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# Plasma adiponectin and resistin levels in women with polycystic ovary syndrome: relation to body mass index and insulin resistance

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**Aim:** To compare the serum levels of adiponectin and resistin between patients with polycystic ovary syndrome (PCOS) and healthy control subjects matched for age and body mass index (BMI), and to assess possible correlations of adiponectin and resistin to the hormonal and metabolic parameters of the syndrome.

**Materials and methods:** Fifty five patients with PCOS diagnosis composed of 25 obese, 13 overweight, 17 normal weight subjects, and 49 healthy women matched for age and BMI were included in this study. Hormone and lipid profile, adiponectin, and resistin were measured in all cases.

**Results:** Serum adiponectin levels were similar in the lean PCOS patients and the healthy control group. In obese patients and the control groups, serum adiponectin levels were significantly lower than those in the lean control group. Serum adiponectin levels were similar in the obese PCOS and the obese control groups. Serum resistin levels were similar in both patient and control groups. There was a correlation between serum adiponectin levels and fasting insulin, HOMA-IR, triglyceride, and HDL-C in the PCOS group. A significant correlation in the positive direction was observed among serum resistin levels and BMI in the patient group.

**Conclusion:** Our study showed that serum adiponectin levels were lower in obese women with PCOS than in the normal weight control group. There was a negative correlation between serum adiponectin levels with insulin resistance. We suggest that resistin is not associated with PCOS pathogenesis but it may be an adipocytokine that is affected by BMI.

**Key words:** Adiponectin, resistin, PCOS, insulin resistance

## Polikistik over sendromu saptanan kadınlarda plazma adiponektin ve rezistin düzeyleri: vücut kitle indeksi ve insülin direnci ile ilişkisi

**Amaç:** Serum adiponektin ve rezistin düzeylerinin Polikistik Over Sendromu (PKOS) lu hastalar ile yaş ve vücut kitle indeksi (VKİ) eşleştirilmiş sağlıklı kontroller arasında karşılaştırılması, adiponektin ve rezistinin, sendromun hormonal ve metabolik parametreleri ile olası ilişkilerinin değerlendirilmesi amaçlanmıştır.

**Yöntem ve gereç:** Çalışmaya 25 obez, 13 fazla kilolu, 17 normal kilolu olmak üzere 55 PKOS tanısı almış hasta ile yaş ve VKİ eşleştirilmiş 49 sağlıklı kadın dahil edildi. Bütün hastalarda adiponektin, rezistin serum düzeyleri ile hormon ve lipid profili ölçümleri yapıldı.

**Bulgular:** Normal kilolu PKOS'lu hasta ve kontrol grubu arasında serum adiponektin düzeyleri açısından istatistiksel anlamda fark saptanmadı ($P > 0,05$). Obez hastalarda ve obez kontrol grubunda serum adiponektin düzeyleri, normal kilolu kontrol grubuna göre istatistiksel olarak anlamlı derecede düşük saptandı. Obez PKOS ve obez kontrol grubunun adiponektin düzeyleri ise benzerdi. Gruplar arasında serum rezistin düzeyleri açısından istatistiksel anlamda farklılık saptanmadı ($P > 0,05$). PKOS'lu grupta serum adiponektin düzeyleri ile açlık insülin, HOMA-IR, trigliserid ve HDL-K arasında bir ilişki saptandı. Hasta grubunda serum rezistin düzeyleri ile VKİ arasında pozitif yönde anlamlı ilişki tespit edildi.

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**Sonuç:** Çalışmada, obez PKOS' lu kadınlarda serum adiponektin düzeyinin normal kilolu kontrol grubuna göre azaldığı gösterilmiştir. Serum adiponectin düzeyi ile insülin direnci arasında negatif bir ilişki mevcuttur. Rezistinin PKOS patogenezi ile ilişkili olmadığı ancak VKİ' den etkilenen bir adipokin olabileceği düşünülmüştür.

**Anahtar sözcükler:** Adiponektin, resistin, PKOS, insülin direnci

## Introduction

Polycystic ovary syndrome (PCOS) is the most common reproductive disorder, affecting 5%-10% of women of reproductive age. About 50% of the women diagnosed with PCOS are overweight. The syndrome is also associated with multiple cardiovascular risk factors such as insulin resistance, dyslipidemia, and hypertension (1,2). However, the mechanism linking PCOS to the metabolic abnormalities are not completely understood.

The adipose tissue not only stores a large quantity of fat as an energy source but also synthesizes several adipocytokines including adiponectin and resistin. Adiponectin is a protein hormone produced exclusively in adipose tissue whose circulating levels are positively correlated with measures of insulin sensitivity (3,4). Resistin is also a peptide secreted from adipose tissue that is assumed to contribute to peripheral insulin sensitivity. Considering the frequent clustering of obesity and insulin resistance in PCOS patients, adiponectin and resistin have been proposed to play a role in pathogenesis of PCOS (5).

The aim of the present study was to evaluate the relationships between metabolic alterations and adiponectin and resistin levels in normal weight, overweight, and obese women with PCOS compared with age and weight matched healthy women.

## Materials and methods

The study group consisted of 55 women with PCOS (17 normal weight, BMI: 18.5-24.9 kg/m$^2$, 13 overweight, BMI: 25-29.9 kg/m$^2$ and 25 obese, BMI ≥ 30 kg/m$^2$) and 49 healthy, normal menstruating women (17 normal weight, 12 overweight and 20 obese; the control group). The Local Research Ethic Committee approved the study (2008/49-İAEK: 7110), and all patients involved gave their informed consent. The study groups were composed of patients between 17 and 40 years of age admitted to the endocrinology outpatient polyclinic with complaints of irregular menstrual cycles and/or increased hair growth. The diagnosis of PCOS was established according to 2003 Rotterdam ESHR/ASRM endocrine criteria (oligoovulation and/or anovulation, clinical and/or biochemical hyperandrogenism and polycystic ovaries as defined by ultrasonography). PCOS can be diagnosed after the exclusion of other medical conditions and if she fulfilled 2 out of 3 criteria mentioned above. Patients with systemic diseases (diabetes mellitus, thyroid diseases, hypertension, cardiovascular diseases, chronic renal failure, and malignancy) and history of taking any other medication such as lipid lowering, oral contraceptives pills, ovulation induction, anti-obesity drugs, corticosteroids, anti-diabetic and antihypertensive drugs within 6 months were excluded. Before the study, a physical examination and appropriate laboratory tests were performed. After overnight fasting, 75 g oral glucose tolerance test was performed for all patients and 120 min values obtained. All patients with diabetes (glucose in 120 min of 75 g OGTT ≥ 200 mg/dL) were excluded from study. The diseases that mimic PCOS such as late onset congenital adrenal hyperplasia and Cushing syndrome were ruled out by testing 17-hydroxyprogesterone and 1 mg dexamethasone suppression screening test. All patients had normal thyroid function tests and normal prolactin levels.

The control group was composed of healthy female volunteers who had regular menstrual cycles and no signs of clinical and biochemical hyperandrogenism. The PCOS and the control group were matched for BMI and age. The body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared (kg/m$^2$) at first admission. The waist circumference was measured at the widest circumference between the waist and thighs.

Serum samples were obtained from all women during the interval from 2nd to the 5th days of their early follicular phase of menstrual cycle. Levels of plasma glucose, insulin, total cholesterol (TC), high-density lipoprotein cholesterol(HDL-C), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), free and total testosterone, LH, FSH, prolactin, free T4, free T3, TSH, cortisol, dehydroepiandrosterone-sulfate (DHEA-SO4), androstenedion, 17-OH progesterone, estradiol (E2), sex-hormone binding globulin (SHBG), adiponectin, and resistin were measured after 8-12 h fasting. Blood samples were taken from antecubital vein. The parameters except adiponectin and resistin were measured immediately. The blood samples were centrifuged at 4000 rpm for 10 min and separated after collection and were stored at -80 °C until they were analyzed for adiponectin and resistin.

**Laboratory analyses:** Adiponectin was measured by using enzyme-linked immunosorbent assay (ELISA), AssayMax Human Adiponectin (Acrp30) ELISA (Catalog EA2500-1 Lot 0201815 AssayPro, USA) kit. Resistin was measured by using AssayMax Human Resistin ELISA (Catalog ER 1001 Lot 0257822 AssayPro, USA) kit. Glucose, TC, HDL, TG, and LDL were analyzed with an Aeroset analyzer using Abbott Diagnostics, Wiesbaden, Germany kit. Insulin, free T4, free T3, TSH, cortisol, prolactin, FSH, LH, DHEA-SO4, E2, total testosterone levels were measured by electrochemiluminescent immunometric assay test method with a Cobas analyzer (Roche Diagnostics, Mannheim, Germany). SHBG levels were measured by chemiluminescent immunometric assay test method with an Immulite 2000 analyzer (Siemens Medical Solutions Diagnostics, Los Angeles, USA). Free testosterone, androstenedione levels were measured by ELISA. 17-OH progesterone levels were measured by enzyme immune assay method with a Dynex-Dsx analyzer.

Insulin resistance (IR) was determined by a number of different methods including fasting insulin, the homeostasis model assessment (HOMA), and quantitative insulin sensitivity check index (QUICKI). The estimate of insulin resistance by score was HOMA-IR score, calculated with the formula: fasting serum insulin (μU) × fasting plasma glucose (mg/dL)/405. QUICKI is derived by calculating the inverse sum of logarithmically expressed values of fasting insulin and glucose. To define the biochemical hyperandrogenemia free androgen index was calculated as follows: Free androgen index: (total testosterone (nmol/L) / SHBG nmol/L) × 100.

**Ultrasonography:** The transvaginal and/or transabdominal ultrasonography were performed in all patients. The morphology of polycystic ovaries was considered if there were 12 or more follicles of 2-9 mm in diameter in each ovary and/or enlarged ovary (>10 $cm^3$).

**Statistical analysis:** The Statistical Package for the Social Sciences (SPSS version 13.0 for Windows, SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The person doing the data analysis was blinded to the diagnosis. Results were expressed as mean ± S.D. The characteristics of distribution were tested with the Kolmogorov-Smirnov test. Because of the skewed distribution of insulin, testosterone, and adiponectin levels, we used log-transformed values in the subsequent statistical analysis. The clinical and laboratory characteristics in the 2 groups were compared by Student's t-test for unpaired data in the normal distributed group. The undistributed group was compared by Mann-Whitney U test. For all analysis, a P-value less than 0.05 was considered statistically significant. Bivariate correlation analysis (calculation of the Pearson coefficient) was used to assess the correlation of serum adiponectin level to each parameter.

## Results

The patients and controls were separated into 3 groups according to their BMI: normal weight (BMI: 18.5-24.9 $kg/m^2$), overweight (BMI: 25-29.99 $kg/m^2$), and obese (BMI ≥ 30 $kg/m^2$). The study group consisted of 55 women with PCOS (17 lean, 13 overweight and 25 obese) and 49 healthy normally menstruating women (17 lean, 12 overweight and 20 obese; the control group). The clinical characteristics of the PCOS sub-groups and control groups are shown in Table 1. In the study, insulin resistance was found 36% of all patients. We observed a significant effect of obesity on insulin resistance. Insulin resistance observed 68% of obese PCOS patients, 15% of overweight PCOS patients and only 5% of lean

Table 1. Clinical characteristics of the study groups.

| | Lean PKOS (n = 17) | Lean control (n = 17) | Overweight PCOS (n = 13) | Overweight control (n = 12) | Obese PCOS (n = 25) | Obese control (n = 20) |
|---|---|---|---|---|---|---|
| Age (year) | 21.11 ± 2.59 | 22.70 ± 2.25 | 22.07 ± 5.18 | 22.58 ± 2.39 | 23.72 ± 6.15 | 23.75 ± 4.5 |
| BMI (kg/m$^2$) | 22.36 ± 2.88 | 20.64 ± 2.12 | 27.38 ± 1.41 | 27.02 ± 1.09 | 34.56 ± 5.72 | 37.12 ± 5.33 |
| Waist circumference (cm) | 80.47 ± 7.45 * | 74.29 ± 7.86 | 89.92 ± 5.37 | 92.91 ± 8.11 | 107.72 ± 12.08 | 111.95 ± 11.85 |
| Hip circumference (cm) | 92.94 ± 6.85* | 93.47 ± 5.66 | 103.38 ± 4.83 | 105.08 ± 3.70 | 115.88 ± 11.17 | 122.35 ± 10.15 |
| Waist to hip ratio | 0.86 ± 0.05 | 0.79 ± 0.07 | 0.86 ± 0.03 | 0.88 ± 0.07 | 0.92 ± 0.06 | 0.91 ± 0.06 |
| Fasting glucose (mg/dL) | 90.35 ± 8.72 * | 82.94 ± 7.65 | 91.53 ± 6.56 | 88.25 ± 6.86 | 92.16 ± 10.86 | 90.7 ± 5.37 |
| Fasting Insulin (μIU/mL) | 6.46 ± 2.94 | 4.8 ± 1.73 | 8.91 ± 3.57 | 8.52 ± 4.67 | 13.89 ± 6.11 | 14.37 ± 6.4 |
| Glucose/Insulin | 18.03 ± 10.36 | 19.89 ± 8.34 | 12.28 ± 5.69 | 12.66 ± 5.21 | 8.99 ± 8.38 | 7.8 ± 3.82 |
| HOMA-IR | 1.44 ± 0.66 * | 0.98 ± 0.38 | 1.98 ± 0.73 | 1.85 ± 1.01 | 3.21 ± 1.66 | 3.22 ± 1.47 |
| QUICKI | 0.367 ± 0.036 | 0.387 ± 0.031 | 0.346 ± 0.023 | 0.351 ± 0.025 | 0.325 ± 0.03 | 0.324 ± 0.02 |
| Total cholesterol (mg/dL) | 167.64 ± 24.09 | 154.52 ± 33.97 | 166.23 ± 27.15 | 179.91 ± 18.37 | 175 ± 35.34 | 164 ± 25.25 |
| LDL-C (mg/dL) | 90.18 ± 29.48 | 79.32 ± 24.50 | 97.43 ± 23.45 | 110.28 ± 17.34 | 101.55 ± 30.16 | 98.16 ± 23.4 |
| HDL-C (mg/dL) | 60.35 ± 14.76 | 61.35 ± 14.39 | 47.84 ± 11.53 | 49.66 ± 7.46 | 50.68 ± 12.54 | 47.2 ± 7.93 |
| Triglyceride (mg/dL) | 85.7 ± 48.60 | 69.23 ± 22.82 | 104.76 ± 49.07 | 84.83 ± 27.03 | 115.75 ± 66.35 | 97.2 ± 49.22 |
| LH (mIU/mL) | 11.92 ± 7.05 * | 4.55 ± 2.71 | 16.15 ± 13.06 # | 5.63 ± 1.60 | 9.44 ± 5.77 ¶ | 4.73 ± 1.88 |
| FSH (mIU/mL) | 5.19 ± 1.84 | 5.44 ± 2.13 | 6.02 ± 1.87 | 5.74 ± 2.29 | 5.56 ± 1.46 | 5.51 ± 1.79 |
| LH/FSH | 2.4 ± 1.39 * | 0.87 ± 0.57 | 2.77 ± 2.1# | 1.20 ± 0.74 | 1.72 ± 1.09 ¶ | 0.92 ± 0.46 |
| DHEA-SO4 (μg/dL) | 281.23 ± 89.50 * | 179.10 ± 79.45 | 267.69 ± 122.21 | 203.81 ± 93.40 | 302.8 ± 109.34¶ | 165.43 ± 69.89 |
| Total testosterone (ng/dL) | 73.57 ± 28.64 * | 33.53 ± 13.29 | 84.33 ± 47.87 # | 38.21 ± 16.09 | 74.51 ± 24.04 ¶ | 33.13 ± 15.81 |
| SHBG (nmol/L) | 33.75 ± 10.98* | 64.73 ± 39.90 | 23.61 ± 11.92 # | 39.32 ± 11.66 | 20.99 ± 12.02 ¶ | 29.31 ± 10.21 |
| Free androgen index | 8.84 ± 4.71 * | 2.78 ± 2.47 | 17.66 ± 21.30 # | 3.76 ± 2.12 | 16.96 ± 10.32 ¶ | 4.27 ± 2.20 |
| Free testosterone (pg/mL) | 4.85 ± 3.45 * | 2.61 ± 1.66 | 4.93 ± 4.87 # | 1.94 ± 1.54 | 4.85 ± 3.10 ¶ | 2.46 ± 1.60 |
| Androstenedion (ng/mL) | 6.31 ± 4.92 * | 2.39 ± 0.88 | 5.13 ± 4.53 | 2.72 ± 1.20 | 4.94 ± 2.90 ¶ | 2.33 ± 0.85 |
| 17-OH Progesterone (ng/mL) | 0.94 ± 0.45 * | 0.61 ± 0.40 | 0.80 ± 0.43 | 0.50 ± 0.23 | 0.84 ± 0.39¶ | 0.60 ± 0.38 |
| Adiponectin (ng/mL) | 30.9 ± 18.3 | 37.82 ± 20.2 | 24.7 ± 12.7 | 31.66 ± 11.9 | 23.5 ± 11.7 | 25.8 ± 14.4 |
| Resistin (ng/mL) | 1.27 ± 0.53 | 1.66 ± 0.99 | 1.33 ± 0.29 | 1.59 ± 0.55 | 1.44 ± 0.40 | 1.44 ± 0.49 |

Data are presented as mean ± SD,* P < 0.05 for difference between respective lean PCOS and the lean control groups, #P < 0.05 for difference between respective overweight PCOS and the overweight control groups, ¶ P < 0.05 for difference between respective obese PCOS and the obese control groups.

PCOS patients. Impaired glucose tolerance was determined in 20% of patients with PCOS. Fasting glucose levels seemed to be higher in the lean PCOS patients than in lean control women and reached statistical significance (P = 0.013). Fasting insulin levels was higher in the PCOS group than in the control group but did not reach statistical significance (P = 0.055). HOMA-IR was significantly higher in the normal weight PCOS group (HOMA-IR: 1.44 ± 0.66) than in the control group (HOMA-IR: 0.98 ± 0.38) and reached statistical significance (P = 0.021). The levels of LH, DHEA-SO4, total and free testosterone, free androgen index, androstenedion, and 17-OH progesterone were significantly higher in the lean PCOS group than in the lean controls. SHBG levels were significantly lower. However, there were no statistically significant differences in serum TC, HDL-C, TG, LDL-C, LH, FSH, prolactin, free T4, free T3, TSH, cortisol, or estradiol levels between the lean PCOS group and the control group (P > 0.05).

In overweight PCOS patients serum LH, total testosterone, free testosterone, and free androgen index were significantly higher than they were in the overweight control group. Serum LH, DHEA-SO4, free androgen index, total and free testosterone, 17-OH progesterone and androstenedione levels were

higher in the obese PCOS group than in the obese controls. SHBG level in the control group was higher than that in the PCOS group and the difference was statistically significant.

There were no statistically significant differences in serum adiponectin concentrations of the lean PCOS and control groups (P > 0.05). Serum adiponectin concentrations of the obese PCOS group were lower than those of the lean PCOS group and the lean control group and the difference was statistically significant. There was no difference in serum adiponectin concentrations of obese PCOS and the obese control group. There were no statistically significant differences in serum resistin concentrations between the groups (P > 0.05). Relationships of serum adiponectin and resistin with anthropometric, biochemical, and hormonal parameters are shown in Table 2. Fasting adiponectin levels showed a significant correlation with insulin resistance indices in the PCOS group. Adiponectin was negatively correlated with insulin and HOMA–IR (P = 0.008, P = 0.012). Adiponectin showed a positive correlation with QUİCKİ. (P = 0.013). Also serum adiponectin showed a positive correlation with HDL (P = 0.003) and a negative correlation with triglycerides (TG). SHBG and adiponectin showed a positive correlation (P = 0.022) while free androgen index and adiponectin showed a negative one (P = 0.048). There was a positive correlation between the BMI and resistin levels (P = 0.036). A positive correlation was found between resistin and waist circumference (P = 0.027). A strong negative linear correlation was observed between resistin and HDL-C levels (P = 0.001).

Table 2. Relationships of serum adiponectin and resistin with anthropometric, biochemical, and hormonal parameters in patients with PCOS.

| | **Adiponectin** | | **Resistin** | |
|---|---|---|---|---|
| | r | P | r | P |
| Age (years) | 0.003 | 0.981 | 0.163 | 0.235 |
| BMI (kg/m$^2$) | -0.227 | 0.095 | 0.284 | **0.036** |
| Waist circumference | -0.173 | 0.205 | 0.298 | **0.027** |
| Insulin (μU/mL) | -0.353 | **0.008** | 0.185 | 0.177 |
| HOMA-IR | -0.338 | **0.012** | 0.218 | 0.110 |
| QUICKI | 0.334 | **0.013** | -0.237 | 0.082 |
| Total cholesterol (mg/dL) | -0.130 | 0.344 | 0.029 | 0.836 |
| LDL-C (mg/dL) | -0.208 | 0.127 | 0.185 | 0.177 |
| HDL-C (mg/dL) | 0.399 | 0.003 | -0.453 | 0.001 |
| Triglyceride (mg/dL) | -0.276 | 0.041 | 0.216 | 0.113 |
| LH (mIU/mL) | 0.003 | 0.981 | -0.020 | 0.885 |
| FSH (mIU/mL) | -0.089 | 0.520 | -0.104 | 0.449 |
| Total testosterone (ng/dL) | -0.172 | 0.210 | -0.133 | 0.333 |
| SHBG (nmol/L) | 0.308 | **0.022** | -0.234 | 0.086 |
| Free androgen index | -0.268 | **0.048** | 0.096 | 0.486 |

## Discussion

Polycystic ovary syndrome (PCOS) is a common endocrine disorder frequently associated with insulin resistance and obesity leading to long-term health risks including type 2 DM, dyslipidemia, and cardiovascular diseases, and manifesting with signs and symptoms of chronic anovulation and hyperandrogenism in reproductive females.

Insulin resistance, which plays a significant role in the pathophysiology of PCOS, is encountered as an important parameter determined in nearly 50% of the patients (6). It is known that the relationship is strengthened in the presence of obesity. HOMA-IR values were significantly higher in PCOS patients with normal weight in comparison to the control group with normal weight, but a similar relation could not be demonstrated between obese and overweight patients and the control group. Higher HOMA-IR level, one of insulin resistance indices, in patients with normal weight in comparison to the age- and BMI-matched control group, is considered an important result supported by literature where insulin resistance in PCOS occurs independently of obesity (7). The best method for determining glucose homeostasis anomalies in PCOS is an oral glucose test (8). The main risk factors responsible for occurrence of glucose intolerance in PCOS are age, BMI, body fat distribution, and familial diabetes history. Impaired glucose tolerance and diabetes occurrence rates were increased particularly in obese patients.

Following the discovery of the hormone leptin in 1994, it is clarified that fatty tissue not only regulates the energy metabolism of our body, it also releases many biological molecules cumulatively referred as adipo(cyto)kines, which contribute to peripheral

insulin sensitivity. In addition, in PCOS, which is regarded among the important features of insulin resistance and central obesity, the role of adipokines in the pathogenesis of the syndrome has attracted attention. Adiponectin is possibly the most important adipocytokine of the fatty tissue. The reason is that it is cytokine only that is synthesized at and released from fatty tissue, and it has well established anti-atherogenic, anti-inflammatory, and insulin sensitizer properties. It is known that adiponectin levels significantly decreases in obese subjects relative to subjects with normal weight (9). Moreover, it was found that serum adiponectin concentrations are inversely related with severity of insulin resistance (10). Taking into consideration the relation of PCOS with obesity and insulin resistance, the role of adiponectin in the pathogenesis of PCOS and whether or not there is a relation with insulin resistance in PCOS attracted our attention.

Studies about the adiponectin levels in PCOS patients have controversial results. PCOS women generally show hypoadiponectinemia. Authors suggested that obesity, insulin resistance, or hyperandrogenemia may be the cause of hypoadiponectinemia in women with PCOS. In the study, no difference was found in serum adiponectin levels between the PCOS patients with normal weight and the control group with normal weight, but serum adiponectin levels in obese patients were significantly lower than those in PCOS patients and the control group, both with normal weight. Adiponectin levels were similar in the obese PCOS and obese control groups. In several previous studies, serum adiponectin levels were found to be similar in the patients with PCOS and BMI-matched control group, which further supported the results of our study (11-14). Similar to our study, some of above-mentioned studies found that serum adiponectin levels of obese and overweight patients with PCOS were significantly lower than those in the PCOS patients with normal weight (11-13). Lack of a significant difference in serum adiponectin levels between PCOS patients and the control group with similar BMI leads to the suggestion that adiponectin has no direct role in the pathogenesis of PCOS (11-14). In contrast, some other studies demonstrated that serum adiponectin levels of patients with PCOS were significantly lower than those in BMI-matched controls, a finding suggestive of the role played by adiponectin in the pathogenesis of the syndrome (15-19).

In our study, it was determined that serum adiponectin levels had negative correlations with fasting insulin level and HOMA-IR, but serum levels had positive relations with QUICKI. This finding is of importance to indicate that serum adiponectin levels are inversely correlated depending on the severity of insulin resistance and the finding is compatible with the literature (10). This relation indicates that obesity is not only a factor in the development of insulin resistance in PCOS patients and that adiponectin may be another factor contributing to insulin resistance. Nevertheless, the relation between insulin resistance in PCOS and adiponectin is still controversial. While some investigators suggest that changes in adiponectin concentrations in the patients with PCOS are related to changes in the quantity of fatty tissue (11,12), others advocate the view that adiponectin is related to insulin resistance independent of obesity (13,14). In some studies, a negative correlation between serum adiponectin levels in PCOS patients and BMI was emphasized but a similar relation was not found in our study (11-14,19).

In our study, a positive correlation between serum adiponectin levels of patients with PCOS and SHBG and a negative correlation with free androgen index were found. A study conducted by Panidis et al. provided a result similar to that of our study, but in their study the fact that SHBG and androgen index were not independent factors influencing adiponectin levels was considered to have a possible relation with obesity (12). In the study conducted by Escobar-Morreale et al., it was suggested that hypoadiponectinemia in patients with PCOS may be a consequence of hyperandrogenism associated with abdominal obesity (18). There are also studies indicating that androgens reduce serum adiponectin levels (20). There are studies suggesting that adiponectin levels are negatively correlated with triglyceride level and positively correlated with HDL-cholesterol (21). In our study, a similar finding consistent with the literature was obtained.

Resistin is an adipokine suggested to be released in large amounts from macrophages besides the fatty

tissue of humans. Moreover, the relation of resistin with obesity and insulin resistance has yet to be clarified. This molecule is regarded as a hormone leading to insulin resistance as it was demonstrated that while serum resistin level increase in the presence of obesity in mice an anti-diabetic agent rosiglitazone decreased levels and that administration of recombinant resistin to mice caused impairment in glucose tolerance and insulin effect. Therefore, Steppan et al. named this new hormone (resist+in[sulin]) (22). Although there are studies supporting the relation between resistin and obesity and insulin resistance, there are also studies reporting contrary views (23-26).

As in many other studies (23-26), our study did not determine a difference between BMI-matched PCOS patients and control groups in terms of serum resistin levels. Panidis et al. found a positive correlation between serum resistin levels and BMI in patients with PCOS and they also emphasized that resistin played no role in the pathogenesis of insulin resistance in PCOS, but it may be related with obesity (27). In our study, a linear relation was determined in the group of patients with PCOS between serum resistin levels and BMI and waist circumference and the finding was compatible with the literature. Seow et al. not only found that serum resistin levels in patients with PCOS were similar to those of the control group, but they also determined that resistin mRNA expression in adiposities was 2-fold higher in the group of patients with PCOS than the control group. In the light of this finding, they suggested that resistin might cause a local paracrine effect in obesity and insulin resistance in PCOS (28).

Additionally, a negative correlation between serum resistin levels and HDL cholesterol was determined in our study. This finding was regarded to result from obesity rather than the effect of resistin on lipid parameters.

In conclusion, our data showed that adiponectin levels were decreased in obese PCOS patients. The study also supports a negative correlation between adiponectin and insulin resistance. We suggest that resistin is not associated with PCOS pathogenesis but it may be an adipocytokine that is affected by BMI. Detailed retrospective studies with long term follow-up and larger populations are required with respect to the clinical significance of these findings.

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