Estimation of renin and D-dimer levels in polycystic ovary syndrome patients with or without coronavirus infection

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Abstract:

Background and objective: Polycystic ovarian syndrome (PCOS) is a common endocrinologic disorder among women of childbearing age. Coronavirus disease 2019 (COVID-19) is an acute respiratory disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This study aimed to determine the levels of renin, d-dimer, and some relevant biomarkers in patients with PCOS (with and without COVID-19) compared with non-PCOS patients (with and without COVID-19).

Methods: This cross-sectional study included 120 women [80 PCOS women (40 with COVID-19 and 40 without COVID-19) and 40 non-PCOS women (20 with COVID-19 and 20 without)] with age range of 15–40 years old. Blood samples were collected from participants, and biochemical assays were carried out. Renin and d-dimer levels were determined using the enzyme-linked-immunosorbent-assay (ELISA), lipid-profile and fasting blood glucose concentrations were assessed by using the colorimetric methods, and hormones were evaluated by VIDAS.

Results: Renin and d-dimer levels were found to be significantly higher in PCOS-women groups compared to non-PCOS group. In addition, the results showed that hormones, fasting blood glucose, and lipid-profile are significantly increased in PCOS patients compared to non-PCOS women, while high-density-lipoprotein and follicle-stimulating-hormone levels were low when comparing PCOS patients with non-PCOS ones. The results also showed that a highly significant increase in renin and d-dimer levels can be detected in PCOS patients with COVID-19.

Conclusions: In the present study, we found there is a possible relationship between renin and d-dimer in PCOS patients who are also COVID-19 infected.

Keywords: COVID-19, D-dimer, Fasting blood glucose, Follicle-stimulating hormone, Polycystic Ovary Syndrome and Renin.
Introduction:

Polycystic ovary syndrome (PCOS) is one of the most common diseases that affects 5-10% of women of childbearing age\(^1\). This disorder is characterized by irregular menstrual, ovulatory dysfunction, and hyperandrogenism as well as metabolic disorders\(^2\). PCOS disease increase the risk of developed highly blood pressure, metabolic imbalance, obesity, endometrial cancer, diabetes, as well as an increased lipid profile imbalance\(^3\). A small percentage of PCOS women have the ability to compensate for their insulin resistance, and a large percentage of them have a defect in the beta function that works on secreting insulin, so the level of blood glucose increases in PCOS women to developed to type 2 diabetes mellitus (T2DM), regardless of age and body mass index (BMI)\(^4\). In PCOS, it has been found that there is a strong relationship between hyperandrogenism and hyperinsulinemia, but the underlying mechanism of their relationship with PCOS is not yet clear. In addition, there are several unclear factors that cause PCOS\(^5\). Coronavirus disease (COVID-19) is an illness caused by viral called severe acute respiratory syndrome. Coronavirus was discovered in 2019\(^6\). This virus was identified for the first time in Wuhan, China, on March-2-2020, and has infected 90,308 people. The number of people who died reached 3,087, or 6% of the total number of patients who were rescued, which was 45,726\(^7\). According to recent reports, the magnitude of some PCOS cases resembled to that of COVID-19 given due to the COVID-19 spread\(^8\). Symptoms and complications of PCOS show significant overlap with risk factors for severe COVID-19 infection\(^9\). This overlap between the profile of complications of the PCOS (such as cardiac disease and metabolic diseases), and the main specific risk factors for clinical outcomes of coronavirus, therefore this group of women expected to be at more risk of infection COVID-19\(^10\). Therefore, the expected relationship between androgens and COVID-19 severity is acceptable and can support the hypothesis that anti-androgens may represent a potential additional intervention against COVID-19\(^11\). Renin-secreting cells are essential to survival and main in blood pressure maintaining and fluid-electrolyte balance. In mammals, the main source of renin is the kidney cells, which are known as the juxtaglomerular cells. Renin cells are powerful sensors with a high ability to sense and respond to changes in blood pressure, and extracellular fluid volume composition. When the blood pressure decreases, the cells adjacent to the glomerulus secrete the renin enzyme and release it into the blood circulation, which leads to hypertension. On the other hand, when the blood pressure rises, the secretion of renin decreases, thus maintaining fulfillment on the normal blood pressure balance in the body\(^12\). D-dimer molecules are generated
when cross-linked fibrin breaks down during fibrinolysis. D-dimer testing is critical for modern diagnosis such as Deep Vein Thrombosis (DVT), Pulmonary Embolism (PE), Disseminated Intravascular Coagulation (DIC)\textsuperscript{13}. Strong evidence that has been found in both human and animal studies supports the interrelationship between the renin angiotensin system, coagulation systems, fibrinolysis, and D-dimer formation. High blood pressure support indirect relationship between the renin system, thrombus formation and D-dimer\textsuperscript{14}. The aim of this study is to investigate the relationship between renin and D-dimer in PCOS patients who are also COVID-19 infected.

**Study design and patients:**

This study is a part of cross-sectional study conducted at the Baghdad University in Baghdad city/ Iraq, from December-2021 to June -2022, this study included 120 samples of women, whose ages ranged from 15–40 years, including 80 patients with polycystic ovary syndrome, who were collected from Kamal Al-Samara Hospital/Baghdad City, and 40 healthy women as a control group. Patients group and healthy group were divided, according to infected or non-infected with COVID-19, into four groups classified as: - (40 women participants) PCOS patients infected with covid-19, (40 women participants) PCOS patients non-infected with covid-19, (20 women participants) healthy infected with covid-19, and (20 women participants) healthy non-infected with covid-19. Inclusion criteria: - PCOS medical history, COVID-19 medical history, and patients ranging from (15-40) years. PCOS women have already been diagnosed with the syndrome according to the American Society for Reproductive Medicine and European Society Standards for Human Reproduction and Fetus. Exclusion criteria: - Menopausal women, women who have had previous surgeries (such as removing one of their ovaries), patients with respiratory disease, heart disease and diabetes.

**Biochemical analyses:** - Ten milliliter (mL) of venous blood were withdrawn from all participants and collected into gel tubes at room temperature for 20 minutes, then serum was separated by centrifugation for 10 minutes, the serum separated was stored in Eppendorf tubes. Serum was used for evaluated of fasting blood sugar (FBS) and lipid profile by applying enzymatic colorimetric method with commercially kit (Human, Germany), a hormonal profile was determine using a VIDAS analyzer (Biomerieux France), and the remaining serum was frozen at -20°C to the evaluation of renin and D-dimer by enzyme-linked immune sorbent assay (ELISA) technique (MyBioSource, USA).
**Statistical analysis:** - All statistical analysis data were performed using SPSS statistically software, version 26 and Medcalc statistical software, version 20 that used in receiver operating characteristic (ROC) curve analysis for the assessment of its value as a marker for discriminating patients with PCOS infected or non-infected with COVID-19. The variables were reported as means ± standard deviation (SD), the one-way ANOVA is used to determine whether there are statistically significant differences between the means of the studied groups. Non parametric Kruskal Wallis test was used for testing the difference between groups for those with non-normally distributed. post-hoc (Conover) analysis was applied to indicate a pairwise variance between each 2 groups whenever Kruskal Wallis test was significant.

**Results:** -

Diagnostic parameters of all participants were appeared in Table 1, that shows laboratory properties and clinical characteristics of all study groups. Anthropometric data of the participants in the present study were descripted in Table 1. In this study, the age of the healthy and patient groups was matched. The result shown no significant differences (p>0.05) in age between all groups, while high significant difference (p≤0.05) noted among all groups in regards to body mass index (BMI), fasting blood sugar (FBS), follicle-stimulating hormone (FSH), luteinizing hormone (LH), LH/FSH, testosterone, insulin, diastolic blood pressure (DBP), systolic blood pressure (SBP).
Table 1: General characteristics of the study participants

<table>
<thead>
<tr>
<th>Parameters</th>
<th>PCOS with COVID-19 Group (mean ± SD)</th>
<th>PCOS without infection with COVID-19 Group (mean ± SD)</th>
<th>Healthy infection with COVID-19 Group (mean ± SD)</th>
<th>Healthy without infection with COVID-19 Group (mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Year)</td>
<td>27.25±5.82a</td>
<td>26.37±5.78a</td>
<td>25.90±6.88a</td>
<td>24.10±5.29a</td>
<td>0.393</td>
</tr>
<tr>
<td>FBS (mmol/L)</td>
<td>5.17±0.52a</td>
<td>5.05±0.51a</td>
<td>4.29±0.61b</td>
<td>3.75±0.69c</td>
<td>**0.0001</td>
</tr>
<tr>
<td>Insulin (μIU/mL)</td>
<td>44.10±16.94a</td>
<td>29.45±10.68b</td>
<td>8.73±2.71c</td>
<td>6.35±2.91c</td>
<td>**0.0001</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>32.39±5.80a</td>
<td>29.47±7.01a</td>
<td>25.46±3.98b</td>
<td>21.40±1.92c</td>
<td>**0.0001</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>124.10±11.85ab</td>
<td>120.25±12.23a</td>
<td>115.90±5.60c</td>
<td>109.0±6.28bc</td>
<td>**0.0001</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>79.05±5.34a</td>
<td>74.6±7.07b</td>
<td>72.95±4.69b</td>
<td>68.20±4.27c</td>
<td>**0.0001</td>
</tr>
<tr>
<td>FSH (mIU/mL)</td>
<td>6.22±2.41ab</td>
<td>4.87±2.22a</td>
<td>8.50±2.20c</td>
<td>7.70±2.91bc</td>
<td>**0.0001</td>
</tr>
<tr>
<td>LH (mIU/mL)</td>
<td>9.18±3.13a</td>
<td>8.69±5.55a</td>
<td>5.09±2.12b</td>
<td>4.44±1.97b</td>
<td>**0.0001</td>
</tr>
<tr>
<td>LH/FSH ratio</td>
<td>1.56±0.46a</td>
<td>1.86±0.98a</td>
<td>0.763±0.76b</td>
<td>0.58±0.16b</td>
<td>**0.0001</td>
</tr>
<tr>
<td>Testosterone (Ng/mL)</td>
<td>0.78±0.22c</td>
<td>0.67±0.21c</td>
<td>0.45±0.22a</td>
<td>0.30±0.10b</td>
<td>**0.0001</td>
</tr>
</tbody>
</table>

Data were presented as mean ± SD (95% CI)

**Significant difference between means using ANOVA test at 0.01 level
- (a, b, c, d) are significant symbols for comparisons between the groups.
- Different letters (a, b, c, and d) mean there is a significant difference in the same row at p<0.001 (Where the group that have (a) letter is significant with the group have (b or c or d) letter, while is non-significant with the group have (a) letter).

BMI=body mass index, FBS= fasting blood sugar, PCOS = polycystic ovary syndrome, COVID-19= coronaviruses ,95 % CI= 95% confidence interval of the difference, FSH= follicle stimulating hormone, LH= luteinizing hormone, (DBP) diastolic blood pressure, (SBP) systolic blood pressure, SD = standard deviation.

As shown in Table 2, the mean ± standard deviation values of lipid profile for the studied groups showed a highly significant (p≤0.05) in cholesterol, triglycerides (TG), high-density lipoprotein
(HDL), and very-low-density lipoprotein (VLDL) levels. Meanwhile the levels of low-density lipoprotein (LDL) showed a significant difference (p≤0.05) between all groups.

Table 2: Lipid profile of the study participants

<table>
<thead>
<tr>
<th>Parameters</th>
<th>PCOS with COVID-19 Group (mean ± SD)</th>
<th>PCOS without infection with COVID-19 Group (mean ± SD)</th>
<th>Healthy infection with COVID-19 Group (mean ± SD)</th>
<th>Healthy without infection with COVID-19 Group (mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholesterol (mmol/L)</td>
<td>7.21±1.41 c</td>
<td>6.47±1.29 bc</td>
<td>5.52±1.67 a</td>
<td>3.74±1.14 b</td>
<td>**0.0001</td>
</tr>
<tr>
<td>Triglycerides (mmol/L)</td>
<td>6.36±2.27 c</td>
<td>4.26±1.73 b</td>
<td>3.98±1.32 b</td>
<td>0.85±0.57 a</td>
<td>**0.0001</td>
</tr>
<tr>
<td>HDL (mmol/L)</td>
<td>1.04±0.59 a</td>
<td>1.08±0.45 b</td>
<td>1.10±0.82 a</td>
<td>1.33±0.39 a</td>
<td>**0.0001</td>
</tr>
<tr>
<td>LDL (mmol/L)</td>
<td>3.27 ±1.31 b</td>
<td>2.89±1.55 ab</td>
<td>2.65±1.75 ab</td>
<td>2.04±0.94 a</td>
<td>*0.020</td>
</tr>
<tr>
<td>VLDL (mmol/L)</td>
<td>2.89±1.03 c</td>
<td>1.78±0.63 b</td>
<td>1.76±0.64 b</td>
<td>0.38±0.26 a</td>
<td>**0.0001</td>
</tr>
</tbody>
</table>

Data were presented as mean ± SD (95% CI)
**Significant difference between means using ANOVA -test at 0.01 level
- (a, b, c, d) are significant symbols for comparisons between the groups.
- Different letters (a, b, c, and d) mean there is a significant difference in the same row at p<0.001 (Where the group that have (a) letter is significant with the group have (b or c or d) letter, while is non-significant with the group have (a) letter)

HDL= high-density lipoprotein, LDL= low-density lipoprotein, VLDL= very-low-density lipoprotein
PCOS = polycystic ovary syndrome, COVID-19= coronaviruses, 95 % CI= 95% confidence interval of the difference, SD = standard deviation.

As shown in Table 3, the results indicted a statistically highly significant differences (p≤0.05) in the serum Renin in unit (pg/mL) between patient groups (PCOS patients infected with COVID-19, and PCOS patients non-infected with COVID-19) and healthy groups (healthy infected with COVID-19, and healthy non-infected with COVID-19) were ((163.93±24.22a)) pg/mL, (190.95±27.56b) pg/mL, (97.079±4.005c) pg/mL, and (101.80±3.08d) pg/mL) respectively. Also, the current study shown highly significant differences (p≤0.05) in D-dimer levels in unit (ng/mL) between all study groups (PCOS patients infected with COVID-19, and PCOS patients non-infected with COVID-19, healthy infected with COVID-19, and healthy non-infected with
COVID-19) were \((290.46±83.38^a)\) ng/mL, \((207.27±75.39^b)\) ng/mL, \((141.28±60.21^c)\) ng/mL, and \((85.10±20.94^d)\) ng/mL respectively.

Table 3: levels of Renin and D-dimer between patient and control groups

<table>
<thead>
<tr>
<th>Parameters</th>
<th>PCOS with COVID-19 Group (mean ± SD)</th>
<th>PCOS without infection with COVID-19 Group (mean ± SD)</th>
<th>Healthy infection with COVID-19 Group (mean ± SD)</th>
<th>Healthy without infection with COVID-19 Group (mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renin (pg/mL)</td>
<td>163.93±24.22^a</td>
<td>190.95±27.56^b</td>
<td>97.079±4.005^c</td>
<td>101.80±3.08^c</td>
<td>0.0001</td>
</tr>
<tr>
<td>D-dimer (ng/mL)</td>
<td>290.46±83.38^a</td>
<td>207.27±75.39^b</td>
<td>141.28±60.21^c</td>
<td>85.10±20.94^d</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

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According to post-hoc analysis (Conover), pairwise comparisons are significantly differences (p≤ 0.05) for serum renin as shown in figure 1. The box plot displays an increase in the levels of serum renin in PCOS patients infected with COVID-19 group, and PCOS patients non-infected with COVID-19 group when compared with healthy infected with COVID-19 group, and healthy non-infected with COVID-19 group. The concentration of serum renin is higher in PCOS patients who are also COVID-19 infected compared with PCOS patients who are not COVID-19 infected. In addition, serum renin concentration is higher in healthy infected with COVID-19 group in comparison with healthy non infected with COVID-19 group. Also, post-hoc analysis (Conover) has shown significant differences (p≤ 0.05) in D-dimer between both patient’s groups, and healthy infected with COVID-19 group with healthy non-infected with COVID-19 group were the levels of D-dimer is increase in PCOS patients with COVID-19 infected, PCOS patients not COVID-19 infected, and healthy infected with COVID-19 group in comparison with healthy non-infected with COVID-19 group as clarify in figure 2.
Figure 1. Box plot of renin comparison between the patient and healthy groups post-hoc analysis (Conover), pairwise comparisons, PCOS = polycystic ovary syndrome, COVID-19= coronaviruses.

Figure 2. Box plot of D-dimer comparison between the patient and healthy groups post-hoc analysis (Conover), pairwise comparisons, PCOS = polycystic ovary syndrome, COVID-19= coronaviruses.
Figure (3) showed ROC curve of renin and Figure (4) showed ROC curve of D-dimer for PCOS women patients. The ROC curve analysis shown that the cut off point for renin and dimer are (>106.35), (>130) respectively had sensitivity [(80.8 %), (78.8%)] respectively and specificity 100%. display that renin and D-dimer possesses a perfect ability (according to the AUC for renin and d-dimer are (0.923), (0.918) respectively) to identify PCOS patients with COVID-19 from healthy controls, as shown in figures (3), (4) the significance level is a very important (P<0.01).

**Figure 3:** ROC curve of renin in PCOS patients  
**Figure 4:** ROC curve of D-dimer in PCOS patients

**Discussion**

In the current study, serum FBS, BMI, and insulin were higher in both PCOS patents infected or non-infected with COVID-19 groups compared with healthy groups. This result is in agreement with previous studies by M. Ollila\(^{15}\), that indicated a strong positive association of the level of blood sugar among PCOS patients. Such findings were also agreement with Kyrou, et al.\(^{16}\) who observed PCOS patients have a higher prevalence of glucose metabolism problems. In vitro investigations on adipocytes and skeletal muscle revealed that both lean and overweight PCOS individuals had an increase in subcutaneous adipocytes. Although the quantity and affinity of adipocyte insulin receptors were equivalent in both controls and PCOS patients. It has been observed that the abundance of insulin receptors-subunit tyrosine phosphorylation in visceral adipose tissue has reduced in PCOS patients\(^{17}\). A decrease in the insulin sensitivity is shown by a rise in insulin levels that facilitated glucose absorption. This phenomenon was identified as the most persistent adipocyte insulin action deficit in polycystic ovarian syndrome, accompanied by decrease the insulin-stimulated glucose transport and insulin responsiveness. As a result, the level
of glucose in the blood increased. In metabolic tissues, insulin enhance glucose take-up and approval its conversion into glycogen and lipids for storage. Resistance of insulin and the related hyperinsulinemia are factors that improved steroidogenesis in PCOS women. Weight-gain and obesity, through their destroy outcomes for insulin resistance, accordingly drive improved steroidogenesis and hyperandrogenism. This multitude of elements heading central issues to give a clarification to the possible relationship among PCOS and COVID-19. Without a doubt, androgens might lead to clinical outcomes in COVID-19. In the present study LH and testosterone levels were higher in patients’ groups compared with healthy groups, such finding was also seen with previous studies; study by Hashemi et al., who found that the activity of LH, testosterone was significantly increased, in addition to revealed significant difference between group of PCOS compared with the healthy groups. And increase in LH level increases ovarian androgen production. In the present study, patients infected with COVID-19 had a higher significant difference (P≤0.05) in concentration of LH, FSH, testosterone compared to non-infected groups, the results are agreement with study by Ding, Ting, et al. That reported COVID-19 illness was proposing a higher risk factor for ovarian capability, which represented 14.3% of the expansion in testosterone, and the serum FSH level was essentially different in examinations between the COVID-19 group and healthy group; Despite higher level, COVID-19 women had a higher FSH than in the control group. At the current, testosterone is the most widely recognized estimation in routine clinical practice for the examination of female hyperandrogenism that can be delivered either direct by the ovaries or created by the digestion of its antecedent androstenedione in fat or limited tissues. Disorders in metabolism of lipid and lipoprotein are considered a metabolic abnormality that fairly common in PCOS patients. The present study, the concentration of lipid profile except HDL were higher in all three groups comparison with healthy non-infected covid-19 group. This result is agreement with studies by Eqbal A. et al., and Ali L et al., are consistent with the resulting of the current study which refers to the increase in levels of TG, LDL, total cholesterol and the decrease in levels of HDL in PCOS patients in compared with control. Lipid metabolism plays an important role in the viral infection cycle. Also, agreement with study Julius, Ulrich, et al., showed that the significantly higher level of TG, HDL, and cholesterol than healthy controls. An elevated cholesterol concentration has been suspected to increase the susceptibility for COVID-19 infection. Cholesterol plays a central role in the mechanisms of the COVID-19 infection. Also, in the present study, serum renin concentration is
higher in PCOS patient compared with healthy groups. This result was agreement with Moin, Abu Saleh Md, et al. That detailed that serum renin levels are higher in PCOS patients contrasting groups and control groups, that seen the overactivated of renin angiotensin system (RAS) prompting high measures of angiotensin II (Ang II). Overabundance in Ang II makes angiotensin-converting enzyme (ACE2) separate from the angiotensin receptor 1 AT1R (AT1R) and bind to AT1R. The binding of Ang II to AT1R brings about vasoconstriction, expanded vascular porousness, pneumonic edema, and intense respiratory trouble disorder. The present study, also, shows that there is highly increasing in D-dimer levels (P<0.05) of PCOS patients compared with control women. The results are agreement with study by Kebapcilar, L, et al. that find high level of D-dimer in PCOS groups compared with control group. In which PCOS patients had fibrinolytic activation as evidenced by elevated D-dimer which could be potentially be used as indicator of risk factor for atherosclerosis in PCOS women. And also, agreement with Lehmann, Antje, et al.

Finally, the present study found that there is a possible relationship between renin and d-dimer by their associated with androgen effect in PCOS and COVID-19 disease. The limitation of this study was the delay in obtaining samples with two diseases ( polycystic ovary syndrome patients that were infected with COVID-19 ), because of each patient was subjected to a medical examination by the Gynecologist, according to the Standards American Society for Reproductive Medicine and European Society for Human Reproduction and Fetus, which diagnosed by some or all of the following symptoms: interruption or irregular menstruation, high androgen level in clinical or chemical blood, and the presence of many cysts in one or both ovaries that appear through an ultrasound examination, also the time and cost take to work required tests to make sure that patient infection with Covid-19. The other limitation of the study is the small sample size and sample collection time, as the blood sample is drawn only on the second or third day of the menstrual cycle because it is the days of ovulation. Perhaps in future studies, the increase sample size and determine the period of infection with the virus will be increased to show the effect of renin more clearly.

**Conclusion:** In conclusion, higher levels of renin and D-dimer found in PCOS patients’ groups and also in healthy infected with COVID-19 groups. independent of insulin and body mass index. Therefore, determining the renin value may provide a novel parameter in diagnosing the syndrome, in addition to the high level of clot formation in the patients’ blood, especially after infection with
the Coronavirus. Which makes it possible that there is a relationship between renin and D-dimer in polycystic ovary syndrome who are also COVID-19 infected.

**List of abbreviations:** -

(ACE2) angiotensin-converting enzyme2, (AUC) area under the curve, (AT1R) angiotensin receptor 1,(BMI) body mass index, (COVID-19) coronavirus infected disease 2019, (DIC) disseminated intravascular coagulation, (DBP) diastolic blood pressure,(DVT) deep vein thrombosis, (ELISA) enzyme-linked immune sorbent assay, (FSH) follicle-stimulating hormone, (FBS) fasting blood sugar, (HDL) high-density lipoprotein, (LDL) low-density lipoprotein, (LH) luteinizing hormone, (PCOS) polycystic-ovary-syndrome, (PE) pulmonary embolism, (RAS) renin-angiotensin system, (ROC) receiver operator curve, (SBP) systolic blood pressure, (SD) standard deviation, (T) testosterone, (T2DM) type 2 diabetes mellitus, (TMPRSS2) transmembrane serine protease2, (TG) triglyceride, (VLDL) very-low-density lipoprotein,

**Acknowledgment:** -My thanks go to the staff of the Kamal-Al-Samara Hospital special Dr. Farah Imad for their assistance in collecting PCOS samples and for the facilities that helped in the completion of this study.

**Authors' declaration:** - Conflicts of Interest: None.

**Ethical approval:** -

This current study was approved by the ethical committee of the College of Science for Women/Department of the Chemistry/University of Baghdad (No. 4618/22, Date 2021/9/29). Also, a model oral consent was obtained for all the subjects participating in this study. A structured questionnaire was used to obtain detailed information about PCOS, age, weight, historical disease, whether the patient was infected or not infected with Coronavirus, change in the menstrual cycle, etc.

**References:** -


