International Journal of Research in Medical Sciences
Onyegbule OA et al. Int J Res Med Sci. 2022 Mar;10(3):599-603
www.msjonline.org
pISSN2320-6071 | eISSN2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20220508

Original Research Article

Serum adiponectin and metabolic profile in women with polycystic ovarian syndrome in relation to body mass index

Onyema A. Onyegbule[1]*, Samuel C. Meludu[2], Chudi E. Dioka[1], John E. Okwara[1], Chikaodili N. Obi-Ezeani[3], Chidiadi M. Njoku[1]

[1]Department of Chemical Pathology, [2]Department of Human Biochemistry, Nnamdi Azikiwe University, Nnewi, Anambra State, Nigeria
[3]Department of Chemical Pathology, Chukwuemeka Odumegwu Ojukwu University, Awka, Anambra State, Nigeria

Received: 29 December 2021
Accepted: 29 January 2022

***Correspondence:**
Dr. Onyema A. Onyegbule,
E-mail: Onyemath1@gmail.com

ABSTRACT

Background: Polycystic ovarian syndrome is a common endocrine disorder which affects approximately 5-10% of women in reproductive age. It is both a reproductive endocrinopathy and a metabolic disorder.
Methods: 160 women aged 18 to 40 years attending obstetrics and gynaecology clinic at Federal medical centre, Owerri, Imo State Nigeria were recruited and divided into 2 groups (women diagnosed with PCOS using Rotterdam criteria and control) of 80 participants each. Anthropometric data were collected, and participants categorized into 3 based on BMI. Fasting blood samples was collected for biochemical analyses. Data were analyzed using the Statistical Package for Social Sciences SPSS version 23.0, and level of significance set at $p<0.05$.
Results: The mean serum levels of adiponectin and high density lipoprotein (HDL-C) were significantly lower while fasting plasma glucose, serum insulin, homeostatic model assessment for insulin resistance, total cholesterol, low density lipoprotein (LDL-C), very low density lipoprotein (VLDL-C) and triglyceride were significantly higher in women with PCOS when compared with the control ($p<0.05$) as well as in obese when compared with normal weight women with PCOS ($p<0.05$). BMI negatively correlated with serum adiponectin and HDL-C, but positively correlated with FPG, insulin, HOMA-IR, TC, TG, LDL-C and VLDL-C in women with PCOS ($p<0.05$).
Conclusions: This study highlights the prevalent biochemical and metabolic derangements in PCOS patients and was more evident in the obese and overweight patients. Early detection with subsequent application of preemptive measures including lifestyle modifications are therefore essential in the management of PCOS patients.

Keywords: Polycystic ovarian syndrome, Adiponectin, Metabolic profile, Body mass index

INTRODUCTION

Polycystic ovarian syndrome (PCOS) is a common endocrine disorder which affects approximately 5–10% of women in reproductive age group with a prevalence of about 4-20% worldwide.[1,2] PCOS is both a reproductive endocrinopathy and a metabolic disorder.[3]

Certain metabolic abnormalities associated with PCOS include obesity, dyslipidemia, insulin resistance, glucose intolerance, and hypertension, which pose an increased risk of cardiovascular disease both in lean and obese women with the disorder and a strong association with metabolic syndrome.[4,5]

Metabolic syndrome is another constellation of endocrine disorders comprised of insulin resistance, obesity, dyslipidemia and hypertension, and also associated with increased risk of cardiovascular disease and type 2 diabetes.[6] The effects of this metabolic disorder which is

associated with insulin resistanceand cardiometabolic risk are significantly amplified by obesity.[7]

According to the modified American heart association/National heart lung blood Institute AHA/NHLBI (ATP III 2005) definition, metabolic syndrome is present if three or more of the following criteria are present; waist circumference of ≥80cm, blood pressure of ≥130/85 mmHg, fasting blood sugar of ≥100 mg/dl, triglycerides of ≥150 mg/dl, and high density lipoprotein cholesterol (HDL-C) of ≤50 mg/dl.[6]

Adiponectin is a circulating protein secreted by adipocytes which plays an essential role in insulin resistance (IR), obesity, metabolic syndrome, and cardiovascular disease through its anti-inflammatory, anti-diabetic and anti-atherogenic properties.[8] Hypoadiponectinemia has been reported to be associated with the pathophysiology and metabolic complications as well as severity ofPCOS.[9,10] There is paucity of data on adiponectin levels and metabolic profile in women with PCOS in Owerri, and with respect to body mass index. This study therefore aimed at assessing serum adiponectin levels and metabolic profile in women with PCOS attending a tertiary health facility in Owerri, Imo State, Nigeria with respect to their body mass index (BMI).

METHODS

This is a case control study which involved 160 women aged 18 to 40 years attending obstetrics and gynaecology clinic at Federal medical centre (FMC), Owerri, Imo State, Nigeria. The participants were divided into 2 groups (A and B) of 80 participants each. Group A (cases) were women diagnosed with PCOS using Rotterdam criteria while group B (control) were apparently healthy age-matched women without PCOS (control).

Sample size was calculated putting the following into consideration; 95% confidence interval, 0.05 precision (d) and 2.2% prevalence rate (P). Prevalence of PCOS patients in Nnewi (2.2%).[11] Sample size was calculated using the formula given by Cochrane as $n=2Z^2PQ/d^2$. This gave a minimum sample size of 75, however, a sample size of 80 was used.[12] Participants' data that were collected included age, weight, height, waist circumference (WC) and hip circumference (HC) while BMI and waist to hip ratio (WHR) were calculated. Participants who met with Rotterdam criteria for diagnosis of PCOS as well as non-pregnant premenopausal women aged 18 to 40 years who gave their consent were included in the study whereas pregnant or breastfeeding women, women who have diabetes, cardiovascular or thyroid disorders as well as those on anti-hypertensives, lipid or glucose lowering drugs, weight reducing agents or glucocorticoids were excluded from the study.

The aim of the study was explained to the participants, and their written informed consent were obtained. The procedures followed were in accordance with the ethical standards and with the Helsinki Declaration. Weight was measured in kilograms (kg), height was measured in centimeters (cm) to the nearest 0.5 cm, waist circumference (WC) was measured in a standing position using a metric tape (cm) at the midpoint between the upper margin of the iliac crest and the lower margin of the last rib, and hip circumference (HC) was measured in a standing position as the greatest distance between the major trochanters (in cm) using a metric tape.

BMI was calculated by the formula; BMI (kg/m^2)=weight (kilogram)/height^2 (in meter) while waist to hip ratio (WHR) was calculated by dividing the waist circumference (in cm) by the hip circumference (in cm). Blood pressure (BP) was measured in sitting position in left arm, and an average of two measurements was taken as the BP reading.

The PCOS participants were classified into 3 based on their BMI which included; normal weight (18.9-24.5 kg/m^2), overweight (25.0-29.9 kg/m^2) and obese (≥30.0 kg/m^2). After an overnight fast, 5 milliliters (ml) of blood samples was collected from the participants by standard venipuncture method, 2ml was dispensed into fluoride oxalate tubes for plasma glucose (FPG) analysis while 3mL was dispensed into plain vacutainer tubes, centrifuged at 3000rpm for five minutes, and the sera obtained used for analyses of serum adinopectin, insulin, insulin resistance, total cholesterol (TC), high density lipoprotein (HDL) and triglyceride (TG). All analyses were performed using the Statistical Package for Social Sciences SPSS version 23.0 (SPSS, Inc. Chicago, IL, USA). Data were expressed as mean±standard deviation (SD). The independent student's t-test was used to compare mean differences between two independent variables, one way analysis of variance (ANOVA) was used to compare the mean differences among groups, and post-hoc test was used to assess the inter group variability. Pearson's correlation co-efficient was used to assess the level of association between two variables, and the level of significance was considered at $p<0.05$.

RESULTS

The results of this study showed no significant differences in the mean age, WHR and systolic blood pressure (SBP) of women with PCOS when compared with the control ($p>0.05$), however, the BMI and diastolic blood pressure (DBP) were significantly higher in these women when compared with the control with p values of 0.003 and 0.021 respectively, as shown in (Table 1). The mean serum levels of adiponectin and HDL-C were significantly lower while the mean FPG, serum insulin, HOMA-IR, TC, LDL-C, VLDL-C and TG were significantly higher in women with PCOS when compared with the control ($p<0.05$) as shown in (Table 2).

Table 1: Age, Anthropometric parameters and blood pressure values in women with PCOS and control (without PCOS) (n=80).

Parameters	PCOS	Control	T value	P value
Age (years)	26.15±5.80	27.91± 7.00	-1.713	0.087
BMI (kg/m^2)	28.29±7.05	25.54±3.90	-3.051	0.003*
WHR	0.92 ±0.11	0.91±0.06	0.694	0.489
SBP (mmHg)	114.13±12.31	116.55±19.28	-0.948	0.345
DBP (mmHg)	75.61±9.03	71.83±11.30	2.333	0.021*

*Significant

Table 2: Serum levels of adiponectin and metabolic profile in women with PCOS and control (n=80).

Parameters	PCOS	Control	T value	P value
Adiponectin (ng/ml)	3.99 ±1.14	6.64±2.84	-7.742	0.0001*
FPG (mmol/l)	4.32 ±1.06	3.854 ±0.84	3.059	0.003*
Insulin (µIU/ml)	16 .24±3.88	13.161 ±2.65	5.854	0.0001*
HOMA-IR	3.07±0.88	2.320±0.433	6.828	0.0001*
TC (mmol/l)	5.66±1.13	5.08±1.27	3.002	0.003*
LDL-C (mmol/l)	3.56±0.98	3.193 ±1.10	2.224	0.028*
HDL-C (mmol/l)	1.14±0.33	1.34±0.64	-2.513	0.013*
TG (mmol/l)	2.63± 0.74	1.51±0.87	8.798	0.0001*
VLDL-C (mmo/l)	1.20±0.34	0.69±0.39	8.798	0.0001*

*Significant

Table 3: Serum levels of adiponectin and metabolic profile in women with PCOS with respect to BMI.

Parameters	A Normal weight (N=29)	B Overweight (N=19)	C Obese (N=32)	A vs. B	A vs. C	B vs. C
Adiponectin (ng/ml)	4.74±1.25	3.68 ±1.07	3.50 ±0.75	0.003*	0.0001*	0.960
FPG (mmol/l)	3.57±0.41	4.26±0.83	4.97±1.16	0.026*	0.0001*	0.019*
Insulin (µIU/ml)	13.78±2.31	15.15±3.01	18.67±4.09	0.045*	0.0001*	0.009*
HOMA-IR	2.61±0.71	2.90±0.63	3.57± 0.91	0.048*	0.0001*	0.009*
TC (mmol/l)	4.18±0.84	4.50±0.71	5.26±0.60	0.424	0.0001*	0.001*
LDL-C (mmol/l)	2.85±0.79	3.34±0.73	4.29±0.71	0.089	0.0001*	0.0001*
HDL-C (mmol/l)	1.33±0.35	1.16±0.25	0.97±0.29	0.183	0.0001*	0.093
TG (mmol/l)	1.99±0.64	2.77±0.42	3.06±0.58	0.0001*	0.0001*	0.232
VLDL-C (mmo/l)	0.91±0.29	1.26±0.19	1.40±0.26	0.0001*	0.0001*	0.232

*Significant

Table 4: Correlation of BMI with adiponectin and metabolic profile in women with PCOS.

Parameters	PCOS		Control	
	BMI (r)	P value	BMI (r)	P value
Adiponectin(ng/ml)	-0.425	0.0001*	-0.040	0.724
FPG (mmol/l)	0.503	0.0001*	0.195	0.083
Insulin (µIU/ml)	0.527	0.0001*	0.159	0.065
HOMA-IR	0.484	0.0001*	0.107	0.345
TC (mmol/l)	0.352	0.001*	0.211	0.098
LDL-C (mmol/l)	0.551	0.0001*	0.125	0.268
HDL-C (mmol/l)	-0.439	0.0001*	-0.072	0.528
TG (mmol/l)	0.590	0.0001*	0.128	0.259
VLDL-C (mmo/l)	0.590	0.0001*	0.128	0.259

*Significant

The mean serum level of adiponectin was significantly lower while FPG, insulin and HOMA-IR levels were significantly higher in overweight and obese women when compared with normal weight women with PCOS ($p<0.05$) (Table 3). Mean serum adiponectin level did not differ significantly in overweight and obese women with

PCOS (p=0.960). Additionally, FPG, insulin and HOMA-IR levels were significantly higher in obese women compared with overweight women with PCOS (p<0.05). The mean serum levels of TC, LDL-C and HDL-C did not differ significantly between the normal weight and overweight women with PCOS (p>0.05), however, the mean serum levels of TG and VLDL-C were significantly higher in overweight compared with normal weight women with PCOS (p=0.0001). The mean serum levels of TC, LDL-C, TG and VLDL-C were significantly higher while HDL-C level was significantly lower in obese compared with the normal weight women with PCOS (p<0.05). Furthermore, the mean serum levels of LDL-C and TC were significantly higher in obese compared with overweight women with PCOS (p<0.05) whereas HDL-C, TG and VLDL-C levels did not differ significantly in overweight and obese women with PCOS (p>0.05). BMI showed significant negative correlations with serum adiponectin and HDL-C, significant positive correlations with FPG, insulin, HOMA-IR, TC, TG, LDL-C and VLDL-C in women with PCOS (p<0.05) whereas no significant correlations were observed between BMI and these parameters in the control (p>0.05) (Table 4).

DISCUSSION

This study assessed serum adiponectin and metabolic profile in women with PCOS with respect to BMI. Serum adiponectin level was observed to be lower in women with PCOS, and this corresponds with the findings of Gowthami et al who also reported significantly lower adiponectin levels in women with PCOS compared to healthy women.[13] Adiponectin, an abundant protein secreted by the adipocytes, and exists as multimers comprising high-molecular, medium-molecular, and low-molecular weight oligomers possess insulin-sensitizing, anti-diabetic and anti-atherogenicproperties.[14,15] Serum adiponectin was also observed to be much lower in obese and overweight women than normal weight women with PCOS, and this may be attributed to increased adiposity or BMI which invariably reduces adiponectin secretion. This scenario is further supported by the inverse association of BMI and adiponectin women with PCOS in the present study. In this study, the metabolic profile of women with PCOS was also altered, which included elevated levels of FPG, serum insulin, HOMA-IR, and dyslipidemia which manifested as elevated serum levels of TC, TG, LDL-C and VLDL-C, with reduced HDL-C levels are established indicators of cardiovascular disease (CVD) risk.CV risk factors thus appear to cluster in women with PCOS when compared with the general population.[16]

These elevations in FPG, serum insulin and HOMA-IR may be attributed to the prevailing insulin resistance in these women which may have resulted from failure in the continuous feedback relationship between the β-cells of the islet of Langerhans and insulin-sensitive tissues deregulating glucose and insulin levels, and subsequent development of diabetes mellitus and insulin resistance.[17] Zhu et al and Veena et al had earlier reported higher fasting blood glucose levels in women with PCOS, which they attributed to the underlying insulin resistance further fueled by the prevalent overweight, obesity and dyslipidemia.[18,19] Kheirollahi et al likewise reported significantly higher TC, TG and LDL-C levels with a lower HDL-C levels in women with PCOS. However, Rashidi et al observed that the lipid profile level in women with PCOS were not altered.[20,21]

Overweight and obesity have been reported as important risk factors for the development and progression of various diseases including type 2 diabetes mellitus and insulin resistance.[22] Therefore, the higher BMI in women with PCOS in the present study may as well have contributed to the altered metabolic profile with resultant metabolic syndrome in these women. Rashidi et al similarly reported a higher mean blood glucose in women with BMI >30 in the PCOS group compared to the control group whereas Gowthami et al on the contrary recorded no significant difference in the mean plasma glucose levels in PCOS participants compared to the control.[13,21]

Additionally, the direct association of BMI with FPG, insulin, HOMA-IR, TC, TG, LDL-C and VLDL-C as well as the inverse association with HDL-C further indicate the role of increased adiposity in exacerbating metabolic abnormalities in PCOS patients, which invariably increases cardiovascular risk. A significant association between BMI and features of PCOS at all ages was shown in the data from the Northern Finland Birth Cohort (NFBC) 1966.[23] Although no significant differences were recorded in the WHR and systolic blood pressure (SBP) in women with and without PCOS, diastolic blood pressure was observed to be higher in women with PCOS. Similarly, Zhu et al reported non-significant alterations in WHR, and Demir et al found no significant differences in mean blood pressure in PCOS women compared with the control.[13,24]

CONCLUSION

This study highlights the prevalent biochemical and metabolic derangements in PCOS patients which were more evident in the obese and overweight patients. Early detection with subsequent application of preemptive measures including lifestyle modifications are therefore essential in the management of PCOS patients.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Azziz R, Woods KS, Reyna R, Key TJ, Knochenhauer ES, Yildiz BO. The prevalence and

features of the polycystic ovary syndrome in an unselected population. J Clin Endocrinol Metab. 2004;89:2745-9.
2. Deswal R, Narwal V, Dang A,Pundir CS. The Prevalence of Polycystic Ovary Syndrome: A Brief Systematic Review. J Hum Reprod Sci. 2020;13(4): 261-71.
3. Aversa A, Sandro LV, Rocco R, Alessandra G, Nappi RE, Calogero AE, et al. Fundamental Concepts and Novel Aspects of Polycystic Ovarian Syndrome: Expert Consensus Resolutions. Front Endocrinol. 2020;11:516.
4. Vignesh JP, Mohan V. Polycystic ovary syndrome: A component of metabolic syndrome? J Postgrad Med. 2007;53:128-34.
5. Legro RS. Polycystic ovary syndrome and cardiovascular disease: A premature association? Endocr Rev. 2003;24:302-12.
6. Grundy SM, Cleeman JL, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation. 2005;112:2735-52.
7. Teede HJ, Joham AE, Paul E, Moran LJ, Loxton D, Jolley DJ, et al. Longitudinal weight gain in women identified with polycystic ovary syndrome: results of an observational study in young women. Obesity. 2013;21:1526-32.
8. Lindberg S, Jensen JS, Bjerre M, Frystyk J, Flyvbjerg A, Jeppesen J, et al. Low adiponectin levels at baseline and decreasing adiponectin levels over 10 years of follow-up predict risk of the metabolic syndrome. Diabetes Metab. 2017;43:134-9.
9. Demirci H, Yilmaz M, Ergun MA, Yurtcu E, Bukan N, Ayvaz G. Frequency of adiponectin gene polymorphisms in polycystic ovary syndrome and the association with serum adiponectin, androgen levels, insulin resistance and clinical parameters. Gynecol Endocrinol. 2010;26:348-55.
10. Shirazi FKH, Khodamoradi Z, Jeddi M. Insulin resistance and high molecular weight adiponectin in obese and non-obese patients with polycystic ovarian syndrome (PCOS). BMC Endocr Disord. 2021;21:45.
11. Igwegbe AO, Eleje GU,Enechukwu CI. Polycystic Ovary Syndrome: A Review of Management Outcomes in a Low Resource Setting. J Women's Health Issues Care. 2013;2:3.
12. Cochrane WG. Sampling techniques. 2nd ed. New York: John Wiley and Sons Inc; 1963.
13. Gowthami P, Kiranmayi VS, Rani BS, Suresh V,Vijayalakshmi DB. Study of serum adiponectin levels in women with polycystic ovary syndrome. Indian J Obstet Gynecol Res. 2019;6(3):288-92.
14. O'Connor A, Phelan N, Tun TK, BoranG, Gibney J, Roche HM. High molecular-Weight adiponectin is selectively reduced in women with polycystic ovary syndrome independent of body mass index and severity of insulin resistance. J Clin Endocrinol Metab. 2010;95(3):1378-85.
15. Wang T, Sha L, Li Y, Zhu L, Wang Z, Li K, et al. Plasma adiponectin levels and type 2 diabetes risk: a nested case-control study in a Chinese population and an updated meta-analysis. Sci Rep. 2018;8(1):406.
16. Zhang J, Xu JH, Qu QQ,Zhong GQ. Risk of Cardiovascular and Cerebrovascular Events in Polycystic Ovarian Syndrome Women: A Meta-Analysis of Cohort Studies. Front Cardiovasc Med. 2020;7:552421.
17. Al-Goblan AS, Al-Alfi MA, Khan, MZ. Mechanism linking diabetes mellitus and obesity. Diabet Metab Synd Obes Targets Ther. 2014;7:587-91.
18. Zhu JP, Teng YC, Zhou J, Lu W, Tao MF, Jia WP. Increased mean glucose levels in patients with polycystic ovary syndrome and hyperandrogenemia as determined by continuous glucose monitoring. Acta Obstet Gynecol Scand. 2013;92(2):165-71.
19. Veena HC, Reshmarani, Shilpa N. Altered blood glucose levels in polycystic ovary syndrome. Sch J Appl Med Sci. 2014;2(5F):1942-5.
20. Kheirollahi A, Teimouri M, Karimi M, Vatannejad A, Moradi N, Borumandnia N, et al. Evaluation of lipid ratios and triglyceride-glucose index as risk markers of insulin resistance in Iranian polycystic ovary syndrome women. Lipids Health Dis. 2020;19(1):235.
21. Rashidi H, Tafazoli M, Jalali MT, Mofrad AME. Serum lipid profile and insulin resistance in women with polycystic ovary syndrome (PCOS). J Diab Metab Disord Control. 2018;5(3):107-11.
22. Linder S, Abu-Omar K, Geidl W, Messing S, Sarshar M, Reimers AK, et al. Physical inactivity in healthy, obese, and diabetic adults in Germany: An analysis of related socio-demographic variables. PloS One. 2021;16(2):e0246634.
23. Ollila MM, Piltonen T, Puukka K, Ruokonen A, Järvelin MR, Tapanainen JS, et al. Weight Gain and Dyslipidemia in Early Adulthood Associate with Polycystic Ovary Syndrome: Prospective Cohort Study. J Clin Endocrinol Metab. 2016;101(2):739-47.
24. Demir I, Guler A, Alarslan P, Isil AM, Ucman O, Aslanipour B, et al. Fractalkine: an inflammatory chemokine elevated in subjects with polycystic ovary syndrome. Endocrine. 2019;65:175-83.

Cite this article as: Onyegbule OA, Meludu SC, Dioka CE, Okwara JE, Obi-Ezeani CN, Njoku CM. Serum adiponectin and metabolic profile in women with polycystic ovarian syndrome in relation to body mass index. Int J Res Med Sci2022;10:599-603.