

Assessment of Metabolic Syndrome in Reproductive Aged Women with Polycystic Ovarian Syndrome: A Cross-Sectional StudyMamatha Pulloori¹, S. Nirmala², Jyothi Gunda³¹Associate Professor, Department of General Medicine, MNR Medical College and Hospital, Sangareddy, Telangana, India²Associate Professor, Department of Obstetrics and Gynecology, MNR Medical College and Hospital, Sangareddy, Telangana, India³Associate Professor, Department of Obstetrics and Gynecology, MNR Medical College and Hospital, Sangareddy, Telangana, India

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Conflict of interest: Nil

Abstract:

Introduction: Polycystic ovarian syndrome (PCOS) is an endocrine disorder affecting reproductive age group women and exhibiting complication including anovulatory infertility, menstrual irregularities, hirsutism, and long-term complications like diabetes, cardiovascular complications. Development of metabolic syndrome in women with PCOS can lead to long term complications. The present study was aimed to evaluate the metabolic syndrome in the women with PCOS of reproductive age group.

Material and Methods: A source of 124 participants of reproductive age attending the OPD, Department of gynecology between age group 18-40 years was included. Laboratory investigations, BMI, waist circumference, fasting blood glucose were measured.

Results: The prevalence of metabolic syndrome was 41.93%. Age, BMI, obstetric score, and clinical problems had statistically significant mean differences (p 0.05). The mean values of triglycerides were 123 mg/dl, HDL was 47.48 mg/dl, LDL was 102.85 mg/dl, total cholesterol was 165.5 mg/dl, and fasting blood sugar was 106.2 mg/dl in women with metabolic syndrome.

Conclusion: The results of present study showed in women with PCOS who were in the reproductive age range, the prevalence of metabolic syndrome was 41.93%. Women over 26 years who have a large waist circumference and BMI over 26 kg/m² are more likely to develop metabolic syndrome.

Keywords: Polycystic ovarian syndrome (PCOS), Metabolic syndrome, BMI, Waist circumference.

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Introduction

Polycystic ovarian syndrome (PCOS) is a common gynaecological endocrine disorder among women of reproductive-age [1]. Insulin resistance, increased adiposity and metabolic syndrome (MS) development are common in PCOS [2]. Worldwide, 1.14% to 11.04% of adolescent girls have PCOS [3, 4]. Menstrual abnormalities based on time since menarche combined with clinical or biochemical hyperandrogenism are the diagnostic criteria for PCOS in adolescents, but only when other reasons have been ruled out [5, 6]. A cluster of endocrinopathies and metabolic disorders, such as hyperglycaemia, insulin resistance, central obesity, dyslipidaemia, and hypertension, is known as the metabolic syndrome [7]. A 5-fold increased risk of T2DM, which is a risk factor for cardiovascular illnesses, and a 2-fold increased risk of cardiovascular disease make metabolic syndrome something to be concerned about [8]. According to the literature, women with PCOS are more likely to

experience metabolic syndrome because these patients have greater rates of insulin resistance, obesity, and visceral obesity [9]. A small number of studies have suggested that anthropometric factors like age and BMI are components of the metabolic syndrome [10]. The pathophysiology of metabolic syndrome is very intricate and has been only partially elucidated. Due to the limitations in the availability of literature in the current study set up the present study was aimed to evaluate the metabolic syndrome in the women with PCOS of reproductive age group.

Materials and Methods

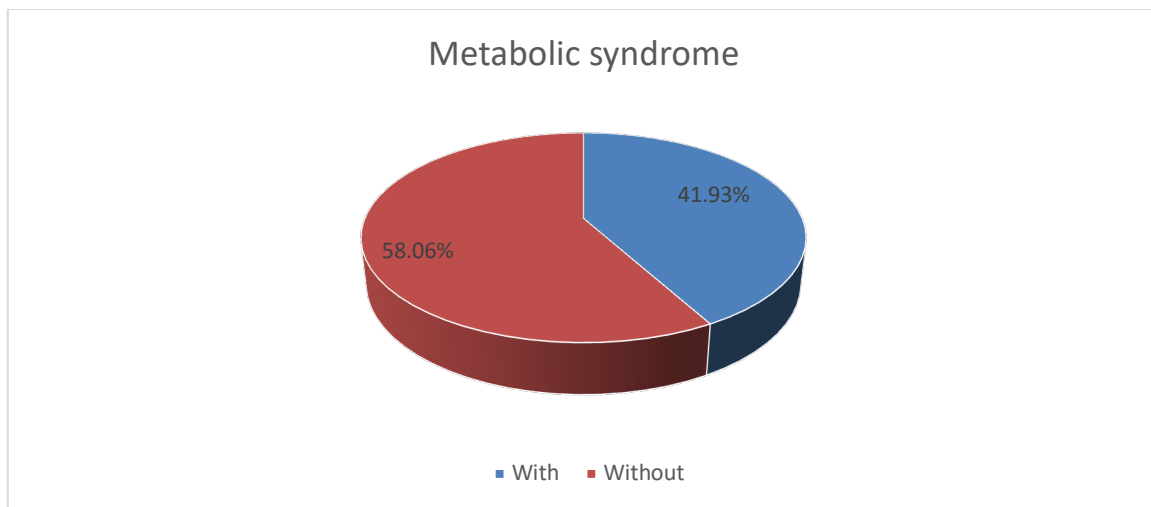
The present cross-sectional study was conducted in the Department of Obstetrics and Gynecology in association with Department of General Medicine at MNR Medical College and Hospital, Sangareddy during January 2022 to April 2023. A total of 124

participants of reproductive age attending the OPD, Department of gynecology were recruited. Women with amenorrhea, oligomenorrhoea, clinical hypothyroidism, hyperandrogenism, increased BMI and willing to participate were included. Cases exhibiting thyroid dysfunction, adrenal hyperplasia, hyperprolactinemia, alcohol consumption, diabetes mellitus, under oral contraceptive medication and not willing to participate were excluded.

Written informed consent was obtained from all the participants and study protocol was approved by institutional ethics committee. Sociodemographic details were collected from all the participants and detailed menstrual history and clinical history was collected. Using a non-stretchable tape, the waist

circumference was measured at midway between costal margin and anterior superior iliac spine. Right upper limb blood pressure was measured while sitting and was recorded as the average of two measurements made using a standard sphygmomanometer with 30 minutes gap. The collected data were analysed by using SPSS version 23.0. categorical variables were presented as frequency and percentage. Trend chi-square analysis was used for comparison of categorical variables and percentages of study variables among BMI and age categories. P<0.05 was considered significant.

Results



Graph 1: Distribution of participants with and without metabolic syndrome

Table 1: Distribution of cases according to clinical and demographic data

Parameters	Metabolic syndrome				Total	Chi-square test	p-value
	With (n=52)		Without (n=72)				
	Frequency	%	Frequency	%			
Age (in years)							
18-25	09	17.3%	25	34.7%	34	9.62	0.0276
26-30	29	55.7%	39	54.16%	68		
31-35	12	23.07%	06	8.33%	18		
36-40	02	3.84%	02	2.77%	4		
BMI (Kg/m2)							
<23	14	26.9%	34	47.22%	48	26.4	0.0180
23-26	16	30.7%	36	50%	52		
>26	22	42.3%	02	2.77%	24		
Obstetric score							
Unmarried	15	28.8%	16	22.22%	31	10.2	0.001
Nulli	32	61.5%	24	33.33%	56		
Primi	04	7.6%	11	15.28%	15		
P2L2	01	1.9%	21	29.17%	22		
Clinical complications							
1 ^o infertility	26	50%	32	44.44%	58	11.42	0.001
2 ^o infertility	08	15.3%	07	9.72%	15		
Hirsutism	03	5.76%	02	2.77%	05		
Menstrual irregularity	15	28.84%	31	43.06%	46		

Table 2: Comparison of clinical parameters between cases with and without metabolic syndrome

Parameters	Metabolic syndrome		t-value	p-value
	With (n=52)	Without (n=72)		
	Mean±SD	Mean±SD		
Height (cm)	156.2±2.8	155.9±3.0	2.18	0.001
Weight (Kg)	69.8±5.36	62.37±4.84	3.92	0.001
BMI (kg/m ²)	29.67±4.42	26.45±4.08	3.56	0.001
Waist circumference (cm)	96.32±8.55	85.69±7.46	5.21	0.001
SBP (mm of Hg)	118.02±12.7	117.45±10.89	2.01	0.051
DBP (mm of Hg)	76.8±1.98	77.6±2.08	1.98	0.048

Table 3: Comparison of laboratory investigations between cases with and without metabolic syndrome

Laboratory investigations (mg/dl)	Metabolic syndrome		t-value	p-value
	With (n=52)	Without (n=72)		
	Mean±SD	Mean±SD		
Triglycerides	123±18.6	111±19.5	3.37	0.001
HDL	47.48±8.64	51.9±7.49	5.96	0.001
LDL	102.85±14.3	95.64±12.8	4.18	0.001
Total cholesterol	165.5±19.28	159.32±15.36	1.08	0.001
Fasting blood glucose	106.2±16.8	92.58±12.29	3.74	0.051

Table 4: Diagnostic prediction of clinical and laboratory between cases with and without metabolic syndrome

clinical and laboratory parameters	Cut off values	AUCs	P-value	Sensitivity	Specificity
BMI (kg/m ²)	≥25 kg/m ²	0.832	0.0178	88	65
Waist circumference (cm)	≥80 cm	0.869	0.001	88	61
Low HDL	≤50 mg/dl	0.712	0.001	90	74
High LDL	≥130 mg/dl	0.698	0.001	81	98
High TGS	≥150 mg/dl	0.638	0.001	55	100
High FBS	≥100 mg/dl	0.716	0.001	64	81

Discussion

The prevalence of metabolic syndrome in women with PCOS of reproductive age group was 41.93%. The prevalence of present study was compared with the findings of previous studies (Table 5).

Table 5: Comparison of prevalence of metabolic syndrome with previous studies

Authors name	No of cases	Prevalence of metabolic syndrome
Ehrmann DA et al. (2006) ¹¹	398	33.4%
Mandrelle K et al. (2012) ¹²	120	37.5%
Pourteymour FTF et al. (2013) ¹³	200	39.5%
Hillman JK et al. (2014) ¹⁴	311	26.3%
Tehrani FR et al. (2014) ¹⁰	85	6.5%
Romanowski MD et al (2015) ¹⁵	101	44.6%
Sharma S et al. (2015) ¹⁶	120	39.16%
Aydin Y et al. (2015) ¹⁷	63	7.9%
Jamil AS et al. (2015) ¹⁸	263	53.6%
Boyle JA et al. (2015) ¹⁹	35	51%
Albu A et al. (2015) ²⁰	398	20.4%
Madusudhanan RR et al. (2017) ²¹	131	45.8%
Jeengar P et al. (2017) ²²	50	58%
Prema N et al. (2018) ²³	146	38.4%
Aghade SM et al. (2018) ²⁴	150	38.67%
Amrita G et al. (2022) ²⁵	106	47.1%
Belen MF et al. (2022) ²⁶	154	69.48%
Present study 2023	124	41.93%

The majority of patients who had metabolic syndrome were between the ages of 26 and 30 (55.7%), followed by 31 to 35 (23.07%). Obese cases made up the majority of cases (BMI >26 kg/m²), followed by overweight cases (30.7%) and normal cases (26.9%). Women who were nulligravida (61.5%) and were not married (28.8%) or primigravida (7.6%) were more likely to have metabolic syndrome. Women with monthly abnormalities (28.84%), secondary infertility (15.3%), hirsutism (5.76%), and main infertility (50%) were the women most likely to have metabolic syndrome (Table 1). Age, BMI, obstetric score, and clinical problems had statistically significant mean differences (p 0.05). Women with PCOS ranging in age from 19 to 38 years, with a mean age of 26.15 years, were included in Mandrelle K et al.'s study. 81.7% of women experienced primary infertility often [12]. Women with and without metabolic syndrome had mean ages of 29.2 years and 28.1 years, respectively, according to Ehrmann DA et al. [11]. The majority of participants, according to Madusudhanan RR et al., were aged between 25 and 29 years (43.5%), followed by 20 to 24 years (33.6%). BMI > 30 kg/m² was present in 17.6% of patients, followed by BMI between 20 and 24.9% (35.1%) and 25 to 29.9% (38.9%) of cases [21].

The mean height was 156.2 cm and 155.9 cm, mean weight was 69.8 kg and 62.37 kg, mean BMI was 29.67 and 26.47, mean waist circumference was 96.32 cm and 8.69 cm, mean systolic blood pressure was 118.02 mm of Hg and 117.45 mm of Hg and mean DBP was 76.8 mm of Hg and 77.6 mm of Hg in women with and without metabolic syndrome respectively (Table 2). The mean difference of height, weight, BMI, waist circumference and SBP was statistically significant (p<0.05). Mandrelle K et al., found a mean BMI of 25.95 kg/m² with a range of 17.6 to 41 kg/m². The prevalence of metabolic syndrome increased with increasing BMI. The mean waist-hip ratio was >0.85 in 45.8% of cases. The mean BMI and waist-hip ratio was significantly high in women with metabolic syndrome [12]. Ehrmann DA et al., found a mean waist circumference 112.7 cm and 97.9 cm, SBP 123.6 mm of Hg and 111.5 mm of Hg, DBP 78.3 mm of Hg and 71.6 mm of Hg, FBS 95.3 mg/dl and 90.2 mg/dl in women with and without metabolic syndromes respectively [11]. Madusudhanan RR et al., observed that the waist circumference was <88 cm in 61.8% and >88 cm in 38.2%, SBP was <135 mm of Hg in 96.2% and >135 mm of Hg in 3.8%, DBP was <85 mm of Hg in 85.5% and >85 mm of Hg in 14.5% and FBS was <100 mg/dl in 73.3% and >100 mg/dl in 26.7% of women with metabolic syndrome [21]. Jeengar P et al., found that the Waist circumference >35 inches in 66%, hypertriglyceridemia was observed

in 30%, HDL levels was seen <50 mg/dl in 80% patients with metabolic syndrome [22].

The mean values of triglycerides were 123 mg/dl, HDL was 47.48 mg/dl, LDL was 102.85 mg/dl, total cholesterol was 165.5 mg/dl, and fasting blood sugar was 106.2 mg/dl in women with metabolic syndrome. Laboratory parameter mean differences were statistically significant (p 0.05) (Table 3). Mandrelle K et al. discovered dyslipidemia in 93.3% of cases, elevated blood pressure in 20%, impaired fasting glucose in 8.3%, and low HDL in 91.7% of cases [12]. According to Amrita G et al., the metabolic syndrome's most prevalent component was low HDL in 84.9% of cases, followed by central obesity in 56.6%, hypertriglyceridemia in 44.3%, high FBS in 32.07%, and high blood pressure in 13.2% [25]. In women with and without metabolic syndrome, Ehrmann DA et al. discovered mean HDL 38.4 mg/dl and 50.7 mg/dl, total cholesterol 202.7 mg/dl and 183.1 mg/dl, triglycerides 203.7 mg/dl and 103.8 mg/dl, and LDL 125 mg/dl and 111.6 mg/dl [11]. According to Madusudhanan RR et al., women with metabolic syndrome had triglyceride levels that were 150 mg/dl in 42% of cases and >150 mg/dl in 58%, and HDL values that were >50 mg/dl in 5.3% of cases and 50 mg/dl in 94.7% of cases [21].

The diagnostic prediction of study variable in the patient with metabolic syndromes showed sensitivity of 88%, 88%, 90%, 81%, 55% and 64% for BMI, waist circumference, low HDL, high LDL, high TGS and high FBS. The specificity of 65%, 61%, 74%, 98%, 100% and 81% for BMI, waist circumference, low HDL, high LDL, high TGS and high FBS. The mean difference of diagnostic prediction between clinical and laboratory parameters was statistically significant (p<0.05).

According to Mandrelle K et al. [12], the occurrence of metabolic syndrome was substantially correlated with age and waist-hip ratio. According to Ehrmann DA et al. [11], metabolic syndrome is prevalent in women with PCOS, especially those who have high BMI and insulin levels. Visceral adiposity index, lipid accumulation product, waist-to-height ratio, and triglycerides-to-HDL cholesterol ratio are the main markers in the assessment of metabolic syndrome in PCOS, as reported by Kauna, Magorzata et al. [27]. According to Pourteymour FTF et al., the individual factors for the high prevalence of metabolic syndrome in PCOS include elevated triglyceride levels and decreased HDL levels [13]. According to a study by Aghade SM et al., the three most common elements of metabolic syndrome in women with PCOS were elevated triglycerides (42%), increased waist circumference

(75.33%), and decreased HDL (84.67%) [24]. The findings of the current investigation were consistent with those of earlier studies, which found that elevated levels of TGL and total cholesterol are essential elements of the metabolic syndrome.

The current study included a smaller participant pool and a shorter study period. It was necessary to conduct more long-term outcome analyses with a sizable sample size to determine the relationship between metabolic syndrome and PCOS in females.

Conclusion

One in four patients who visit a gynaecologist have PCOS, which is a common illness affecting women of reproductive age. The current study emphasises the importance of complete metabolic syndrome screening in PCOS-affected patients.

The results of present study showed in women with PCOS who were in the reproductive age range, the prevalence of metabolic syndrome was 41.93%. Women over 26 years who have a large waist circumference and BMI over 26 kg/m² are more likely to develop metabolic syndrome. In women with PCOS, the prevalence of metabolic syndrome can be decreased with dietary and lifestyle changes, exercise, and suitable medication.

References

1. Kauffman RP, Baker TE, Baker VM, DiMarino P, Castracane VD. Endocrine and metabolic differences among phenotypic expressions of polycystic ovary syndrome according to the 2003 Rotterdam consensus criteria. *Am J Obstet Gynecol.* 2008;198(6): 670.e1-7.
2. Teede HJ, Misso ML, Costello MF, et al. Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. *Hum Reprod* 2018; 33: 1602–1618.
3. Cioana M, Deng J, Nadarajah A, Hou M, Qiu Y, Chen S, et al. Prevalence of Polycystic Ovary Syndrome in Patients with Pediatric Type 2 Diabetes. *JAMA Network Open.* 2022;5(2): e2147454.
4. Christensen SB, Black MH, Smith N. Prevalence of polycystic ovary syndrome in adolescents. *Fertil Steril.* 2013;100(2):470-7.
5. Ibáñez L, Oberfield SE, Witchel S. An international consortium update: pathophysiology, diagnosis, and treatment of polycystic ovarian syndrome in adolescence. *Horm Res Paediatr.* 2017;88(6):371-95.
6. Peña AS, Witchel SF, Hoeger KM. Adolescent polycystic ovary syndrome according to the international evidence-based guideline. *BMC Med.* 2020;18(1):72.
7. Huang PL. A comprehensive definition for metabolic syndrome. *Dis Model Mech.* 2009; 2:231-237.
8. Cheung LP, Ma RC, Lam PM, Lok IH, Haines CJ, So WY, Tong PC, Cockram CS, Chow CC, Goggins WB. Cardiovascular risks and metabolic syndrome in Hong Kong Chinese women with polycystic ovary syndrome. *Hum Reprod* 2008;23(6):1431-1438.
9. Moran LJ, Misso ML, Wild RA, Norman RJ. Impaired glucose tolerance, type 2 diabetes and metabolic syndrome in polycystic ovary syndrome: a systematic review and meta-analysis. *Hum Reprod Update.* 2010; 16:347-363.
10. Tehrani FR, Rashidi H, Khomami MB, Tohidi M, Azizi F. The prevalence of metabolic disorders in various phenotypes of polycystic ovary syndrome: a community based study in Southwest of Iran. *Reprod Biol Endocrinol.* 2014; 12:89.
11. Ehrmann DA, Lijenquist DR, Kasza K, Azizi R. "Prevalence and predictors of the metabolic syndrome in women with polycystic ovary syndrome." *The Journal of clinical endocrinology and metabolism* 2006; 91(1): 48-53.
12. Mandrelle K, Kamath MS, Bondu DJ, Chandy A, Aleyamma TK, George K. Prevalence of metabolic syndrome in women with polycystic ovary syndrome attending an infertility clinic in a tertiary care hospital in south India. *J Hum Reprod Sci* 2012; 5:26-31.
13. Pourteymour FTF, Alipoor B, Mehrzad Sadaghiani M, Ostadrahimi A, Malek Mahdavi A. Metabolic syndrome and its characteristics among reproductive-aged women with polycystic ovary syndrome: A Cross-sectional Study in Northwest Iran. *Int J Fertil Steril* 2013; 6(4): 244-249.
14. Hillman JK, Johnson LN, Limaye M, Feldman RA, Sammel M, Dokras A. Black women with polycystic ovary syndrome (PCOS) have increased risk for metabolic syndrome and cardiovascular disease compared with white women with PCOS [corrected]. *Fertil Steril.* 2014; 101:530-535.
15. Romanowski MD, Parolin MB, Freitas AC, Piazza MJ, Basso J, Urbanetz AA. Prevalence of non-alcoholic fatty liver disease in women with polycystic ovary syndrome and its correlation with metabolic syndrome. *Arq Gastroenterol.* 2015; 52:117-123.
16. Sharma S, Majumdar A. Prevalence of metabolic syndrome in relation to body mass index and polycystic ovarian syndrome in Indian women. *J Hum Reprod Sci.* 2015; 8:202-208.
17. Aydin Y, Hassa H, Burkankulu D, Arslantas D, Sayiner D, Ozerdogan N. What is the risk

- of metabolic syndrome in adolescents with normal BMI who have polycystic ovary syndrome? *J Pediatr Adolesc Gynecol.* 2015; 28:271-274.
18. Jamil AS, Alalaf SK, Al-Tawil NG, Al-Shawaf T. A case-control observational study of insulin resistance and metabolic syndrome among the four phenotypes of polycystic ovary syndrome based on Rotterdam criteria. *Reprod Health.* 2015; 12:7.
 19. Boyle JA, Cunningham J, Norman RJ, Dunbar T, O'Dea K. Polycystic ovary syndrome and metabolic syndrome in Indigenous Australian women. *Intern Med J.* 2015; 45:1247-1254.
 20. Albu A, Radian S, Fica S, Barbu CG. Biochemical hyperandrogenism is associated with metabolic syndrome independently of adiposity and insulin resistance in Romanian polycystic ovary syndrome patients. *Endocrine.* 2015; 48:696-704.
 21. Madusudhanan RR, Nambisan B, Brahmanandan M, Radha S. Study on the Prevalence and Characteristics of Metabolic Syndrome in Women of Reproductive Age Group with Polycystic Ovarian Syndrome. *J South Asian Feder Obst Gynae* 2017;9(4):341-347.
 22. Jeengar P, Chauhan M. Association of metabolic syndrome in polycystic ovarian syndrome. *The New Indian Journal of OBGYN.* 2017; 3(2): 90-4.
 23. Prema N, Vaidehi A. An Observational Study on the Prevalence of Metabolic Syndrome in Reproductive Aged Women with PCOS. *Indian Journal of Obstetrics and Gynecology.* 2018;6(6):581-587.
 24. Aghade SM, Bavikar JS. Prevalence of Metabolic Syndrome among Reproductive-aged Women with Polycystic Ovarian Syndrome: A Study from West-Central India. *Indian J Med Biochem* 2018;22(1):61-65.
 25. Amrita G, Anshumala J, Shrestha S, Ashlesha C. Metabolic syndrome among patients with polycystic ovarian syndrome presenting to a tertiary care hospital: a descriptive cross-sectional study. *J Nepal Med Assoc* 2022; 60(246):137-41.
 26. Belen MF, Lao SS. Association of metabolic syndrome with different phenotypes of polycystic ovarian syndrome among Filipino women in a tertiary hospital: A retrospective cohort study. *Philipp J Obstet Gynecol* 2022; 46:242-8.
 27. Kałużna, Małgorzata et al. Lipid ratios and obesity indices are effective predictors of metabolic syndrome in women with polycystic ovary syndrome. *Ther Adv Endocrinol Metab* 2022;10(13):20420188211066699.