**RESEARCH ARTICLE**

# The Correlation of BMI and Age to Some Hormonal Indices in Iraqi Women with the Polycystic Ovarian Syndrome

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**ABSTRACT**

Only a few researchers have looked at the link between age and the occurrence of polycystic ovary syndrome (PCOS). The goal of this study was to see if there was a link between age and body mass index (BMI) and the prevalence of PCOS and to compare the levels of certain endocrine profiles in PCOS and healthy females. In this study, 75 random females participate, 75 healthy females, and fifty are patients in PCOS. Age has no significant difference among females with PCOS as compared with females with normal ovaries. Otherwise, thirty cases of PCOS group occurred in a high percentage (64%) at (18–26) years. Also, highly significant differences in BMI of the PCOS group as compared with a control group, in which in 30 cases (60%) of total study cases, 50 (100%) of females diagnosed with PCOS were obese, and their BMI over 30.

On the other hand, the results of the control group (healthy females) were categorized mostly under an average weight 24 (96.0%) from a total study count of 25 (100%). Finally, highly significant differences in serum levels of luteinizing hormone (LH) and testosterone of the PCOS group compared with the control group and non-significant differences in follicle stimulating hormone (FSH) serum levels of the PCOS group compared with the control group. In summary, we observed that women with PCOS with signs and symptoms of PCOS represented mainly in obesity, menstrual irregularity, and hirsutism had higher body mass index, LH levels, and testosterone than women with normal ovaries.

**Keywords:** Age, Body Mass Index, Hormones, Polycystic, Obesity, Ovaries.

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## INTRODUCTION

Polycystic ovarian syndrome (PCOS) is a form of an endocrine disease that affects female ovaries. Ultrasound can readily detect a variety of cysts within the ovaries. Excess androgen production in the female body, as well as insulin resistance, are the main causes of PCOS. Testosterone is thought to be the primary cause of PCOS in girls and women.[1] The Rotterdam criteria are used to diagnose this condition, and at least two of the three criteria are met: 1) hyperandrogenism (HA) (clinical or biochemical), 2) menstrual irregularities (oligomenorrhea or amenorrhea), and 3) polycystic ovaries verified by ultrasonography.[2] PCOS affects women in a variety of ways, including irregular menstruation, polycystic ovaries, excess of androgen, acne, hirsutism, and alopecia.[3] Excessive LH and decreased follicle-stimulating hormone (FSH) are also prevalent. Roughly 60 to 80% of all PCOS cases are highly risky of developing insulin resistance (IR), compensatory hyperinsulinemia, in which ovulation failure and ovarian androgen production are exacerbated in PCOS patients.[4-6] Excess ovarian androgen production is important in the clinical and biochemical symptoms of HA in PCOS patients.[7,8] Hirsutism, acne, and alopecia are all symptoms of clinical HA.[9] Hirsutism refers to the abnormal development of the terminal hair in a male-like pattern, which is a typical complaint in women with PCOS.[9,10]

Obesity is a prevalent symptom of PCOS, and it exacerbates many of the condition's reproductive and metabolic symptoms. The link between PCOS and obesity is complicated and poorly understood, with genetic and environmental variables most likely playing a role.[11] Women with PCOS are likely to be overweight (35–80%; BMI 25–29 kg/m$^2$) or obese (20–69%; BMI more than 30 kg/m$^2$).[12] The increase in fat cell size (hypertrophic obesity) rather than the rise in cell quantity (hyperplastic obesity) is the marker of obesity in women with PCOS.[13]

Thus, despite numerous studies, this study was aimed for further investigation and declared the correlation of BMI and age on the outcomes of some hormonal indices in Iraqi women with PCOS.

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## MATERIALS AND METHODS

### Measurements

The Cobas e 411-analyzer is a fully autonomous immunoassay analyzer that uses a proprietary Electro Chemi Luminescence (ECL) technique were used for the measurement of the follicle-stimulating hormone FSH (µLU/mL) and LH (µLU/mL) concentrations, sandwich principle, total duration of the assay: 18 minutes. The measurement of testosterone hormone (T) concentration (ng/mL), competition principle, and total duration of the assay: 18 minutes.

### Study Design and Blood Samples Collection

The study was done during the period (November/2020 to February/2021) on 50 females who were diagnosed clinically by a specialist physician as having PCOS in Al-Kut city, Wasit; their ages were about 18 to 39 years. Twenty-five apparently healthy females were selected as a healthy control group. Their ages were about 18 to 39 years. Every donated girl was approved for inclusion in this research and replied to our queries about her medical history, particularly for thyroid disorders (hypothyroidism), cushing's syndrome, diabetes mellitus (DM), hypertension, and ischemic heart illnesses none of them suffered. The age of all the females was recorded. Body weight and height of all females in all groups were recorded to measure BMI before collecting the blood sample by using an Electronic balance and Height Measuring Tape. The BMI was determined by multiplying the weight (kg) by the squared height ($m^2$). BMI (categorical) was classified as less than 25 kg/$m^2$ (normal weight), 25–29.9 kg/$m^2$ (overweight), and 30 + kg/$m^2$ (obese). Blood samples were collected from the individuals using disposable 5 mL syringes. The collected blood was poured into plain test tubes and centrifuged at 3000 rpm for 15 minutes; serum was obtained after centrifugation and kept in Eppendorf tubes and stored at -20°C until used for hormonal analysis.

### Statistical Analysis

Analysis of data was done using Chi-square (X2) test to compare percentages. Independent samples t. A test was used to compare between two numeric variables. Numeric data were described by (mean ± SD). A significance level of $\alpha = 0.05$ was used in the test. (SPSS 24) program was used to analyze current data.

**Table 1:** Distribution of age groups according to the studied groups

| *Categorical age group (years)* | | *Study Groups* | | | |
|---|---|---|---|---|---|
| | | *Case* | *Control* | *Total* | **p-value* |
| (18–26) | N | 32 | 11 | 43 | 0.178 **(NS) |
| | % | 64.0% | 44.0% | 57.3% | |
| (27–34) | N | 9 | 9 | 18 | |
| | % | 18.0% | 36.0% | 24.0% | |
| (>34) | N | 9 | 5 | 14 | |
| | % | 18.0% | 20.0% | 18.7% | |
| Total | N | 50 | 25 | 75 | |
| | % | 100.0% | 100.0% | 100.0% | |

*Chi-square test;**; N.S; non-significant.

## RESULTS

### Distribution of Age Groups According to the Studied Groups

The data in Table 1 showed that the cases of PCOS occurred in a high percentage (64%) at 18–26 years also Table 1 indicated that there were no significant differences in the ages among studied Cases groups of PCOS as compared with the control groups (healthy females) with (p-value = 0.17).

### Distribution of BMI (Kg/$m^2$) According to the Studied Group

The results presented in Table 2 reveal that in 30 cases (60%) of total study cases, 50 (100%) of females diagnosed with PCOS were obese, and their BMI was over 30. On the other hand, the results of the control group (healthy females) were categorized mostly under normal weight 24 (96.0%) from a total study count of 25 (100%), in which statistically, this difference was highly significant (p-value = 0.00).

### Levels of BMI (Kg/$m^2$), FSH (mIU/ml), LH (mIU/mL) and Testosterone (ng/ml) between Case (PCOS) and Control Group

The results illustrated in Table 3 indicate that the level of BMI (Kg/$m^2$) was variable among cases of PCOS and control (healthy females), which was indicated by an increase in the scores of mean and SD among cases (30.78 ± 4.702), (23.71 ± 1.170) respectively. Statistically, these differences were highly significant (p-value = 0.00). Also, these tables demonstrated that the level of FSH (mIU/ml) among cases of PCOS and the control group was normal which was indicated by normalizing the score of mean and SD (6.6980 ± 2.32260), (7.3360 ± 2.48695) respectively, statistically this differences was non-significant (P-value = 0.2). Otherwise, the level of LH (mIU/mL) was variable among cases of PCOS and control (healthy females), which revealed an increase of the scores of mean and SD (16.6800 ± 5.94554), (4.6080 ± 1.77926), respectively, statistically, this differences was highly significant (p-value = 0.00). Also, testosterone hormone level illustrated with an increase of the mean and SD between PCOS and control groups (1.7040 ± 0.63950), (0.2044 ± 0.12567), respectively, which statistically was highly significant (p = 0.00).

**Table 2:** Distribution of BMI (Kg/$m^2$) according to the studied group

| *BMI (Kg/$m^2$)* | | *Case* | *Control* | *Total* | **p* |
|---|---|---|---|---|---|
| <18.5 underweight | N | 0 | 1 | 1 | ** (H.S 0.00) |
| | % | 0.0% | 4.0% | 1.3% | |
| 18.5–24.9 Normal weight | N | 5 | 24 | 29 | |
| | % | 10.0% | 96.0% | 38.7% | |
| 25–29.9 Pre- Obese | N | 15 | 0 | 15 | |
| | % | 30.0% | 0.0% | 20.0% | |
| >30 Obese | N | 30 | 0 | 30 | |
| | % | 60.0% | 0.0% | 40.0% | |
| Total | N | 50 | 25 | 75 | |
| | % | 100.0% | 100.0% | 100.0% | |

*Chi-square test;**; HS; highly significant.

**Table 3:** Levels of BMI (Kg/m$^2$), FSH (mIU/ml), LH (mIU/mL) and Testosterone (ng/mL) between case (PCOS) and control groups

| *Variables* | *Study Groups* | *N* | *Mean* | *SD* | *T-Test* | **P-value* |
|---|---|---|---|---|---|---|
| BMİ (Kg/m$^2$) | Case | 50 | 30.78 | 4.702 | 4.56 | ** (H.S0.00) |
| | Control | 25 | 23.71 | 1.170 | | |
| FSH (mIU/ml) | Case | 50 | 6.6980 | 2.32260 | 1.095 | ***(N.S0.2) |
| | Control | 25 | 7.3360 | 2.48695 | | |
| LH (mIU/ml) | Case | 50 | 16.6800 | 5.94554 | 9.9 | ** (H.S0.00) |
| | Control | 25 | 4.6080 | 1.77926 | | |
| Testosterone (ng/ml) | Case | 50 | 1.7040 | 0.63950 | 11.57 | ** (H.S0.00) |
| | Control | 25 | 0.2044 | 0.12567 | | |

Independent-sample t-test,** highly-significant,*** non-significant, SD; Standard Deviation

**Table 4:** Association between FSH (mIU/mL) among cases (PCOS) and BMI (Kg/m$^2$) according to the cutoff point of FSH

| *Categorial BMI (Kg/m$^2$)* | | *Categorial FSH (mIU/mL)* | | | |
|---|---|---|---|---|---|
| | | *3–11* | *>11* | *Total* | *p* |
| (18.5–24.9) | N | 5 | 0 | 5 | (0.7) N.S |
| | % | 10.0% | 0.0% | 10.0% | |
| 25–29.9 | N | 14 | 1 | 15 | |
| | % | 28.0% | 2.0% | 30.0% | |
| >30 | N | 27 | 3 | 30 | |
| | % | 54.0% | 6.0% | 60.0% | |
| Total | N | 46 | 4 | 50 | |
| | % | 92.0% | 8.0% | 100.0% | |

**Table 5:** Association between LH (mIU/ml) among cases PCOS and BMI (Kg/m$^2$) according to the cutoff point of LH

| *Categorial BMI (Kg/m$^2$)* | | *Categorial LH (mIU/m)* | |
|---|---|---|---|
| | | *>8* | *Total* |
| 18.5–24.9 | N | 5 | 5 |
| | % | 10.0% | 10.0% |
| 25-29.9 | N | 15 | 15 |
| | % | 30.0% | 30.0% |
| >30 | N | 30 | 30 |
| | % | 60.0% | 60.0% |
| Total | N | 50 | 50 |
| | % | 100.0% | 100.0% |
| Chi-sequare | No statistics are computed because LH is a constant | | |
| p | - | | |

### Association between FSH (mIU/mL) Among Cases (PCOS) and BMI (Kg/m$^2$) according to the Cutoff Point of FSH

The result shown in Table 4 revealed that the only three (6.0%) cases of females with PCOS showed increased levels of FSH above the normal range (>11 mIU/ml) has BMI >30 (Kg/m$^2$) versus 27 (54.0%) cases out 46 cases showed normal FSH (3-11 mIU/ml) levels under the same BMI >30 (Kg/m$^2$). Statistically this differences was non-significant (p-value = 0.7).

### Association between LH (µlU/ml) among cases (PCOS) and BMI (Kg/m$^2$) according to the Cutoff Point of LH

Table 5 documented that the most cases of increasing LH (µLU/mL) were about 30 (60.0%) out of total study cases 50 100% were among patients with body mass index value >30 (Kg/m$^2$). At the same time, the lowest cases of increasing LH (µlU/ml) were about 5 (60.0%) from total study cases 50 (100%) among PCOS females with body mass index values 18.5 to 24.9 (Kg/m$^2$).

**Table 6:** Association between Testosterone (ng/ml) among cases (PCOS) and BMI (Kg/m$^2$) according to the cutoff point of testosterone

| *Categorial BMI (Kg/m$^2$)* | | *Categorial Testosterone (ng/ml)* | | | |
|---|---|---|---|---|---|
| | | *<1* | *>1* | *Total* | *p-value* |
| (18.5–24.9) | N | 1 | 4 | 5 | (0.1) NS |
| | % | 2.0% | 8.0% | 10.0% | |
| (25–29.9) | N | 4 | 11 | 15 | |
| | % | 8.0% | 22.0% | 30.0% | |
| (>30) | N | 2 | 28 | 30 | |
| | % | 4.0% | 56.0% | 60.0% | |
| Total | N | 7 | 43 | 50 | |
| | % | 14.0% | 86.0% | 100.0% | |

### Association between Testosterone (ng/mL) among Cases (PCOS) and BMI (Kg/m$^2$) according to the Cutoff Point of Testosterone

Table 6 presented that 28 cases out of 43 showed an increase in testosterone level >1 (ng/mL) among patients has BMI (>30) versus 2 cases out of seven cases showed a decrease in testosterone level <1 (ng/mL) under the same BMI (Kg/m$^2$) categories, statistically this differences was non -significant with (p = 0.1).

## DISCUSSION

This study was designed to provide further insights into the relation of age and BMI in PCOS and evaluate the hormonal indices, particularly FSH, LH, and Testosterone levels among PCOS females and healthy females. The incidence of PCOS in a high percentage (64%) at 18-26 years, the exact cause is not known. Still, it might be due to hormonal disturbances in which the ovaries produce excessive quantities of male hormones such as testosterone. Normally, the ovaries produce very small quantities, but in PCOS, they make more, which could cause irregular periods, acne, and unwanted hair growth. BMI of PCOS females in this study indicates that 60% of them are obese. As a result, our findings are in line with previous research and underline the importance of the high rates of

obesity is one of many signs that occur in PCOS females,[14] the obesity is of an android type and a waist-to-hip ratio greater than 0.85 indicates android obesity.[15,16] Obesity is a condition in which androgen production increases with synchronous rushed clearance in hirsute women, which leads to a decline in androgen effects.[17] In contrast, Most of the healthy females in this study were under normal weight. Women might be underweight for a variety of reasons, including poor eating habits and health issues, and medication. In this study, all the healthy participants were not suffering from any medical problems and took no medication; eating habits and their desire to have a slim and perfect body may be the reason for their under normal weight.

In the current study, we have demonstrated that the level of BMI was variable among cases of PCOS and control (healthy females). Statistically, these differences were highly significant. The level of FSH among cases of PCOS and the control group was normal, which indicated non-significant differences. Otherwise, the LH and testosterone hormone levels were variable among cases of PCOS and control (healthy females), which statistically, these differences were highly significant. As in our study, higher BMI, and serum levels of LH and testosterone were significantly higher in the PCOS group, compared to women with normal ovaries.[18,19] Consequently, our results are consistent with Marx and Mehta who declared that The frequency and amplitude of pulses enhance the usual pulsatile production of LH, whereas FSH remains unaltered or muted. As a result, even during ovulatory cycles, LH levels might rise and the LH: FSH ratio can rise to greater than 2.5. On the other hand, these levels may be normal as many as 12% - 20% of PCOS women.[20] PCOS, on the other hand, is linked to a low amount of follicle-stimulating hormone (FSH) and a high level of luteinizing hormone (LH). Simultaneously, a high amount of LH stimulates the production of estrogen, testosterone, and dehydroepiandrosterone sulfate (DHES). This eventually results in the formation of an ovarian cyst.[21] Lucidi also suggested that FSH levels in PCOS individuals are either within the standard range or low. Tanner stage, sex, and age all result in increased amounts of luteinizing hormone (LH). The ratio of LH:FSH is generally more than three.[22] The pituitary gland produces LH, which acts in conjunction with FSH; a rise in estrogen signals the pituitary gland to stop generating FSH and start producing more LH. The egg is released from the ovary when the hormone LH is switched on, a process known as “ovulation.” In general, if a woman’s LH levels are greater than usual, it means her ovaries are really not responding. High levels in a young woman may indicate that puberty has shown up early.[23-28]

Consequently, our findings are consistent with current research and highlight the need for hormonal monitoring for PCOS diagnosis to develop early detection and avoid long-term reproductive, cardio-vascular, and psycho-emotional problems.

## CONCLUSIONS

The study showed that PCOS cases were occurred in high percentage 64% at 18–26 years old. There were highly significant differences (p-value = 0.00) in BMI of 30 cases (60%) from total study cases of 50 (100%) females diagnosed with PCOS as compared with healthy females. Furthermore, there are disturbances in some hormonal indices, particularly FSH, LH, and Testosterone of PCOS females compared to healthy females. Further, studies are needed to include different areas of Iraq, study more samples than the samples of the current study, more studies on married females to evaluate their fertility, evaluate other hormonal indices such as prolactin, progesterone, insulin, and anti-Mullerian hormone, and evaluate lipid profile and Vitamin D to estimate their relation with PCOS.

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