-30 yrs.	18	35.30%	17	33.3%
31-35 yrs.	4	7.80%	8	15.7%
36-40 yrs.	0	0%	2	3.9%

Table2. *Waist, Hip circumference and W/H ratio with insulin resistance of cases. (n=51)*

Variables	Insulin resistance	
	<.2 (normal)	>3.2 (high)
	(n=23)	(n=28)
	Mean ±SD	Mean ±SD
Waist circumference (cm)	82.4±6.7	86.6±3.9
Hip circumference (cm)	99.4±4.6	101.4±5.6
W/H Ratio	0.80±0.38	0.83±0.18

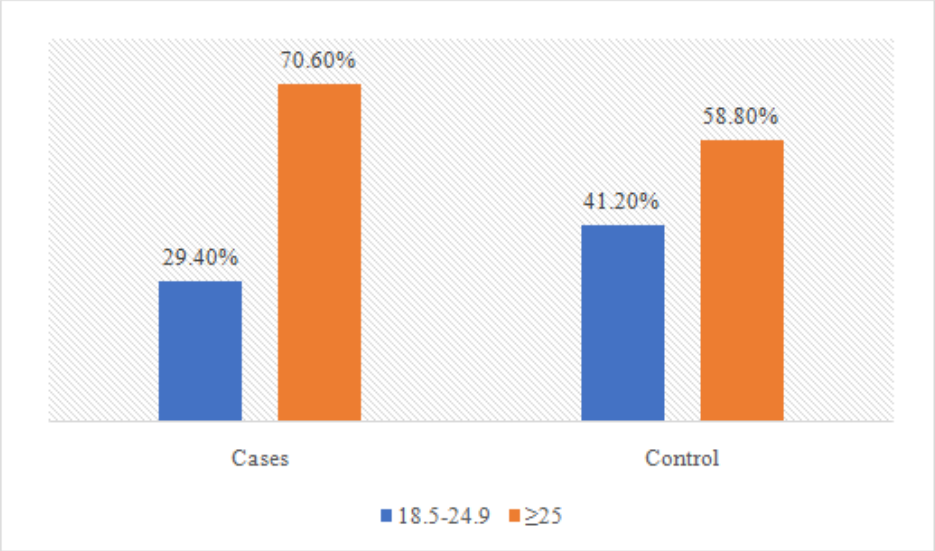

Figure1. *BMI status of the study population*

Table2. *Waist, Hip circumference and W/H ratio with insulin resistance of cases. (n=51)*

Variables	Insulin resistance	
	<.2 (normal)	>3.2 (high)
	(n=23)	(n=28)
	Mean ±SD	Mean ±SD
Waist circumference (cm)	82.4±6.7	86.6±3.9
Hip circumference (cm)	99.4±4.6	101.4±5.6
W/H Ratio	0.80±0.38	0.83±0.18

Table3. *Distribution of the study population by clinical parameters. (n=79)*

Clinical parameters	Case (n=51)		Control (n=28)		P value
	n	%	n	%	
Hirsutism	33	64.7	5	9.8	0.001[s]
Acne	10	19.6	6	11.8	0.006[s]
Acanthosis nigricans	30	58.8	4	7.8	0.001[s]
Oligomenorrhoea	38	74.5	0	0	0.001[s]
Amenorrhoea	13	25.5	0	0	0.001[s]
Hypertension	10	19.6	0	0	0.001[s]

S: significant, p-value reached fromchi-square test

Table4. *Comparison between clinical parameters of PCOS patients with IR and non-IR and control IR (n=4).*

Clinical parameters	HOMA-IR level				P value
	<3.2 (n=23)		>3.2 (n=28)		
	n	%	n	%	
Case group					
Hirsutism	11	47.8	22	78.6	0.022[s]
Acne	4	17.4	6	21.4	0.051n[s]
Acanthosis nigricans	10	43.5	20	71.4	0.043[s]
Oligomenorrhoea	14	60.9	24	85.7	0.042[s]
Amenorrhea	5	21.7	8	28.6	0.577[ns]
Hypertension	4	17.4	6	21.4	0.500[ns]
Control Group (n=4)					
Hirsutism			3	75	0.076ns
Acne			2	50	0.538ns
Acanthosis nigricans			3	75	0.033s

Table5. *USG finding of both group cases. (N=102)*

USG finding	Case (n=51)		Control (n=51)		P value
	n	%	n	%	
Polycystic	20	92.2	0	0	0.001
Enlarged ovary	14	27.5	0	0	
Normal	17	33.3	51	100	

Table6. *Laboratory findings in study population. (N=102)*

Parameter	Case (n=51)		Control (n=51)		P value
	n	%	n	%	
Serum testosterone (ng/ml)					
0.5-1.2 (normal)	29	56.90%	47	92.20%	
>1.2	22	43.10%	4	7.80%	
Mean ±SD	1.8±0.9		0.9±0.2		0.001[s]
D2 Serum FSH (IU/L)					
2.8-8.6 (normal)	43	84.30%	46	90.20%	
>8.6	8	15.7	5	9.80%	
Mean ±SD	5.7±2.0		5.1±1.3		0.075[ns]
Serum LH (mIU/mL)					
2.8-13.7	22	43.10%	46	90.20%	
> 13.7	29	56.90%	5	9.80%	
Means ±SD	12.7±6.7		5.9±1.4		0.001[s]

S: significant, p-value reached from unpaired t-test

Table7. *Hormone profile variation with IR in case group and control group. (n=4)*

Variables	HOMA-IR		P value
	<3.2 (n=23)	>3.2 (n=28)	
	Mean±SD	Mean±SD	
Case group			
Serum testosterone (ng/ml)	2.2±1.0	2.8±0.8	0.021s
D2 Serum FSH (IU/L)	4.8±1.9	5.2±2.1	0.483ns
D2 Serum LH (mIU/mL)	11.2±3.3	14.5±5.0	0.006s
Fasting insulin ((µU/ml)	26.8±12.1	32.8±8.3	0.041s
Control Group (N=4)			
Serum testosterone (ng/ml)		0.9±0.2	
D2 Serum FSH (IU/L)		5.3±2.0	
D2 Serum LH (mIU/mL)		9.2±2.2	
Fasting insulin (((µU/ml)		25.5±2.2	

Table8. *Comparison of serum LH/FSH ratio between both groups. (N=102)*

Serum LH/FSH ratio	Case (n=51)		Control (n=51)		P value
	n	%	n	%	
<2	21	41.20%	47	92.20%	0.001[s]
≥2	30	58.80%	4	7.80%	

Table9. *Distribution of the study population by insulin resistance. (N=102)*

Variables	Case (n=51)		Control (n=51)		P value
	n	%	n	%	
Fasting insulin ((µU/ml)	21	41.20%	47	92.20%	
>25	30	58.80%	4	7.80%	
Mean+SD	27.3+10.7		14.3+6.0		0.001s

Serum fasting blood sugar (mmol/L)					
3.6-6.1 (Normal)	29	56.90%	46	90.20%	
6.1-6.9	22	43.20%	5	9.80%	
Mean±SD	5.1+0.8		4.6+0.6		0.005[s]
HOMA IR					
<3.2	23	45.10%	47	92.20%	
>3.2	28	54.90%	4	7.80%	
Mean±SD	4.1+1.3		2.4+1.2		0.001[s]

s= significant, ns= not significant P value reached from unpaired test

Table10. *Comparison between BMI with HOMA-IR in the case group. (N=102)*

HOMA-IR	**BMI (Kg/m^2)**				**P value**
	Case (n=51)		**Control (n=51)**		
	n	**%**	**n**	**%**	
<3.2	16	44.4	7	46.7	0.112[ns]
≥3.2	20	55.6	8	53.3	

Table11. *Distribution of the study population by fasting lipid profile. (N=102)*

Fasting lipid profile	**Case (n=51)**		**Control (n=51)**		**P value**
	n	**%**	**n**	**%**	
Total cholesterol (mg/dl)					
≤200	42	83.4%	44	86.3%	
>200	9	17.6%	7	13.7%	0.586ns
Triglycerides (mg/dl)					
≤150	20	39.2%	25	49%	
>150	31	60.8%	26	51%	0.326n
HDL (mg/dl)					
<40	28	54.9%	11	21.6%	
≥40	23	45.1%	40	78.45	0.001s
LDL(mg/dl)					
≤130	16	31.45	39	76.55	0.001[s]
>130	35	68.6%	12	23.5%	

Table12. *Comparison between fasting lipid profile with IR level in case and control. (n=4)*

Fasting lipid profile	**HOMA-IR**		**P value**
	3.2 (normal) (n=23)	**>3.2 (high) (n=28)**	
	Mean +SD	**Mean +SD**	
Case group			
Total cholesterol (mg/dl)	192.8+31.1	198.5+31.2	0.518ns
Triglycerides (mg/dl)	144.5+13.3	155.9+15.6	0.003s
HDL (mg/dl)	35.9+5.1	33.1+5.6	0.070ns
LDL(mg/dl)	158.2+15.5	176.5+14.5	0.001s
Control group (n=4)			
Total cholesterol (mg/dl)		185.2+18.4	
Triglycerides (mg/dl)		177.7+21.0	
HDL (mg/dl)		37.6+4.5	
LDL(mg/dl)		168.0+5.5	

4. DISCUSSION

In this study,the mean age was 25.0±3.2 years in PCOS patients and 26.5±4.7 years in the control group, showing a close resemblance. This aligns with the findings of Amisi et al. [14], who reported a mean age of 24.45±5.1 years in PCOS and 24.20±6.8 years in control women, in agreement with the present study. In this study, women with PCOS had a mean BMI of 27.0±3.1 kg/m2, compared to their control counterparts with a BMI of 26.1±2.1 kg/m2. These findings are consistent with Yildir et al. [15], who reported BMIs of 26.12±5.68 kg/m2 in the case group and 24.3±4.65 kg/m2 in the

control group. In this study, the mean waist-to-hip ratio was 0.82±0.43 in the case group and 0.81±0.18 in the control group. A similar study by Cakir et al. [16] found ratios of 0.84±0.5 in the case group and 0.81±0.06 in the control group. Regarding hirsutism, the present study revealed a prevalence of 64.7% in the case group and 9.8% in the control group. Azziz et al. [17] found that 70.0% of PCOS patients present with hirsutism. Acne affected 19.6% of the patients in the case group and 5.9% in the control group in this study. This is in line with a study by Aziz et al. [17].In the present study, mean insulin resistance was significantly higher in the case group compared to the control group. Fasting HOMA-IR was found in 54.9% of the case group and 7.8% of the control group. The mean HOMA-IR was 4.1±1.3 in the case group and 2.4±1.2 in the control group. Cakir et al. [16] found insulin resistance in 45.5% of PCOS patients using HOMA-IR, while Yildir et al. [15] observed insulin resistance in 64.7% of PCOS patients. In this study, the mean insulin level was 27.3±10.7 μU/ml in the case group and 14.3±6.0 μU/ml in the control group. Sun et al. [18] also found higher fasting insulin levels in PCOS patients compared to the control group, with levels of 16.4±9.15 μU/ml in the case group and 7.63±3.42 μU/ml in the control group. Dipankar et al. [19] conducted a study on PCOS patients and found high insulin levels in 38.6% of cases. In this study, impaired fasting blood sugar was observed in 43.1% of the case group and 9.8% of the control group. The mean fasting blood sugar levels were 5.4±0.8 mmol/L in the case group and 4.9±0.6 mmol/L in the control group. This aligns with findings from Haq et al. [20], who reported that 33.5% of PCOS patients had impaired fasting blood sugar. Another study by Jahan et al. [21] also reported similar findings for this parameter, with mean values of 5.11±0.71 mmol/L in the case group and 4.75±0.61 mmol/L in the control group. Additionally, Begum [22] found that the mean fasting blood sugar level was 5.98±1.08 mmol/L among cases and 4.44±1.1 mmol/L among controls, with a significant p-value (<0.01). In this study, PCOS patients had a significantly higher LH/FSH ratio of 58.5% compared to 9.8% in the control group. This is consistent with the findings of Razzak et al. [23], who reported that 64.0% of PCOS patients had an LH/FSH ratio greater than 2, which aligns with the results of this study. In this current study, serum testosterone levels were significantly higher in the case group than in the control group. Elevated serum testosterone levels were observed in 26.9% of cases and 7.8% of the control group. This is in line with the findings of Yousouf et al. [24], who found elevated serum testosterone in 57.7% of PCOS patients.Regarding the lipid profile, in our study, the mean HDL level was 1.25±0.31 in the case group and 1.44±0.36 in the control group, while the mean LDL level was 3.0±0.71 in the case group and 2.58±0.66 in the control group. Total cholesterol levels were not found to be statistically significant. Cakir et al. [16] reported that patients with PCOS had elevated levels of serum triglycerides (TG), LDL, and HDL, but they found no significant difference between the patients and the control group in terms of total cholesterol. In this study, it was observed that PCOS patients with HOMA-IR >3.2 had a greater waist circumference than those with HOMA-IR <3.2. Enzevaie et al. [25] reported that the waist/hip ratio did not show a significant difference between the two groups, but the average waist circumference was 90.9±10.04 in the insulin-resistant group and 83.1±10.2 in the normal group, which showed a significant difference (p=0.008), consistent with the findings in this study.

5. Limitation of the Study

This study had several limitations. The small sample size was primarily due to time and financial constraints, potentially impacting the study's statistical power. The study was conducted in a single hospital in Dhaka City, which may limit the generalizability of the findings to the broader population of the country. While modern methods, such as the hyper-insulinaemic euglycemic clamp, were used to assess insulin resistance, the complexity, feasibility, and resource-intensive nature of these methods led to the utilization of the HOMA-IR method for insulin resistance measurement.

6. Conclusion And Recommendation

The findings of this study underscore the substantial risk that women with Polycystic Ovary Syndrome (PCOS) face in developing insulin resistance when compared to their counterparts without PCOS. It is a significant and concerning association that highlights the need for careful monitoring and management of metabolic health in PCOS patients. Notably, several factors emerge as potential predictors of

PCOS among reproductive-age women. These include a higher LH/FSH (Luteinizing Hormone/Follicle-Stimulating Hormone) ratio, the presence of insulin resistance, the observation of cystic ovaries, and elevated serum testosterone levels.

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