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ORIGINAL ARTICLE

The Effect of BMI and Lipid Metabolism on Pregnancy Outcomes of PCOS Patients Treated with ICSI_IVF

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Abstract

Background and Aim Polycystic ovary syndrome is a highly prevalent and important cause of infertility. This complication demonstrates relationships with obesity, increased androgen production, and insulin resistance. The typical pattern of dyslipidemia in women with PCOS is a decrease in high-density lipoprotein and an increase in triglycerides. On the other hand, fat people are at a higher risk of hyperandrogenism, insulin resistance, hypercholesterolemia, hypertriglyceridemia, and infertility compared to ordinary people.

Methods In this cross-sectional study, 150 patients under 40 years suffering from PCOS based on the Rotterdam criteria, who were candidates for in vitro fertilization (IVF), were examined at Yas Hospital (Tehran, Iran) from April to September 2022. In addition to demographic information, lipid profile, body mass index, obstetric, fasting blood sugar (FBS), beta HCG (negative or positive), and ultrasound were also checked and pregnancy status was checked six weeks later.

Results The rate of clinical and chemical pregnancy in women with a normal BMI was about two times that of women with a BMI above 25 kg/m^2. In addition, the pregnancy rate in women with dyslipidemia was significantly lower than that in ordinary women. The amount of FBS was substantially lower in people with positive pregnancies.

Conclusion The probability of pregnancy in PCOS women with a BMI is higher than normal women, and dyslipidemia is lower than that in ordinary people. Therefore, enhancing BMI and dyslipidemia in these women before starting infertility treatment is recommended.

Keywords Body mass index · Dyslipidemia · Infertility · Pregnancy · Polycystic ovary syndrome

Introduction

As a metabolic and endocrine disorder, polycystic ovary syndrome (PCOS), with a 4 to 18 percent prevalence, is the most common reason for infertility in women with no ovulation and high androgen levels [1]. PCOS can be diagnosed in adults based on Rotterdam criteria so that at least two symptoms (viz. biochemical and clinical symptoms of hyperandrogenism, ovulation disorder, or polycystic ovaries) need to be confirmed through ultrasound examination. In cases of irregular menstruation and signs of hyperandrogenism, ultrasound examination is not necessary [2].

Abnormal ovarian appearance, increased androgen production, and hyperinsulinemia are seen in 80 percent of obese PCOS people [3].

Recent studies have introduced a healthy lifestyle as one of the most important ways to treat PCOS [4]. On the other hand, some studies have shown that body mass index (BMI) and weight loss affect the outcome of in vitro fertilization (IVF) treatment cycle [5].

In addition, research works have shown that obese women with PCOS are at a higher risk of hyperandrogenism, insulin resistance, hypercholesterolemia, hypertriglyceridemia, and even increased C-reactive protein (CRP) compared to women with normal-weight PCOS [6]. The probability of clinical pregnancy in obese women with PCOS is 69 percent

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less than that of women with normal weight [7]. The studies on the effect of BMI and lipid metabolism on pregnancy outcomes of PCOS patients treated with assisted reproductive methods are controversial [8, 9]. Thus, this work was conducted to determine the effects of BMI and lipid metabolism on the pregnancy outcomes of PCOS patients undergoing IVF treatment.

Materials and Methods

This cross-sectional study was conducted with the participation of 150 patients under 40 years old with PCOS and candidates for IVF who were referred to the infertility clinic of Yas Hospital in Tehran, Iran, from April 2022 to September 2022. All required data were carefully collected and recorded by a gynecology ward resident (MG) under the direct supervision of a gynecologist (FAA) and recorded in the patient's medical records. The participants signed a written form of consent. The study was approved by the Ethics Committee of Tehran University of Medical Science (IR.TUMS.MEDICINE.REC.1398.896).

The study's inclusion criteria were age less than 40 years, a history of infertility, and being a candidate for the first round of IVF according to the antagonist protocol. Patients with a history of IVF, infertility due to male factor, infertility due to tubal factor, infertility due to premature ovarian failure (POF), age ≤ 40 years, incomplete patient tests, or tests performed at another center were excluded from the study.

BMI was performed using a precise digital scale by a trained nurse for all patients. The measurement was taken, while the patient was standing and leaning against the wall, with the least possible amount of clothes and without shoes. Lipid profiles such as high-density lipoprotein (HDL), total cholesterol, triglyceride, low-density lipoprotein (LDL), and FBS were routinely performed in this center. Other necessary information, embryo quality, number of ovum, and demographic information were obtained from the patient's file. The lipid profile was determined based on the instructions of the kit.

TG: < 150 normal, 150–199 intermediate, > = 200 high (mg/dL).

Cholesterol: < 200 normal, 200–239 intermediate, > = 240 high (mg/dL).

LDL: < 100 normal, 100–129 intermediate, > = 130 high (mg/dL).

HDL: < 200 normal, ≥ 50 intermediate, < 50 high (mg/dL).

All patients entered the IVF cycle with antagonist protocol, puncture, and transfer. Four weeks after embryo transfer, a Beta HCG test would be performed. A chemical pregnancy would be confirmed if the results were positive (18 U/ml or more). For assessing clinical pregnancy, if chemical pregnancy was approved, vaginal ultrasound would be performed six weeks after transfer to check the presence of the gestational sac and to measure the fetus's heart rate.

Ovarian hyperstimulation syndrome was determined based on ultrasound results in patients who showed large cysts and free fluid during surgery [10].

Statistical Analysis

The Chi-square or Fisher exact test was used to examine quantitative variables between groups. The coefficient of quantitative variables was checked by using Pearson's correlation coefficient (p value < 0.05). Data were analyzed in SPSS statistical software.

Results

The mean age of the patients was 31.7 ± 4/4 years, with the mean BMI equal to 2.82 ± 3/4 kg/m^2. The mean number of previous pregnancies was 0.4 ± 0.6. 62.7%. In total, 62.7% of the patients had abnormal triglycerides, 26.7% had abnormal cholesterol, 57.3% had abnormal LDL, and 5.2% had abnormal HDL. Ninety-four patients (62.7%) had primary infertility and 54 cases (37.7%) had secondary infertility. The average duration of infertility was 3.51 ± 1.76 years, with minimum and maximum periods equal to 1 and 10 years, respectively. Fifty-three people (53.3%) had mild ovarian hyperstimulation syndrome (OHSS), and eight had moderate OHSS. No cases of severe OHSS were reported (Table 1).

Eighty-one people (54.0%) had a chemical pregnancy, and 58 (38.7%) had a favorable clinical pregnancy. Chemical pregnancy was higher in patients with an increased antral follicle count (P = 0.041), lower BMI(P = 0.052), cholesterol less than 200 mg/dl (P = 0.002), LDL lower ≤ 100 mg/dl (P = 0.002), and HDL ≥ mg/dl (P = 0.012) (Table 2).

Patients who had a lower mean age (P = 0.043), lower FBS (P = 0.005), and lower BMI (P = 0.006) had a significantly higher frequency of clinical pregnancy (Table 3).

A statistically significant correlation was observed between patients' lipid profile disorders and OHSS. The frequency of lipid difference was higher in patients with moderate and mild OHSS than those with no OHSS (Table 4).

Discussion

The findings showed that the rate of chemical and clinical pregnancy in women with a normal BMI was about twice that of women with a BMI above 25 kg/m^2. Therefore,

Table 1 Patient characteristics, lipid profiles, and obstetric information

Variable		Detail
Age (yr.), mean ± SD, (rang)		31.7 ± 4.4 (23–39)
BMI (kg/m^2) mean ± SD, (rang)		28.2 ± 3.4 (19.5–39.1)
Previous gravid, mean ± SD, (rang)		0.4 ± 0.6 (0–2)
FSH (mIU/mL) mean ± SD, (rang)		6.9 ± 1.8(3–12)
LH (mg/dl) mean ± SD, (rang)		7.0 ± 2.9(2–17)
Antral follicle count, mean ± SD, (rang)		16.6 ± 5.7(5–30)
FBS (mg/dl) mean ± ds, (rang)		103.1 ± 14.2 (78–142)
Oocyte mean ± ds, (rang)		8.8 ± 3.4 (3–20)
Fetus, mean ± SD, (rang		3.4 ± 1.3 (1–8)
Triglyceride, (mg/dl) *n* (%)	< 150	56 (37.3)
	150–199	61 (40.7)
	≥ 200	33 (22.0)
Cholesterol (mg/dl), *n* (%)	< 200	95 (63.3)
	200–239	40 (26.7)
	≥ 240	15 (10.0)
LDL (mg/dl), *n* (%)	≤ 100	64 (42.7)
	100–130	61 (40.7)
	> 130	25 (16.7)
HDL (mg/dl), *n* (%)	≥ 50	71 (47.3)
	< 50	79 (52.7)
OHHS, *n* (%)	Non	89 (59.3)
	Mild	53 (35.3)
	Moderate	8 (5.3)
Infertility, *n* (%)	Primary	94 (62.7)
	Secondary	56 (37.3)
Quality fetus *n* (%)	A	11(7.3)
	B	21 (14.0)
	AB	62 (41.3)
	BC	40 (26.7)
	ABC	16 (10.7)

FBS fasting blood sugar; *BMI* body mass index; *TG* triglyceride; *HDL* high-density lipoprotein; *LDL* low-density lipoprotein; *FSH* follicle-stimulating hormone; *LH* luteinizing hormone

obesity may increase the probability of fertility failure compared to women with normal BMI.

Consistent with our findings, various studies have demonstrated that the success rate in fertility treatments is lower in obese women than in women with a normal BMI; this could be due to the association between obesity with less normal fertilized oocytes and lower estradiol levels [11, 12]. Bailey and colleagues [13] showed that BMI affected the result of cycle therapy of assisted reproductive methods and decreased the chance of successful treatment. They reported that the likelihood of clinical pregnancy in obese women with PCOS was 69% lower than that of non-obese women.

Milone et al. [14] showed that weight loss in infertile women led to an increase in the incidence of pregnancy in them, and it was recommended that weight loss in obese infertile women should also be considered.

One of the problems related to obesity is infertility, so infertility in obese and overweight men and women is more than in people with normal BMI. On the other hand, pregnancy in obese women usually leads to highly unfavorable outcomes such as infant mortality and macrosomia [15]. Authors in [15] examined the effects of BMI and lipid metabolism on embryo quality and pregnancy outcomes in PCOS patients. According to the findings, there were a direct relationship between BMI and TG/LDL and a negative relationship between BMI and HDL. In addition, high BMI and dyslipidemia affected the quality of the fetus and the outcome of pregnancy; the findings were similar to the results of this study. For this reason, screening and controlling lipids and weight loss before transfer are recommended to improve the rate and outcome of pregnancy in PCOS patients.

Table 2 Relationship of chemical pregnancy status with profile lipid, demographic antral follicle count, and endometrial thickness

Variable		Chemical pregnancy		*P*
		Yes, ($n=81$)	No, ($n=69$)	
Age (yr.), mean ± sd		31.2 ± 4.3	32.3 ± 4.5	0.144
Antral follicle count, mean ± sd		15.7 ± 5.5	17.6 ± 5.7	0.041
ET (mm) mean ± sd		7.4 ± 1.1	7.1 ± 1.1	0.181
FBS, (mg/dl) mean ± sd		101.2 ± 14.1	105.4 ± 14.1	0.072
BMI mean ± sd		27.6 ± 3.3	28.9 ± 3.4	0.052
TG, (mg/dl) *n* (%)	< 150	36 (44.4)	20 (29.0)	0.110
	150–199	31 (38.3)	30 (43.5)	
	≥ 200	14 (17.3)	19 (27.5)	
Cholesterol, (mg/dl) *n* (%)	< 200	59 (72.8)	36 (52.2)	0.002
	200–239	20 (24.7)	20 (29.0)	
	≥ 240	2 (2.5)	13 (18.8)	
LDL, (mg/dl) *n* (%)	≤ 100	44 (54.3)	20 (29.0)	0.002
	100–130	30 (37.1)	31 (44.9)	
	> 130	7 (8.6)	18 (26.1)	
HDL, (mg/dl) *n* (%)	≥ 50	46 (56.8)	25 (36.2)	0.012
	< 50	35 (43.2)	44 (63.8)	

ET endometrial thickness; *FBS* fasting blood sugar; *BMI* body mass index; *TG* triglyceride; *HDL* high-density lipoprotein; *LDL* low-density lipoprotein

Table 3 Relationship of clinical pregnancy status with profile lipid, demographic antral follicle count, and endometrial thickness

Variable		Clinical pregnancy		*P*
		Yes, ($n=58$)	No, ($n=92$)	
Age (yr.), mean ± sd		30.8 ± 3.8	32.3 ± 4.7	0.043
Antral follicle count mean ± sd		15.6 ± 5.3	17.3 ± 5.8	0.075
FBS (mg/dl) mean ± sd		99.2 ± 12.4	105.6 ± 14.7	0.005
BMI (kg/m^2) mean ± sd		27.2 ± 3.3	28.9 ± 3.4	0.006
TG, (mg/dl) *n* (%)	< 150	27 (46.6)	29 (31.5)	0.017
	150–199	25 (43.1)	36 (39.1)	
	≥ 200	6 (10.3)	27 (29.3)	
Cholesterol (mg/dl) *n* (%)	< 200	45 (77.6)	50 (54.3)	0.005
	200–239	12 (20.7)	28 (30.4)	
	≥ 240	1 (1.7)	14 (15.2)	
LDL (mg/dl) *n* (%)	≤ 100	35 (60.3)	29 (31.5)	0.001
	100–130	21 (36.2)	40 (43.5)	
	> 130	2 (3.4)	23 (25.0)	
HDL (mg/dl) *n* (%)	≥ 50	38 (65.5)	33 (35.9)	0.001
	< 50	20 (34.5)	59 (64.1)	

FBS fasting blood sugar; *BMI* body mass index; *TG* triglyceride; *HDL* high-density lipoprotein; *LDL* low-density lipoprotein

Li et al. [16] reported that the number of dominant follicles, the number of oocytes retrieved, the level of estrogen on the day of HCG injection, the implantation, the clinical pregnancy, biochemical pregnancy rate, and live birth in the group of PCOS women with dyslipidemia were significantly lower than the normal group. In the present study, the pregnancy rate of women with dyslipidemia was significantly lower than that of the normal group.

Moreover, the gonadotropin and stimulation doses were higher in the dyslipidemia groups. Although the number of oocytes and estrogen levels significantly differed in patients with BMI > 24 kg/m^2, the present study did not investigate other variables.

Soumya Panda and colleagues [17] reported that the level of triglycerides in the group of women with PCOS was higher than control group. They recommended lipid profile

Table 4 Relation of ovarian hyperstimulation syndrome with profile lipid

Variable		Ovarian hyperstimulation syndrome			*P*(chi2)
		NO, ($n=58$)	Mild, ($n=92$)	Moderate	
		n (%)	*n* (%)	*n* (%)	
TG (mg/dl)	< 200	46 (51.7)	10 (18.9)	–	0.001
	150–199	35 (39.3)	23 (43.4)	3 (37.5)	
	≥ 200	6 (10.3)	27 (29.3)	5 (62.5)	
Cholesterol (mg/dl)	< 200	72 (80.9)	22 (41.5)	1 (12.5)	0.001
	200–239	16 (18.0)	20 (37.7)	4 (50.0)	
	≥ 240	1 (1.1)	11 (20.8)	3 (37.5)	
HDL (mg/dl)	≥ 50	55 (61.8)	14 (26.4)	2 (25.0)	0.001
	< 50	34 (38.2)	39 (73.6)	8 (75.0)	
LDL (mg/dl)	≤ 100	48 (53.9)	15 (28.3)	1 (12.5)	0.001
	100–130	34 (38.2)	26 (49.1)	1 (12.5	
	> 130	7 (7.9)	12 (22.6)	6 (75.0)	

TG triglyceride; *HDL* high-density lipoprotein; *LDL* low-density lipoprotein

screening before treatment of facial infertility in non-obese PCOS patients, like obese PCOS women.

Rashidi et al. [18] performed a case–control study on 153 PCOS patients and 499 healthy women (controls) and showed that women with PCOS had lower HDL levels and higher cholesterols than the control group. In the case of women with a BMI below 25 and between 25 and 30, the PCOS group had higher cholesterol levels than the control group. However, no significant difference was seen between the two groups in women with a BMI over 30 in terms of cholesterol. In women with BMI over 30, the average triglycerides and FBS in PCOS patients were higher than in the control group. Therefore, triglyceride and FBS levels were higher in obese women than in non-PCOS women. There was no way to compare the variables in the control group. However, our study showed that the amount of FBS was significantly lower in people with positive pregnancies.

Veronica Saradis et al. [19] reported a significant decrease in the percentage of mature oocytes in women with BMI over 30. Here, a significant relationship was observed between having a normal BMI and the quality of the fetus.

Moreover, Cui et al. [20] showed that obese PCOS women had a higher risk of miscarriage and a low clinical pregnancy rate compared to non-PCOS. Therefore, obesity in PCOS patients was associated with bad pregnancy outcomes. However, our study did not include a follow-up examination, and the pregnancy outcomes were not investigated.

One of the strengths of this study is its high generalizability. Because the infertility department of Yas Hospital is one of the main infertility treatment centers in Iran, and many people refer to this center from other provinces of the country, its results can be generalized to other infertile women.

One of the limitations of this study was its retrospective nature and reliance on existing data in medical files in which cases of incomplete or illegible information were recorded. It is notable that medical files are filled out for medical purposes, not research purposes. Therefore, similar studies with a large sample size in a multicenter manner or a more extended period are recommended.

Conclusion

The likelihood of pregnancy in PCOS women with BMI higher than normal and dyslipidemia is lower than that of normal individuals. Therefore, correcting BMI and dyslipidemia before starting infertility treatments is recommended.

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Author Contributions MG reviewed and edited the manuscript and conceptualized and designed the study. FAA collaborated on the analysis. MR critically reviewed the manuscript and conceptualized and designed the study. All the authors reviewed the manuscript and agreed with the final version.

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Data Availability Not applicable.

Code Availability Not applicable.

Declarations

Conflict of interest The authors declare that no competing interests exist.

Ethical Approval This study was approved by the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.MEDICINE.REC.1398.896).

Consent to Participate Consent to participate from all patients was obtained.

Consent for Publication Not applicable.

Informed Consent Informed consent was obtained from all participants who were included in the study.

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