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Prevalence of metabolic and hematologic manifestations among women with polycystic ovarian syndrome

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Abstract

Polycystic Ovarian Syndrome (PCOS) is a prevalent endocrine disorder that significantly affects women's health, but its impact on women remains overlooked. In this study, various metabolic and hematologic tests were performed, with the aims: (1) determine test results of metabolic parameters: (a) fasting blood sugar (FBS), (b) total cholesterol, (c) blood urea nitrogen (BUN), & (d) creatinine; and (2) hematologic parameters: (e) hematocrit (Hct), (f) hemoglobin (Hb), (g) prothrombin time (PT), & (h) activated partial thromboplastin time (aPTT) among PCOS-diagnosed women. As well as to (3) determine the significant relationship between the date of PCOS diagnosis with the metabolic and hematologic parameters. The group consists of 10 PCOS-diagnosed women Ten (10), 18-35-year old women, medically diagnosed with PCOS by a physician in City of San Fernando, La Union. Statistical analysis revealed that the mean total cholesterol of the respondents are interpreted as "high" and are therefore more likely to exhibit abnormally elevated total cholesterol levels more than FBS, BUN and creatinine. They are also more likely to exhibit normal hematologic parameters, such as Hct, Hb, PT, and aPTT. It was also pointed out that there is no significant relationship between the date of diagnosis of PCOS and the metabolic and hematologic parameters in PCOS-diagnosed women. Thus, regardless of the time of diagnosis of PCOS, it does not actually affect their metabolic and hematologic manifestations. This study posits that PCOS-diagnosed women are likely to have affected metabolic functions more than hematologic functions.

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INTRODUCTION

Polycystic ovary syndrome (PCOS) is defined by the World Health Organization (2023) as a chronic, incurable collection of symptoms commonly affecting women of reproductive age. It is characterized by dysfunction in ovulation, clinical or biochemical hyperandrogenism, and the presence of polycystic ovarian morphology. Symptoms may develop during adolescence, but may fluctuate overtime.

The word "polycystic" means "many cysts." These sacs are actually follicles, each one containing an immature egg, wherein they never mature enough to trigger ovulation. This is pertaining to bilateral enlarged ovaries studded with atretic follicles and evidence of fluid-filled cysts as identified by ultrasound scanning. The lack of ovulation alters levels of estrogen, progesterone, follicle stimulating hormone (FSH), and luteinizing hormone (LH), but androgen levels are higher than usual. (Watson, 2023; International Classification of Diseases, 2022)

PCOS is a significant public health problem and is one of the commonest hormonal disturbances affecting women of reproductive age. The condition affects an estimated 116 million (8–13%) of women of reproductive age, and up to 70% of cases are undiagnosed. The biological and psychological effects of PCOS, particularly those related to obesity, body image and infertility, can lead to mental health challenges and social stigma (World Health Organization, 2023).

According to a thorough screening of women using National Institutes of Health (NIH) diagnostic criteria, 4-10% of reproductive-age women worldwide are estimated to have PCOS. PCOS begins with menstruation, although can develop at any age, the majority of incidence occurs in the ages of 20 to 30. Globally, PCOS affects 1.55 million women of reproductive age, it accounts for 0.43 million disability-adjusted life years (DALYs). The age-standardized incidence rate of PCOS in women of reproductive age was 82.44 per 100,000 in 2017, 1.45% higher from 2007 (Singh *et al.*, 2023).

In the Philippines, PCOS affects many women of reproductive age, with an estimate of about 4.5 million Filipina patients diagnosed and the cause of female infertility in the Philippines. However, healthcare for them is poor, focusing on surgical removal of ovaries. This has a devastating impact on the women, affecting their relationships, has its own health risks and is ruinously expensive (UK Research and Innovation, 2024).

In a study by Bisquera (2023), researchers looked at 142 Filipino women aged 18 to 45 with PCOS (Polycystic Ovary Syndrome). On average, the women were about 30 years old. Most of the women in the study had the type of PCOS known as phenotype A (37.32%). Women with PCOS often show signs of high male hormones, especially those with types A and B. Many of these women also have obesity and carry extra weight around their midsection. The types of PCOS that affect ovulation (A, B, and D) are linked to more severe metabolic issues.

In the City of San Fernando, La Union as reported by the Ilocos Training and Regional Medical Center, PCOS cases are rarely reported as part of the population of common comorbidities in the province. A total of 131 PCOS patients were recorded from 2023-2024: 10 in-patients, 10 ER-patients, and 111 out-patients, respectively. Meanwhile, according to the City Health Office of City of San Fernando, La Union, there are a total of 76 reported PCOS cases from 2023 and 7 cases in 2024. This very low number of reported cases signifies that PCOS is often overlooked in the community and it is not entirely correlated with the different common comorbidities in the society.

Inherent insulin resistance in PCOS is due to an improper response to insulin in metabolically active tissues like adipose tissue and skeletal muscle. Obese women with PCOS are more prone to insulin resistance, potentially causing abnormal glucose and lipid metabolism. Moreover, increasing insulin lowers the circulating amount of

sex hormone-binding globulin (SHBG) and promotes free androgens, which constrains follicle formation resulting in irregular menses and impotency (Xing *et al.*, 2020).

Insulin resistance (IR) in PCOS happens because the body doesn't respond well to insulin in various tissues. This leads to higher baseline insulin levels and a weaker response to glucose intake. PCOS affects many organs and tissues. Insulin has different roles in different tissues to balance nutrient supply and demand. High insulin levels due to tissue resistance are central to PCOS problems. In women with PCOS, insulin resistance impacts how metabolism and cell growth work in both main insulin target tissues (like the liver, muscles, and fat) and other tissues (like the ovaries and pituitary gland) (Zhao *et al.*, 2023)

PCOS causes oxidative stress by promoting the development of immature red blood cells. This leads to higher red cell distribution width and hemoglobin levels. For people with PCOS, their elevated red cell distribution width and average hemoglobin concentrations may thus be tied to ongoing low-grade inflammation. Moreover, PCOS patients are affected 30-70% by obesity, and reduced supply of oxygen to fat tissues activates overexpression of factors like hypoxia-inducible factor 1, that stimulates hemoglobin synthesis. The interplay between inflammation, blood cell production, and weight issues offers clues about how PCOS disrupts bodily functions. Research also shows that insulin may promote the growth of bone marrow and hematopoietic stem cells, and bind to receptors on red blood cells, increasing their production and hemoglobin levels (Ha *et al.*, 2023).

Dyslipidemia, marked by elevated triglycerides and low high-density lipoprotein cholesterol levels, is the most frequent metabolic abnormality in PCOS. Advanced lipid profiling in some studies has shown high low-density lipoprotein cholesterol levels, an increase in atherogenic lipoproteins, and a reduction in high-density lipoprotein cholesterol efflux capacity, all of which indicate a heightened risk of cardiovascular disease (CVD) (Hoeger *et al.*, 2021).

Hyperinsulinemia and insulin resistance are metabolic features shared by the majority of slim women with PCOS. Hyperinsulinemia, along with β cell dysfunction, raises the risk of developing metabolic abnormalities such as type 2 diabetes, hypertension, dyslipidemia, and cardiovascular disease. Importantly, the frequency of these metabolic abnormalities is substantial in women with this condition, and the combination of overweight or obesity with PCOS worsens not only metabolic complications, but also reproductive derangements associated with this endocrinopathy (Sanchez-Garrido *et al.*, 2020).

The metabolic characteristics of non-obese PCOS patients remain debated. Some studies have demonstrated that even after accounting for body mass index (BMI), women with PCOS still face a higher risk of metabolic dysfunctions. A meta-analysis also found a higher prevalence of impaired glucose tolerance (IGT) and metabolic syndrome (Mets), especially in lean women (BMI <25 kg/m^2) with PCOS compared to those with similar BMI but without PCOS (Zhu *et al.*, 2019).

This study aims to investigate the prevalence of metabolic and hematologic manifestations among Polycystic Ovarian Syndrome (PCOS) -diagnosed women in the City of San Fernando, La Union. The lack of focused research leaves a gap in understanding the detailed metabolic abnormalities that may significantly affect the health of women with PCOS. The researchers aim to bridge the gap by providing a detailed analysis of metabolic and hematologic manifestations among women diagnosed with PCOS. By focusing on fasting glucose levels, total cholesterol, albumin, blood urea nitrogen (BUN) and creatinine levels, the research will uncover specific patterns of metabolic dysfunction and hematologic abnormalities such as prothrombin time (PT) and activated partial thromboplastin time (aPTT), which are often overlooked.

MATERIALS AND METHODS

The study employed a descriptive-correlational method to gather valid and reliable data to address all research questions and all research objectives as stated. As defined by Bhat (2023), descriptive research is defined as a research method that involves observing behavior to describe attributes objectively and systematically. A descriptive research project seeks to comprehend phenomena or groups in depth. Meanwhile, a correlational design method that describes and predicts how variables are naturally related in the real world without the researcher attempting to alter them or assign causation between them (Bhat, 2024).

Moreover, the study tackles the population of PCOS-diagnosed women. Using descriptive-correlational study, the PCOS-diagnosed women will serve as the subjects to make an in-depth analysis and explain the phenomena.

The respondents to this study were chosen through snowball sampling. Snowball sampling is a recruitment technique in which research participants are asked to assist researchers in identifying other potential subjects (Oregon State University, 2010). This approach is ideal for populations that are difficult to access, such as individuals involved in illegal or stigmatized activities. Leveraging referrals from trusted members of the community helps establish rapport, resulting in more accurate and honest data. (InnovateMR, 2024)

This method is applicable in this study because the relationship between metabolic parameters: (a) fasting blood sugar (FBS), (b) total cholesterol, (c) blood urea nitrogen (BUN), and (d) creatinine; and hematologic parameters: (a) hematocrit (Hct), (b) hemoglobin (Hb), (c) prothrombin time (PT), and (d) activated partial thromboplastin time (aPTT) among PCOS-diagnosed women. Through purposely selecting the respondents with a range of metabolic and hematologic manifestations, the research could better understand this relationship with PCOS. Moreover, snowball sampling allows researchers to choose participants who meet the specific criteria that is relevant to the study. Therefore, the researchers can concentrate only on the group of interest, reducing the number of individuals that are not relevant to the research purpose.

A total of 10 respondents were pre-selected for the study, particularly PCOS-diagnosed women. The respondents that will be selected are between 18–35 years old and will come from various socio-economic status. However, an extensive inclusion-exclusion criteria will be strictly implemented. Such inclusion-exclusion parameters are discussed in the following.

A participant is enrolled in the sampling group if she: (1) has been duly diagnosed with PCOS by a board-certified physician, (2) did not have any known inherent metabolic dysfunction and hematologic conditions prior to the PCOS diagnosis, including but not limited to diabetes mellitus, pancreatic insufficiencies, growth hormone imbalances, and (3) does currently not take any medications that can interfere with their metabolic and hematologic function such as blood glucose-lowering medications, anticholesterolemic, antihypertensive drugs, blood thinners, and other similar medications.

Simultaneously, the respondent is enlisted if she: (1) presents a normal physical and cognitive function and presentation of a medical certificate or sonography report confirming PCOS diagnosis, (2) did not have any known predisposing metabolic dysfunction and hematologic conditions prior to PCOS diagnosis similar to the conditions listed above. All participants that will be enrolled in the study will voluntarily participate. The failure to satisfy these requirements deferred the individual to participate in the study.

The testing and data analysis will be conducted primarily at LORMA Colleges- Center for Health

Sciences Campus, located in Carlatan, City of San Fernando, La Union as well as partner hospitals and laboratories within the city.

This study was conducted independently, without any external funding, and was entirely financed by the researchers themselves. A comprehensive, multifaceted approach was utilized to gather the necessary data for the research.

In terms of metabolic parameters, several key measurements were taken: (a) Fasting Blood Sugar (FBS) was measured using a POCT glucose meter device with Flavin Adenine Dinucleotide-dependent Glucose Dehydrogenase (FAD-GDH) principle; (b) Total Cholesterol was measured using a clinical chemistry reagent kit using the principle of Cholesterol Oxidase- Para Aminophenazone (CHOD-PAP) method, ensuring proper specimen preparation, test procedure, and concentration calculation indicated in the reagent kit. A wavelength of 546 nm was used to measure the intensity of the colored-complex solution; (c) Blood Urea Nitrogen (BUN) was also measured using a clinical chemistry reagent kit with the principle of Berthelot/Colorimetric method, ensuring proper specimen preparation, test procedure, and concentration calculation indicated in the reagent kit as well. A wavelength of 578 nm was used to measure the intensity of the colored-complex; (d) Creatinine was measured by the principle of Kinetic-Jaffe Method without deproteinization using a clinical chemistry reagent kit. A wavelength of 490 nm was used to measure the intensity of the colored-complex formed.

Additionally, hematologic parameters were also analyzed to deepen our understanding of the participants' health conditions: (a) Hematocrit and (b) Hemoglobin (Hct/Hb) were measured by the researchers measuring, focusing on red blood cell volume and hemoglobin concentration to ascertain the participants' overall blood health; (c) Prothrombin Time (PT) and (d) Activated Partial Thromboplastin Time (aPTT) tests were conducted by sending blood samples to partner hospitals using automated equipment. Notably, these tests did not require fasting specimens, allowing for greater flexibility in sample collection.

The normal values of the following parameters used in the study to compare are stated Table 1&2.

Table 1. Metabolic parameters and values

Metabolic Parameters	Ranges	Categorization
Fasting Blood Sugar	<69.99 mg/dL	Hypoglycemic
	70.00 – 100.00 mg/dL	Normal
	>100.01 mg/dL	Hyperglycemic
Total Cholesterol	<200.00 mg/dL	Normal
	200.01 – 240.00 mg/dL	Suspect
	>240.01 mg/dL	High
Blood Urea Nitrogen	<6.99 mg/dL	Low
	6.00 – 21.00 mg/dL	Normal
	>21.01 mg/dL	High
Creatinine	<0.69 mg/dL	Low
	0.70 – 1.20 mg/dL	Normal
	>1.21 mg/dL	High

Fasting Blood Sugar: Okuda-Shimazaki *et al.* (2020)

Total Cholesterol: Richmond (1973)

Blood Urea Nitrogen: Berthelot (1859), Tabacco *et al.* (1979)

Creatinine: Fabiny and Ertingshausen (1971)

Table 2. Hematologic parameters and values

Hematologic Parameters	Ranges	Categorization
Hematocrit	<0.36 L/L	Decreased
	0.37 – 0.47 L/L	Normal
	>0.48 L/L	Increased
Hemoglobin	<119 g/L	Decreased
	120 – 160 g/L	Normal
	>161 g/L	Increased
Prothrombin Time	<9.99 seconds	Shortened
	10.00 - 13.00 seconds	Normal
	>13.01 seconds	Prolonged
Activated Partial Thromboplastin Time	<24.99 seconds	Shortened
	25.00 – 35.00 seconds	Normal
	>35.01 seconds	Prolonged

Hematocrit: Primacare Medical and Diagnostic Center (n.d.)

Hemoglobin: Primacare Medical and Diagnostic Center (n.d.)

Prothrombin Time: Mayo Clinic (2024)

Activated Partial Thromboplastin Time: Cleveland Clinic (2023).

The recruitment of individuals diagnosed with polycystic ovary syndrome was conducted through a snowball sampling method as well as through personally communicating with the respondents. This approach aimed to gather essential demographic information such as their medical history from potential participants. To ensure the accuracy of the data collected, each respondent's PCOS diagnosis was verified through their medical records, confirming their eligibility for the study. This method was anticipated to yield a significant number of participants, thereby enhancing the study's robustness and validity.

Data collection was conducted in collaboration with a local hospital or laboratory to run blood samples from participants diagnosed with polycystic ovary syndrome for some tests. The researchers collected blood samples from the participants through venipuncture and performed the tests and analysis of the following parameters: fasting blood sugar (FBS), total cholesterol, blood urea nitrogen (BUN), creatinine. As for the prothrombin time (PT), and activated partial thromboplastin time (aPTT) tests, hematocrit (Hct), and hemoglobin (Hb) these were performed by the healthcare professionals in a local hospital laboratory.

The researchers computed the descriptive statistics, including the mean, median, standard deviation, as well as the significant relationship of the date of diagnosis of PCOS to the metabolic and hematologic parameters and other relevant statistics for each variable. Then the researchers compared the laboratory results with the reference ranges to assess the prevalence rates on the metabolic and hematologic parameters and its relationship with the date of diagnosis of PCOS.

Descriptive statistics which include the mean, standard deviation, standard error of the mean were utilized to summarize the data gathered. Descriptive statistics provides tools to explore, summarize and illustrate the research data. A 95% confidence interval is utilized, whereas this is defined as a range of values that contains the true mean value (population μ) with a probability of 95% (Bulanov *et al.*, 2021). The data was analyzed using Microsoft Excel to compute the descriptive statistics aforementioned.

Pearson R was used to determine the statistical relationship between the date of diagnosis of PCOS and the different metabolic and hematologic parameters. This method demonstrates the relationship between variables in a given sample, and it is often used to clean up and summarize scattered data, which is crucial for making inferential statistical comparisons and conducting research (Kaur, 2018; Dong, 2023). A positive correlation indicates a direct relationship while a negative correlation suggests an inverse relationship. The strength of the correlation will be determined by the magnitude of the correlation coefficient, with values closer to +1 or -1 indicating stronger relationships. SPSS v.21 was used to compute the statistical relationship between the date of diagnosis of PCOS and the metabolic and hematologic parameters

RESULTS

The data presented were the results of metabolic parameters in terms of: (a) fasting blood sugar (FBS), (b) total cholesterol, (c) blood urea nitrogen (BUN), (d) creatinine; and hematologic parameters in terms of: (e) hematocrit (Hct), (f) hemoglobin (Hb), (g) prothrombin time (PT), (h) activated partial thromboplastin time (aPTT).

Table 3. Mean results of metabolic parameters of PCOS-diagnosed patients

Parameter	N	Mean	Min.	Max.	Interpretation
FBS	10	95.300	82	121	Normal
TC	10	248.523	92.2	426.99	High
BUN	10	21.752	7.15	54.61	High
Crea	10	1.108	0.84	1.38	Normal

FBS: Hypoglycemic= <69.99 mg.dL Normal= 70-99 mg/dL, Hyperglycemic= >100 mg/dL;

TC: Normal= <200 mg/dL, Suspect= 200-240 mg/dL, High= >240 mg/dL;

BUN: Low= >6.99 mg/dL, Normal= 7.00 – 20.00 mg/dL, High = >20.01 mg/dL;

Crea: Low= <0.69 mg/dL, Normal= 0.70 - 1.20 mg/dL, High= >1.21 mg/dL

Presented in Table 3 were the means of the metabolic parameters: (a) fasting blood sugar (FBS)= 95.300, (b) Total Cholesterol= 248.523, (c) Blood Urea Nitrogen= 21.752, and (d) Creatinine= 1.108, respectively, obtained from the laboratory results of the PCOS-diagnosed patients and in accordance with the ranges presented in Table 1. It is important to note that these PCOS-diagnosed patients were not previously diagnosed with diabetes mellitus or any other metabolic disorders as well as did not intake any medications that could falsely affect the different metabolic parameters prior to testing.

Table 4. Mean results of hematologic parameters of PCOS-diagnosed patients

Parameter	N	Mean	Min.	Max.	Interpretation
Hct	10	0.4180	0.37	0.45	Normal
Hb	10	140.10	126	153	Normal
PT	10	11.890	10.6	13.1	Normal
aPTT	10	30.840	26.9	36.5	Normal

Hct: Decreased= <0.36 L/L, Normal= 0.37-0.47 L/L, Increased= >0.47 L/L;
Hb: Decreased= <119 g/L, Normal= 120 – 160 g/L, Increased= >161 g/L;
PT: Shortened= <10.99 seconds, Normal= 11.00-13.00 seconds, Prolonged= >13.01 seconds;
aPTT: Shortened= <22.99 seconds, Normal= 23.00 – 35.00 seconds, Prolonged= >35.01 seconds

Table 4 presented the means of the hematologic parameters: (e) Hematocrit= 0.418, (f) Hemoglobin= 140.100, (g) Prothrombin Time= 11.890 and (h) Activated Partial Thromboplastin Time= 30.840, respectively. Obtained from the laboratory results of the PCOS-diagnosed patients and in accordance with the ranges presented in Table 2, Chapter 2. It is important to note that these PCOS-diagnosed patients were not previously diagnosed with anemia, hereditary bleeding, hematopoietic or any other hematologic disorders as well as did not intake any medications that could falsely affect the different hematologic parameters prior to testing.

Presented in Table 5 is the total number and percentage of PCOS patients falling under the category of normal and hyperglycemic under the fasting blood sugar parameter. It can be observed that eight (8) or 80% of the PCOS-patients had normal FBS values, whereas two (2) or 20% of them had hyperglycemic FBS values.

Table 5. Frequency Table of the Fasting Blood Sugar of the PCOS-diagnosed Patients

Classification	N	%
Hypoglycemic	0	0
Normal	8	80
Hyperglycemic	2	20

Table 6. Frequency table of the total cholesterol of the PCOS-diagnosed patients

Classification	N	%
Normal	4	40
Suspect	1	10
High	5	50

Presented in Table 6 is the total number and percentage of PCOS patients falling under the categories of normal, suspect, and high in terms of total cholesterol. It was observed that four (4) or 40% of the PCOS patients had normal total cholesterol values, whereas one (1) or 10% had suspect values, and five (5) or 50% had high total cholesterol values. These findings reinforce the established link between PCOS and dyslipidemia, particularly elevated cholesterol levels, as a significant metabolic feature of PCOS.

Table 7. Frequency table of the blood urea nitrogen of the PCOS-diagnosed patients

Classification	N	%
Normal	4	40
Suspect	1	10
High	5	50

The data presented in Table 7, showing that 70% of the PCOS patients had normal Blood Urea Nitrogen (BUN) levels and 30% had high levels, aligns with the broader findings from the cited studies, suggesting a nuanced relationship between PCOS and renal function.

Presented in Table 8 is the total number and percentage of PCOS patients falling under the categories of normal and high only of the Creatinine levels.

It was observed that eight (8) or 80% of the PCOS patients had normal creatinine values, whereas two (2) or 20% had high creatinine values. These findings support existing evidence that while most women with PCOS do not exhibit obvious kidney dysfunction, a subset may show early indicators of renal impairment. This is consistent with research suggesting a potential link between PCOS and specific blood markers of chronic kidney disease, such as creatinine, indicating that PCOS may subtly affect kidney function through underlying metabolic and inflammatory mechanisms.

Table 8. Frequency table of the creatinine of the PCOS-diagnosed patients

Classification	N	%
Low	0	0
Normal	8	80
High	2	20

Table 9. Frequency table of the hematocrit of the PCOS-diagnosed patients

Classification	N	%
Decreased	0	0
Normal	10	100
Increased	0	0

Presented in Table 9 is the total number and percentage of PCOS patients falling under the category of normal only in the hematocrit parameter. It can be observed that 10 or 100% of the PCOS patients had normal hematocrit levels and none presenting abnormal values.

Table 10. Frequency table of the hemoglobin of the PCOS-diagnosed patients

Classification	N	%
Decreased	0	0
Normal	10	100
Increased	0	0

Presented in Table 10 is the total number and percentage of PCOS patients falling under the category of normal levels only of hemoglobin levels, with no abnormal results manifested in patients.

Presented in Table 11, it was observed that 9 out of 10 or 90% of PCOS-diagnosed patients had normal Prothrombin Time (PT) values, while 1 out of 10 or 10% had prolonged PT, with a mean of 11.89 seconds. This suggests that the majority of PCOS patients in this sample maintained normal coagulation profiles based on PT. However, the presence of even one case of prolonged PT warrants clinical attention, especially in the context of PCOS, which has been increasingly linked to coagulation abnormalities.

Table 11. Frequency table of the prothrombin time of the PCOS-diagnosed patients

Classification	N	%
Shortened	0	0
Normal	9	90
Prolonged	1	10

Table 12. Frequency table of the activated partial thromboplastin time of the PCOS-diagnosed patients

Classification	N	%
Shortened	0	0
Normal	9	90
Prolonged	1	10

Table 13. Relationship between the duration of diagnosis of PCOS and the metabolic and hematologic parameters

Parameter	N	Pearson correlation	Sig. (2-tailed)
FBS	10	.660*	.038
Total cholesterol	10	.088	.808
BUN	10	-.474	.167
Creatinine	10	-.605	.064
Hematocrit	10	-.349	.323
Hemoglobin	10	-.355	.314
PT	10	.301	.397
aPTT	10	.447	.196
Duration of diagnosis of PCOS	10	1	–

Presented in Table 12 is the total number and percentage of PCOS patients falling under the categories of normal and prolonged only. It was observed that nine (9) or 90% of the PCOS patients had normal aPTT values, whereas one (1) or 10% had high aPTT values. These findings reinforced the current understanding that most women with PCOS do not show abnormalities in standard coagulation parameters such as aPTT.

In Table 13, it is stated that there is no significant relationship between the duration of diagnosis of

PCOS and the metabolic and hematologic parameters. This is due to the higher level of significance obtained than the set alpha at $p < 0.05$. Although the Fasting Blood Sugar (FBS) alone signifies a significant relationship with the date of diagnosis of PCOS with a p-value of .380.

DISCUSSION

For fasting blood sugar parameters, in a similar study by Suslade *et al.* (2024), in order to determine the correlation of insulin levels in changes in FBS in PCOS-diagnosed patients, a population consisted of a total of 60 women subject among them 30 women cases suffering from PCOS aged between 30 to 40 years taken as case group and 30 age-matched healthy women taken as control group. Results show mean serum insulin level in cases was 16.25±7.38 (U/mL) and control subjects was 5.58±3.17(U/mL). Result showed a highly significant (0.001) increase in serum insulin level in cases when compared to the control group. Thus, it reflects statistically significant (0.001) increased levels of total FBS in the PCOS group compared to the control group.

This concept is corroborated in a seminal study by Chang *et al.* (2024), the study found significant correlations between insulin resistance and hyperinsulinemia as key factors in PCOS, linking hyperglycemia to metabolic dysfunction. Corroborating factors include genetic predispositions, environmental influences, and lifestyle choices, all contributing to the complexity of PCOS pathophysiology. In fact, insulin resistance (IR) is one of the key elements to the genotypes and phenotypes of PCOS (Escobar-Morreale, 2018). Insulin resistance results in hyperinsulinemia and hyperandrogenism, leading to a series of cellular reactions that reflect on the physical traits of PCOS.

Furthermore, studies by Xu and Qiao (2022) state that overexposure of androgen is directly linked with insulin resistance and hyperinsulinaemia. Therefore insulin resistance and elevated androgen levels are major factors in the pathophysiology of PCOS. This is further supported by Ezeh *et al.* (2022), stating that hyperandrogenic PCOS women with amenorrhea, compared to those with oligomenorrhea or eumenorrhea, had a greater risk of post-challenge hyperinsulinemia, which may explain their higher prevalence of dysglycemia. But according to Tosi *et al.* (2022), age, adiposity, metabolic clearance rate of insulin (MCRI), and insulin sensitivity, but not serum androgens, were independent predictors of insulin secretion which predisposes the common finding of hyperinsulinemia in women with PCOS.

The findings can also be correlated in a study by Shakeel *et al.* (2024) investigated that hyperglycemia manifestation of PCOS patients are at significantly higher risk of developing Type 2 Diabetes Mellitus (T2DM). This highlights the need for early screening and comprehensive management strategies for mitigation. Similarly in a study by Liao *et al.* (2022), women with PCOS were associated with 5-fold higher risk of developing T2DM compared with women without PCOS. The overall incidence of T2DM was 6.25 per 1000 person-years in the PCOS group compared with 1.49 in the control group. However, the risk disappeared among women diagnosed with PCOS after age 35. These findings highlight the importance of prompting a more aggressive treatment to prevent diabetes among women diagnosed with PCOS at a young age, and in contrast, the lessened importance of this type of intervention in women diagnosed with PCOS at a late reproductive age.

These findings do not align with the concerns of Suslade, *et al.* (2024) and Chang *et al.* (2024) wherein according to them, increased FBS levels is associated with insulin resistance and hyperinsulinemia as key factors in PCOS. Although we can agree with Chang *et al.* that corroborating factors include genetic predispositions, environmental influences, and lifestyle choices, may contribute pathophysiologic manifestations of PCOS. However, these values may also alter overtime depending on the dysfunction severity of the blood glucose regulating mechanism of the body with the influence of the said corroborating factors and how the patient manages the condition.

According to review study by Livadas *et al.* (2022), possible explanations and causes of dysglycemia that poses risk for T2DM in PCOS patients can be attributed to the following: age of the studied subjects, with the higher incidence (12.4%) recorded in a study evaluating mostly perimenopausal women with PCOS and a mean age of 46 years (Pelanis et al, 2017); and another is ethnic variation, since a prevalence of 6.3% and 10.1% has been reported in two studies from Asia (Ganie, 2016; Seneviratne, 2009); last factor is that amenorrheic (absence of menstrual periods) women with PCOS had greater degrees of hyperinsulinemia compared to those who were oligomenorrheic (irregular menstrual cycle) or eumenorrheic (regular menstrual cycles with no significant symptoms or heavy bleeding).

Moreover, Purwar and Nagpure (2022) as well as majority of literature state that insulin resistance is the most attributed cause of dysglycemia in PCOS patients which is further amplified by obesity. Experts also consider hyperandrogenism to be a key characteristic of PCOS. Several theories propose different explanations for the condition, including a primary enzymatic defect in the production of adrenal and ovarian steroids. Other suggested factors include disruptions in the release of gonadotropin-releasing hormone (GnRH), which promotes luteinizing hormone (LH) secretion, as well as changes in insulin activity that lead to insulin resistance (Baptiste, *et al.*, 2010).

For the results from total cholesterol levels, this concept can be corroborated in a study by Prajapati (2022), who investigated the lipid profile variations in women diagnosed with PCOS. The study included 60 PCOS patients and 30 age-matched healthy controls. Results showed that PCOS patients had a notably higher mean total cholesterol level (197.04±18.16 mg/dL) compared to controls (174.53±12.36 mg/dL). Furthermore, this elevation was more pronounced in overweight and obese individuals, suggesting a compounding effect of BMI on lipid disturbances in PCOS. The study concluded that increased cholesterol levels were significantly associated with higher BMI and irregular menstrual cycles, common characteristics of PCOS.

A similar pattern was observed in a study conducted by Marbaniang *et al.* (2023), where lipid profiles of 45 women with PCOS were compared against 45 healthy controls. The findings indicated that PCOS patients had elevated levels of total cholesterol (mean 203.40±54.20 mg/dL) in contrast to controls, alongside higher LDL and triglyceride levels and lower HDL concentrations. These values were statistically significant, supporting the hypothesis that women with PCOS are more prone to dyslipidemia. The said study emphasized that these abnormalities, if left unmanaged, could heighten the risk for cardiovascular diseases.

Further evidence is presented in a large-scale observational study by Luo *et al.* (2021), which analyzed lipid parameters in 1,000 Chinese women diagnosed with PCOS. The results demonstrated that 41.3% of participants exhibited some form of dyslipidemia, with 8.6% showing elevated total cholesterol levels. The study also found that lipid abnormalities were significantly associated with increased waist circumference, hyperinsulinemia, and decreased sex hormone-binding globulin (SHBG), all of which are characteristic metabolic disruptions in PCOS. Notably, the study revealed that even non-obese PCOS patients could present with abnormal cholesterol levels, illustrating that dyslipidemia in PCOS is not solely a byproduct of obesity but a core component of the syndrome's pathophysiology.

The findings are supported by a study conducted by Parveen and Khan (2021), which focused on the association of lipid profiles with obesity in PCOS patients. The research demonstrated that obese women with PCOS had significantly elevated total cholesterol, LDL, and triglyceride levels compared to their non-obese counterparts. These results reinforce the idea that while obesity worsens lipid profiles, the dyslipidemic tendencies in PCOS patients are intrinsic to the disorder itself. The authors also emphasized that early intervention-particularly

dietary regulation and exercise—can significantly reduce cholesterol levels and improve the metabolic profile in affected individuals.

An article by Chan (2022) on Healthline, explains that declining estrogen levels during menopause are linked to increased total cholesterol, LDL, and triglycerides, as well as reduced HDL levels—factors that significantly elevate cardiovascular risk. The article references multiple studies showing that estrogen plays a key role in lipid regulation via its effects on the liver.

A comparable hormonal pattern is observed in women with PCOS. Although typically younger, PCOS patients often experience relatively low or imbalanced estrogen levels combined with elevated androgens. This hormonal environment disrupts lipid metabolism in a similar way, frequently resulting in elevated LDL and triglycerides and decreased HDL levels. These similarities indicate that dyslipidemia in PCOS, like in menopause, may be largely attributable to impaired estrogen-mediated lipid regulation, compounded by androgen excess and insulin resistance.

These findings are consistent with studies by Prajapati (2022), Marbaniang *et al.* (2023), Luo *et al.* (2021), and Parveen and Khan (2021), which also report higher levels of total cholesterol in PCOS patients, even in those who are not overweight. This suggests that high cholesterol is not just a result of obesity but a key feature of PCOS, linked to hormonal changes, insulin resistance, and how the body handles fats. While the percentage of PCOS patients with high cholesterol in this study supports these findings, it also shows the need for regular cholesterol checks and proper management to prevent heart problems. Although factors like insulin resistance, weight, and menstrual issues are known to affect cholesterol levels in PCOS, these may change over time based on how well the person manages their condition.

For blood urea nitrogen (BUN) parameter, animal studies by Fitria *et al.*'s (2023) indicates that hyperandrogenism, a key feature in some PCOS presentations, can indeed elevate BUN levels, pointing towards potential renal impairment in such cases. This could explain the 20% of patients exhibiting high BUN levels, assuming these individuals also presented with significant hyperandrogenism.

Conversely, Albalawi *et al.*'s (2024) meta-analysis of human studies found no significant differences in serum creatinine and eGFR between women with PCOS and controls, suggesting that overall renal filtration and function are typically normal in PCOS patients. This supports the finding of majority (50%) of the patients had normal BUN levels.

The observation of low BUN levels in 30% of the patients is not directly attributed to PCOS pathology in the literature. Oktanella *et al.* (2023) suggest that such low levels likely stem from coexisting factors unrelated to PCOS itself.

Furthermore, Zhou *et al.*'s (2023) Mendelian randomization analysis hints at a potential long-term association between PCOS and chronic kidney disease, particularly in the presence of metabolic comorbidities. The fact that the current study shows a majority with normal BUN might indicate the absence of significant pre-existing kidney disease or severe metabolic disturbances in this specific cohort, which aligns with the idea that renal issues in PCOS may manifest over time and with added complications.

Finally, the strong association between PCOS and nonalcoholic fatty liver disease (NAFLD), as highlighted by Falzarano *et al.* (2021) and Kelley *et al.* (2014), introduces another layer of complexity. While NAFLD can affect BUN levels independently, the study doesn't provide data to directly link the low BUN levels to NAFLD in this specific patient group.

In conclusion, showing a predominance of normal BUN levels alongside some instances of low and high levels in PCOS patients, correlates well with existing research. The normal BUN levels likely reflect the

absence of overt renal impairment in many PCOS patients, consistent with meta-analyses. The high BUN levels could be linked to hyperandrogenism, as suggested by animal studies. The presence of low BUN levels likely points to other underlying factors not directly related to PCOS pathology itself. Overall, these findings underscore that while PCOS alone may not typically lead to immediate renal dysfunction reflected in elevated BUN, the interplay of hyperandrogenism and potential long-term metabolic complications necessitates careful monitoring of renal health in women with PCOS.

While for the creatinine parameter, these findings indicated that renal function—as reflected by creatinine levels—remains within normal limits in this patient population. Monitoring creatinine is essential for assessing kidney health, and these results offer reassurance that, at baseline, PCOS does not appear to adversely impact renal function. However, the relationship between PCOS and kidney health is complex, and research presented mixed results. Several systematic reviews and meta-analyses have found no significant difference in serum creatinine or estimated glomerular filtration rate (eGFR) between women with PCOS and healthy controls, suggesting that creatinine alone may not fully capture subtle renal changes in this group.

For example, Widjanarko *et al.* (2024) conducted a systematic review and meta-analysis evaluating serum uric acid, serum creatinine, and estimated glomerular filtration rate (eGFR) as outcomes of interest in women with PCOS. The study found that uric acid levels were significantly higher in women with PCOS compared to controls (mean difference [MD] = 0.70, 95% confidence interval [CI] [0.45–0.95], $P < 0.00001$). In contrast, both serum creatinine and eGFR were statistically similar between the two groups (creatinine: MD = 0.08, 95% CI [−0.05–0.21], P = 0.22; eGFR: MD = 3.54, 95% CI [−4.53–11.61], P = 0.39). These results suggested that while PCOS is significantly associated with elevated uric acid, there is no significant difference in baseline creatinine or eGFR levels compared to healthy controls, which was relatively similar to the results obtained.

Nonetheless, PCOS is closely linked to a higher prevalence of metabolic syndrome, obesity, hypertension, and type 2 diabetes—all of which are established risk factors for kidney disease. Some studies suggest that inflammatory processes and metabolic complications in PCOS could indirectly increase the risk of glomerular injury, potentially reflected in elevated creatinine in certain subgroups, particularly those with obesity or poorly controlled metabolic syndrome.

With that, a cross-sectional study conducted by Sun *et al.* (2012) involving 34 women with PCOS and 36 controls employed nuclear magnetic resonance (NMR)-based techniques to analyze plasma samples. The study utilized multivariate statistical methods to examine the content of small metabolites and lipids. Notably, significant differences were observed between PCOS patients and controls. Specifically, PCOS patients showed decreased levels of certain amino acids (leucine, isoleucine, methionine, glutamine, and arginine), citrate, choline, and glycerophosphocholine/phosphocholine (GPC/PC) ($P < 0.05$). Conversely, increased levels of lactate, dimethylamine (DMA), creatine, and N-acetyl glycoproteins were detected ($P < 0.05$). Furthermore, subgroups of PCOS patients with obesity, metabolic syndrome, or hyperandrogenism exhibited more pronounced metabolic disturbances compared to their counterparts without these conditions. Overall, the study highlighted that PCOS is associated with perturbations in amino acid metabolism, the tricarboxylic acid (TCA) cycle, and gut microflora, as well as mild disturbances in glucose and lipid metabolism. These findings underscore the complex metabolic alterations in PCOS, which may be exacerbated by comorbid conditions.

Further evidence is provided by El-Eshmawy *et al.* (2022), who investigated the relationship between the serum uric acid/creatinine (UA/Cr) ratio and metabolic and hormonal parameters in obese women

with PCOS. The study included 40 obese women with PCOS and 40 age- and BMI-matched control women with regular menstrual cycles. Results demonstrated that the UA/Cr ratio was significantly higher in obese women with PCOS compared to controls. Moreover, the UA/Cr ratio showed significant correlations with various clinical and biochemical markers, including BMI, waist and neck circumferences, blood pressure, fasting insulin, HOMA-IR, lipid profile, LH/FSH ratio, estradiol, DHEAS, total testosterone, free androgen index (FAI), and SHBG. Importantly, both the UA/Cr ratio and FAI were identified as independent risk factors for PCOS in obese women. The study also found that the combined effect of an elevated UA/Cr ratio and FAI conferred a substantially higher risk for PCOS, with an odds' ratio of 4.3 (95% CI: 3.4–7.58, P = 0.002), indicating a significant additive or synergistic impact.

The data showed normal creatinine levels in PCOS patients, consistent with studies indicating that creatinine often remains normal unless complicated by metabolic or renal conditions. Renal disturbances in PCOS vary depending on disease severity, duration, and comorbidities.

For hematologic parameters starting with hematocrit, although literature regarding PCOS and its correlation to hematologic parameters are limited and studies linking these parameters to PCOS are yet to be done, Alhabardi *et al.* (2020) stated that there is no significant difference in hematological parameters white blood cells (WBC), platelets (PLT), and hemoglobin (Hb), including hematocrit (Hct), between women with PCOS and healthy controls. The women's mean age was 29.8±3.9 years in age, residence, and education between the cases and the controls. BMI was significantly higher in women with PCOS compared with the controls (P ¼ 0.024).

This aligns with the findings of Ucakturk *et al.* (2014) whereby the relationship of androgen levels was correlated with hematocrit levels in 40 adolescents with PCOS and compared with an age- and BMI-matched group of 40 obese girls without PCOS. It was found that there were no significant differences in hematocrit (5.03±0.66 vs. 41.2±2.66%) between the PCOS and obesity groups without PCOS (P>0.05). There was no correlation between the level of testosterone and CBC parameters.

Further studies by Al kafhage *et al.* (2023) state that women with PCOS have higher levels of hormones [luteinizing hormone (LH), follicle-stimulating hormone (FSH), prolactin, thyroid-stimulating hormone (TSH)] and hematological parameters [white blood cells (WBC), hemoglobin, platelet (PLT)] compared to controls.

However, further elucidation by Barath *et al.* (2022) says estradiol valerate administration in a PCOS rat model led to decreased red blood cell count, hemoglobin, and hematocrit. PCOS has various effects on blood circulation. PCOS causes raised plasma viscosity, which affects microcirculation (Vervita *et al.*, 2009).

Additionally, obesity might contribute to the development of PCOS in susceptible individuals due to the hormonal effects of adipose tissue. Adipose tissue, known for its endocrine function, plays a role in the hormonal dysregulation observed in PCOS (Romacho, 2014). Thus, the association between obesity and PCOS is further supported by the observed menstrual irregularities and hyperandrogenic status in affected women.

Moreover, from similar studies, alterations in hematocrit levels are seemingly tied to increased testosterone, LH, fasting insulin levels, higher triglyceride, and fibrinogen concentration. With fibrinogen level having a positive correlation with plasma viscosity (Haydardedeoglu *et al.*, 2014). The elevated plasma viscosity increases the whole blood viscosity, and this can impair the blood flow (Simmonds *et al.*, 2016). Thus, hormone administration, such as contraceptive use, seems to have an effect on elevating hemoglobin levels, as claimed by Barath *et al.* (2022).

Alhabardi *et al.* (2020) previously stated that there were no significant differences in hemoglobin between women with PCOS and controls. However, according to the study of Han *et al.* (2015), overweight and obese PCOS-diagnosed women tend to have elevated hemoglobin levels than their overweight/obese non-PCOS control counterparts. Al kafhage *et al.* (2023) and Mescher (2016) further support this claim, stating that hemoglobin concentrations may be affected by oligomenorrhea or amenorrhea and androgen excess, two important diagnostic criteria for PCOS. In comparison with healthy controls, women with PCOS had significantly greater hemoglobin levels and a decreased incidence of anemia.

In the study of Barath *et al.* (2022), a result of estradiol-valerate treatment, there is an established decrease in red blood cell count, hemoglobin, and hematocrit levels, and an increase in aggregation indices. Hormone levels in women with PCOS affect hemoglobin levels, as testosterone is a hematopoietic hormone and has a dose-dependent stimulatory effect on erythropoiesis (Berria *et al.*, 2006; Coviello *et al.*, 2008). The reduced frequency of menstruation in women with PCOS is also thought to cause differences in hemoglobin levels between women without PCOS.
For hemoglobin findings, this aligns with the findings of Alhabardi *et al.* (2020) and Ucakturk *et al.* (2014) where hemoglobin levels have no significant difference with PCOS and controls. Again pointing out that there was a significant increase in hormone levels (LH, FSH, prolactin, TSH) and CBC values (WBC, Hb, and PLT) in the PCOS group compared to the control group, with women aged 26-35 being more susceptible to PCOS. The mean values for WBC, PLT, and Hb were higher in the PCOS group (WBC: 14.50±1.97; PLT: 477.2±111.4; Hb: 15.121.14) compared to the control group (WBC: 6.4±2.3; PLT: 203.8±69.09; Hb: 7.2±1.93).

However, according to a study by Virtanen *et al.* (2024), higher hemoglobin levels have been associated with poorer metabolic profiles in the general population, and higher Hb levels among the normal variation are an independent risk factor for an adverse metabolic profile (Hashimoto *et al.*, 2015; Auvinen *et al.*, 2021). In their study, a significantly higher percentage of women with PCOS had Hb levels above the normal range at the age of 31 years (0.12% vs. 2.22%, $p = 0.002$), whereas a lower percentage had levels below the normal range compared to controls (5.72% vs. 3.56%, non-significant). Therefore, women with PCOS have elevated Hb levels, irrespective of menstrual status, and the connection between higher Hb and poor metabolic health is even more pronounced in PCOS women than in non-PCOS counterparts, and these PCOS-related effects on Hb grow less severe with age. This suggests the possibility of using Hb levels as an additional indicator for efficient metabolic therapies in PCOS.

Due to the limited number of studies regarding the relationship of PCOS and hemoglobin levels, it is mostly pointed out in the majority of literature, including Al kafhage *et al.* (2023) and Mescher (2016) that hemoglobin concentrations may be affected by oligomenorrhea or amenorrhea, androgen excess and that hyperandrogenism is the cause of elevated hemoglobin levels. We can also consider the idea of Virtanen *et al.* (2024) to use hemoglobin as an additional indicator for efficient metabolic therapies in PCOS given that patients manifest the said symptoms of hyperandrogenism and oligomenorrhea or amenorrhea in a variety of PCOS phenotypes.

While in prothrombin time (PT) parameter, this finding is supported by the This finding is supported by the Sun *et al.* (2019), which emphasized that PCOS can present with a subclinical prothrombotic state. Factors such as elevated androgen levels, insulin resistance, and low-grade chronic inflammation may alter coagulation mechanisms, even when PT and other routine markers remain within reference ranges. Moreover, Sun *et al.* (2019) found that specific coagulation parameters, including PT, activated partial thromboplastin time (APTT), and thrombin time (TT), may serve as predictive markers in PCOS, indicating underlying clotting disturbances even in the absence of clinical events.

These studies supported the present findings in the consideration of coagulation profiles as part of routine evaluations for PCOS patients. Although PT remained largely within normal ranges in this study, the evidence suggested that more sensitive or advanced coagulation assessments may be necessary to detect early or subclinical hemostatic changes. These findings align with current concerns that PCOS, due to its complex hormonal and metabolic imbalances, may predispose patients to thrombotic events.

Lastly for hematologic parameters which is activated partial thromboplastin time, although PCOS is often associated with a prothrombotic or hypercoagulable state, routine laboratory tests like aPTT and prothrombin time (PT) typically remain within normal limits for the majority of patients. This suggests that while PCOS may increase the risk of thrombosis, these changes are not usually reflected in conventional coagulation assays.

The predominance of normal aPTT values in this patient group aligned with existing literature and highlights that only a small proportion of PCOS patients exhibit prolonged aPTT, which could indicate other coagulopathies or unrelated conditions.

Elevated levels of pro-coagulation proteins such as plasminogen activator inhibitor-1 (PAI-1), fibrinogen, von Willebrand factor, D-dimer, and thrombin-activatable fibrinolysis inhibitor (TAFI) have been consistently reported in PCOS patients, indicating impaired fibrinolysis and a hypercoagulable condition (Güldaş *et al.*, 2015; Karakurt *et al.*, 2008-2021).

These coagulation abnormalities appear to be driven largely by obesity, inflammation, and insulin resistance rather than PCOS alone. Oral contraceptive use, a common treatment in PCOS, has been shown to increase coagulation markers including activated partial thromboplastin time (aPTT), potentially exacerbating thrombotic risk, whereas combination therapy with metformin may improve endothelial function and mitigate some cardiovascular risks (Luque-Ramírez *et al.*, 2009; 2019 study). Large meta-analyses confirm that PCOS is associated with increased risks of cardiovascular disease, myocardial infarction, and stroke, highlighting the clinical importance of managing coagulation disturbances alongside metabolic and inflammatory factors in this population. These findings suggest that addressing coagulation abnormalities could be an important component of comprehensive cardiovascular risk management in women with PCOS.

The activated partial thromboplastin time (aPTT) results in this PCOS study (mean 30.84, range 26.9–36.5 seconds) fall within the normal reference range, consistent with studies showing that standard coagulation tests like aPTT often remain normal in PCOS despite underlying prothrombotic tendencies. While PCOS is associated with hypercoagulability through mechanisms such as elevated fibrinogen, von Willebrand factor (vWF), and plasminogen activator inhibitor-1 (PAI-1), these changes primarily affect platelet function and fibrinolysis rather than the intrinsic pathway factors (VII, IX, XI, XII) measured by a PTT. This explains why the aPTT values appear normal despite evidence of heightened thrombotic risk in PCOS populations.

As stated in the previous corroborations, PCOS is one of the most common endocrine diseases among women of reproductive age and is associated with many metabolic manifestations, such as obesity, insulin resistance (IR) and hyperandrogenism. The metabolic symptoms of PCOS seem to be connected. It has been proposed that androgen excess is the beginning of a vicious cycle of metabolic disorders in PCOS patients. It is believed that with the induction of IR and hyperinsulinemia, hyperandrogenemia facilitates the formulation of visceral adipose tissue, which exacerbates the secretion of androgen in the ovaries and adrenal glands.

Accordingly, the vicious cycle is the potential mechanism of steroidogenesis defects, and the severity depends on different factors (Chen and Pang, 2021).

This is further supported by a seminal study by Rahman *et al.* (2023), PCOS also involves various metabolic dysfunctions such as insulin resistance (IR), hyperandrogenemia, obesity, dyslipidemia, as well as steroid hormone irregularities. Although the exact cause of PCOS is still unknown, it is known to cause several hormonal disturbances, including hyperandrogenemia, IR, and hyperinsulinemia. Therefore, metabolic symptoms of PCOS are interrelated, and hyperandrogenism triggers a cycle of metabolic disorders in patients with PCOS. This cycle is initiated by hyperinsulinemia and insulin resistance, which lead to the accumulation of visceral adipose tissue, causing an increase in androgen production in the adrenal glands and ovaries. Thus, a vicious cycle is formed, a possible mechanism for steroidogenesis defects.

In correlation with these metabolic dysfunctions, a narrative review by Sangaraju *et al.* (2022) stated there is yet another unexplored and under-diagnosed category in the PCOS spectrum of diseases: its cardio-metabolic consequences. The usual pathogenesis of PCOS is a culmination of several genetic and environmental factors. Regarding its cardio-metabolic aspects, insulin resistance (IR) is said to be the single most important cause of a variety of metabolic risk factors, including type 2 diabetes mellitus (T2DM), metabolic syndrome (MetS), dyslipidemia, obesity, and hypertension (HTN), whereas a few other non-traditional factors such as C-reactive protein (CRP), carotid intima-media thickness (IMT), coronary artery calcification (CAC), and endothelial dysfunction are also said to be increased in PCOS patients, further increasing their risk of complications due to cardiovascular diseases (CVD).

According to a study by Fernandez *et al.* (2021), 56 women with a prior clinical diagnosis of PCOS (5.7%) and a further 64 (6.6%) were undiagnosed until study entry. They stated that metabolic problems were also higher in PCOS groups compared to women without PCOS. Although obtaining a clinical diagnosis of PCOS is strongly linked to the experience of fertility problems, but not clinical depression or poor metabolic health, these were highly prevalent in women with PCOS irrespective of when they were diagnosed. Over one third had severe (class 2/3) obesity. That they had fewer diagnosed metabolic conditions compared with those with a prior PCOS diagnosis (among whom a quarter had severe obesity) points to lack of appropriate health care, rather than better health.

In a study by Lana *et al.* (2020), that increased metabolic risk can be found at the time of diagnosis of PCOS and not as a long term complication. Patients with PCOS should be fully evaluated to determine baseline metabolic parameters. Women with PCOS may require more regular screening at diagnosis for such risks as well as effective and targeted early lifestyle advice. Considering the high prevalence of MetS or altered metabolic components in PCOS patients, its early diagnosis is necessary to reduce the mortality and morbidity rates in these women.

We could agree with the evidence of dyslipidemia among PCOS patients based on the similar findings of the study with those of Rahman *et al.* (2023) and Sangaraju *et al.* (2022). However, we can agree with Lana *et al.* (2020) that “increased metabolic risk can be found at the time of diagnosis of PCOS and not as a long term complication”, given the results obtained from the study. Although these findings do not actually diagnose a PCOS patient with cardiovascular abnormalities, rather posit it as a risk. Actual diagnosis for CVD needs to be done with further testing for parameters that assess heart functionality and other metabolic parameters affecting lipid regulation mechanisms.

For hematologic parameters, according to a correlational study of eighty-two women between the ages of 18 and 35 years who were diagnosed with

PCOS by Cho *et al.* (2023), found that all hematological parameters: absolute neutrophil count, absolute monocyte count, platelet count, and neutrophil-lymphocyte ratio were found between a insulin-resistant group and an insulin-nonresistant group, except for the platelet-lymphocyte ratio, were associated with at least one insulin resistance-associated metabolic parameter. This means that the association between hematologic parameters indicative of systemic inflammation and insulin resistance-associated metabolic parameters seems to be strongly influenced by other anthropometric covariates in women with PCOS.

But this was contraindicated in a previous discussion by Alhabardi *et al.* (2020), whereby there were no significant differences in any of the hematological parameters (hemoglobin, red blood cells, red cell distribution width, white blood cells, platelets, and mean platelet volume) between the two groups: women with PCOS and an an equal number of healthy women as controls.

However, according to Al kafhage *et al.* (2023), women with PCOS demonstrated significantly higher levels of white blood cells (WBC), platelets (PLT), and hemoglobin (Hb) compared to the control group ($p<0.05$). The mean values for WBC, PLT, and Hb were higher in the PCOS group (WBC: 14.50±1.97; PLT: 477.2±111.4; Hb:15.121.14) compared to the control group (WBC: 6.4±2.3; PLT: 203.8±69.09; Hb: 7.2±1.93).

With this, we could further agree with Alhabardi *et al.* (2020) that PCOS does not necessarily affect the hematological parameters that were tested. But further testing on different hematological parameters could be done to further prove the claim of Al kafhage *et al.* (2023) regarding complete blood count parameters. We can also commend the claim of Cho *et al.* (2023) of the association of insulin resistance with hematologic parameters such as absolute neutrophil count, absolute monocyte count, platelet count, and neutrophil-lymphocyte ratio. Although the study did not cover these parameters, further testing can be done to confirm as well as explore other hematologic parameters that may be affected.

CONCLUSION

In summary, the researchers were able to identify the prevalence of the different metabolic and hematologic manifestations among PCOS-diagnosed women. On the metabolic parameters, patients manifested more on abnormally elevated total cholesterol and blood urea nitrogen (BUN) levels than fasting blood sugar (FBS) and creatinine levels based on the mean computed with respect to the reference ranges set for interpretation.

While on hematologic parameters, all patients manifested normal hematocrit (Hct), hemoglobin (Hb), prothrombin time (PT), and activated partial thromboplastin time (aPTT); where the means computed are within the interpretation “normal” from the references range set.

Lastly, there was also no significant relationship between the date of diagnosis of PCOS and the metabolic and hematologic parameters tested, which denoted that individuals with PCOS regardless of date of diagnosis tend to have no significant effect on the metabolic and hematologic parameters being measured.

Based on the above findings of the investigation, the researchers were able to articulate the following conclusions:

1. PCOS-diagnosed patients are more likely to exhibit abnormally high Total Cholesterol and BUN levels more than the other metabolic parameters, as presented in the notable difference between the mean of Total Cholesterol levels (mean= 248.523) and BUN (mean= 21.752) from FBS (mean= 95.300) and Creatinine (mean= 1.108)
2. PCOS-diagnosed patients are more likely to exhibit normal hematologic parameters, as presented in the means of Hct (mean= 0.418), Hb (mean= 140.100), PT (mean= 11.890), and aPTT (mean= 30.840).

3. There is no significant relationship between the date of diagnosis of PCOS and the metabolic and hematologic parameters in PCOS-diagnosed women. Thus, regardless of the time of diagnosis of PCOS, it does not actually affect their metabolic and hematologic manifestations.

RECOMMENDATION(S)

The following recommendations were drawn from the findings and conclusions of the study:

1. Further research with a larger sample size can be done in future studies to further assess and obtain higher strength of potential correlation between the different metabolic and hematologic manifestations with PCOS.
2. Further research is needed to understand the linkage of different metabolic and hematologic manifestations with PCOS diagnosis. This could involve expounding the investigation to factors such as liver function, pancreatic function, cardiac function, acid-base balance, immune response, response to inflammation, other disease susceptibilities as well as psychological aspects on women that can be corroborated to the condition.
3. Additional research is necessary to establish a more comprehensive understanding of the long-term effects of PCOS that may affect daily lives of women including those who are having fertility problems and difficulty in conception.
4. Those who are caring for patients with PCOS should be aware of the increased prevalence of the different metabolic and hematologic manifestations, and possible disease corroborations in their patients, since failure to diagnose the problem may adversely affect prognosis.

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