nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2024; 44(2):122-129
DOI: 10.12873/442abu

Effect of intermittent fasting on improve body composition and anthropometric measurements of women with polycystic ovarian syndrome

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Recibido: 21/enero/2024. Aceptado: 29/marzo/2024.

ABSTRACT

Introduction: Polycystic ovary syndrome is a metabolic disorder that affects women of reproductive age and is associated with insulin resistance.

Objectives: The study aims to evaluate the effect of intermittent fasting and dietary intervention in improving anthropometric measures and body composition.

Material and Methods: An interventional trial was carried out on eighty-six women between the ages of 19 and 40 with a body mass index of more than 25 kg/m^2 were assigned to two intervention groups: the first group (n = 57) followed intermittent fasting plus dietary restriction, and the second group (n = 29) followed dietary restriction without intermittent fasting.

Results: The results show that the fasting polycystic ovarian syndrome women experienced a significant (P < 0.05) increase in muscle mass (2.2 ± 2.4) compared to the non-fasting group (0.01 ± 1.5). At the end of the intervention, fasting women with the polycystic ovarian syndrome had significantly (P < 0.05) lost weight (9.2 ± 4.5kg), fat mass % (4.6 ± 3.4), and visceral fat (2.3 ± 2.1 kg), while gaining muscle mass (2.2 ± 2.4 kg). However, non-fasting women with polycystic ovarian syndrome showed significantly reduced body weight (2.4 ± 0.4 kg), fat mass % (1.2 ± 1.1), and visceral fat (0.5 ± 0.7). The results of the linear regression model showed that the highest effect of intermittent fasting was seen in weight, fat-free mass, and muscle mass. Body fat mass changed by 93% under the effect of intermittent fasting.

Conclusion: Intermittent fasting may improve health outcomes, reduce body fat, maintain muscle mass, and aid weight loss in women with polycystic ovarian syndrome. Large-scale randomized controlled trials can improve our understanding of intermittent fasting in polycystic ovarian syndrome.

KEYWORDS

Dietary intervention, fat mass, insulin resistance, muscle mass, overweight.

ABBREVIATIONS

PCOS: Polycystic ovary syndrome.

BMI: Body mass index.

BFM: Body fat mass.

FM: Fat mass.

FFM: Fat-free mass.

MM: Muscle mass.

WHR: Waist-hip ratio.

kcal/d: Kilocalorie per day.

CHO: Carbohydrate.

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FAs: Fatty acids.

SFAs: Saturated fatty acids.

MUFAs: Monounsaturated fatty acids.

PUFAs: Polyunsaturated fatty acids.

INTRODUCTION

Polycystic ovarian syndrome is a metabolic endocrine disorder that affects women of reproductive age[1], characterized by hirsutism, amenorrhea, acne, and insulin resistance. Insulin resistance can lead to obesity and overweight[2]. Over the past 40 years, women's obesity prevalence has risen 2.5 times, reaching 15%. This has led to a rise in obesity-related diseases, including metabolic anomalies, including hyperandrogenism, infertility, menstrual abnormalities, and type 2 diabetes[3].

The relationship between Insulin resistance and polycystic ovarian syndrome is not fully understood yet. Nevertheless, regardless of the amount of body fat, Insulin resistance results in hyperinsulinemia[4]. This, in turn, increases androgen receptor sensitivity and causes overproduction of ovarian androgen, which leads to elevated plasma testosterone levels[5].

Furthermore, diet composition is associated with Insulin resistance and androgen hormone abnormalities[6]. Quality and quantity of dietary composition, such as consuming high-glycemic index foods, less fiber, and high saturated fat, are the leading causes of polycystic ovarian syndrome[7]. A case-control study found that women with polycystic ovarian syndrome tend to consume fewer dairy products, fruits, vegetables, and nuts[8].

Lifestyle changes and modified dietary patterns, such as a diet that contains complex carbohydrates, have been linked to various health benefits. Such a diet has been shown to increase insulin sensitivity, delay stomach emptying, promote a feeling of fullness[9], improve insulin sensitivity, reduce postprandial glucose levels, and prevent hyperinsulinemia[10]. Furthermore, the recommended dietary modification involves balancing energy and promoting a healthy diet, low-glycemic-index diet, Mediterranean diet, ketogenic diet, and vegetarian diet have gained popularity for the treatment of polycystic ovarian syndrome[11], through weight loss, improved insulin sensitivity, and metabolic status[12].

Intermittent fasting is an eating pattern that involves alternating between periods of eating and fasting at specific times of the day[13]. The most common type of intermittent fasting is a 16-hour water fast followed by an 8-hour eating period. Numerous studies have shown that intermittent fasting when combined with a restricted diet, can help with weight loss and improve glucose metabolism, lipid metabolism, and insulin sensitivity[14,15]. Additionally, intermittent fasting alone can also lead to weight loss and improvements in these health markers[16]. However, the effects of intermittent fasting combined with a dietary program on anthropometric measures and body composition in women with polycystic ovarian syndrome have not been thoroughly investigated yet. Previous research has mostly evaluated the effects of different dietary approaches to treating polycystic ovarian syndrome based on androgen hormone levels[17]. Therefore, the purpose of this study is to evaluate the impact of adherence to intermittent fasting combined with a dietary program on the body composition and anthropometric measurements of women with polycystic ovarian syndrome.

METHODS

Study design and participation: A six-month interventional trial was conducted in a convenient sample of 86 women who were referred to nutrition clinics from obstetrics and gynecological clinics in Al-Mafraq Hospital, Jordan from November 2022 to July 2023. Eligible women aged 19 – 40 years with polycystic ovarian syndrome and a body mass index greater than 25 kg/m^2. While, women who were pregnant or lactating, diabetic, using contraceptive pills, insulin or oral glycemic medication, previously diagnosed with hypothyroidism or hyperthyroidism, hyperprolactinemia, on a weight loss restriction diet, or using medication or herbs to control appetite or reduce weight were excluded from the trial.

The eligible women were randomly assigned to one of two intervention groups using a simple computer-generated algorithm randomization technique. The intervention group (n = 57) followed intermittent fasting plus dietary restriction, while the control group (n = 29) followed dietary restriction without intermittent fasting.

The Rotterdam criteria are used to diagnose polycystic ovarian syndrome[17]. The diagnosis requires the presence of at least two of the three polycystic ovarian syndrome symptoms, including irregular menstruation (oligomenorrhea or amenorrhea), hyperandrogenism (such as hirsutism), and biochemical signs (a raised free androgen index or free testosterone) as well as polycystic ovarian morphology. A specialist gynecologist performs the ultrasound.

Ethical consideration: The study protocol was carried out in compliance with the Helsinki Declaration and received approval from the ethics committee of the Ministry of Health (reference number 13470) and by the Deanship of Academic Research at Jerash University (1/9/2022/23). The participant provided informed written consent at the time of enrollment.

Anthropometric measurement and body composition analysis: Anthropometric measurements were taken at the beginning and end of the study. The waist and hip circumferences were measured with a precision of 1 mm. Height was measured barefoot with a precision of 1 cm. Body composition was evaluated using bioelectrical impedance (BIA) with Tanita body composition analyzer SC-330. The measurements included fat mass (FM) in kg, fat mass percentage (FM%), muscle mass (MM) in kg, skeletal muscle mass (SMM) in kg, fat-free mass (FFM) in kg, and visceral fat area (VFA) in cm2. The same researcher took all measurements three times, and the average value of the three measurements was used. The waist-to-hip ratio (WHR) and body mass index (BMI) were also calculated.

Dietary intake assessments: During the initial phase of the trial, participants were asked to maintain a food diary for two nonconsecutive weekdays and one weekend day to determine their dietary intake. The food records were analyzed using the Food Processor SQL Nutrition and Software, 2008 (ESHA) to calculate the total energy, carbohydrate, dietary fiber, protein, and fat consumption for each participant.

Intervention: Both groups of participants were given a calorie-restricted diet with dietary changes to lose weight. The participants were instructed to adhere to unrefined carbohydrates, a highly soluble and insoluble diet, and reduce saturated fatty acids. The Harris-Benedict Equation was used to calculate the maximum calories a participant could consume while assuming a typical day's physical activity multiplied by 1.2 activity factors. To lose 0.5 kg per week, 500 calories were subtracted from the total calories. The macronutrient distribution was 30% for fat calories, 20% for protein calories, and the remainder for carbohydrate calories. The intervention group was instructed to fast for 18 hours on non-consecutive days up to three times per week. In contrast, the control group was given a reduced diet without intermittent fasting.

Statistical analysis: Data analysis was performed using SPSS software (SPSS Inc. Released 2008. SPSS Statistics for Windows, Version 17.0. Chicago: SPSS Inc). Data was provided as a mean ± standard deviation. A one-way ANOVA was used to examine the mean difference value of continuous variables. The student's unpaired t-test was used to assess the effect of intervention on primary outcomes. The Analysis of covariance (ANCOVA) procedure is used to evaluate the main and interaction effects between variables. A P value of < 0.05 will be statistically significant.

RESULTS

The study investigated 86 women diagnosed with polycystic ovarian syndrome, who were referred from reproductive endocrinology clinics. Table 1 presents the baseline anthropometric measurements and body composition of both fasting and non-fasting women with polycystic ovarian syndrome. The study concluded that women with polycystic ovarian syndrome who fasted had significantly higher visceral fat (P=0.01) and marginally higher weight, body mass index, and fat-free mass (P=0.05) compared to non-fasting women with polycystic ovarian syndrome. However, there were no significant differences between the two groups in any of the other baseline variables studied.

Tabla 1. Baseline Anthropometric measurements and body composition of participants

Variable	Fasting PCOS women (n= 57)	Non- fasting PCOS women (n= 29)	P- value
Age (year)	34.5 ± 7.2	36.5 ± 11.2	0.32
Weight (kg)	92.6 ± 18.2	84.7 ± 15.1	0.05
BMI (kg/m^2)	34.6 ± 5.7	32.1 ± 5.3	0.05
BFM (kg)	37.5 ± 11.9	34 ± 11.6	0.20
FM%	40.1 ± 7.1	39.2 ± 7.5	0.57
FFM (kg)	54.8 ± 10	50.7 ± 7	0.05
Visceral Fat	11 ± 4	8.6 ± 3.2	0.01*
MM (kg)	51.2 ± 11.7	48.1 ± 6.6	0.12
WHR	0.88 ± 0.01	0.88 ± 0.01	0.85

Data are presented as mean ± SD. P value is considered significant for values < 0.05.
PCOS: Polycystic ovary syndrome, BMI: Body mass index, BFM: Body fat mass, FM: Fat mass, FFM: Fat free mass, MM: Muscle mass, WHR: Waist-to- hip ratio.

The dietary intake of both participant groups for three consecutive days is shown in Table 2. There were no significant differences between the groups in terms of the total calories consumed daily (P > 0.05). However, fasting polycystic ovarian syndrome women consumed significantly (p < 0.05) more total carbohydrate (251.15 ± 55.7g/d), higher calories from fatty acids (908.7 ± 325 kcal/day), and higher saturated fat intake (25 ± 6.8 g/day). On the other hand, non-fasting polycystic ovarian syndrome women consumed significantly (p < 0.05) more carbohydrates (44.8 ± 10%) as a percentage of the total daily calories they consumed and had a higher soluble fiber intake (2.3 ± 1.5 g/day). However, there was no statistical difference (P > 0.05) in protein, polyunsaturated fatty acids, monounsaturated fatty acids, insoluble fiber, or sugar consumption between the two groups.

Table 3 shows the differences in body composition and anthropometric parameters across groups of individuals before and after the intervention. The fasting polycystic ovarian syndrome group experienced a significant (P < 0.05) increase in muscle mass (2.2 ± 2.4) compared to the non-fasting group (0.01 ± 1.5) after the intervention. At the end of the intervention, fasting women with polycystic ovarian syndrome had significantly different anthropometric measurements and body composition compared to their baseline values (P < 0.05). Women with polycystic ovarian syndrome

Tabla 2. Dietary intake characteristics of the participants groups

Variable	Fasting PCOS women (n= 57)	Non-fasting PCOS women (n= 29)	P- value
Total calorie (Kcal/day)	2265.5 ± 653.4	2051 ± 674.2	0.23
Protein (g/d)	77.7 ± 15.8	70.2 ± 28	0.22
% protein	14.2 ± 2.5	13.9 ± 3.1	0.56
CHO (g/d)	251.15 ± 55.7	230 ± 83	0.01*
% CHO	45.3 ± 6.5	46 ± 10	0.04*
Total FAs (g/d)	99 ± 37	83 ± 35	0.71
% total FAs	40.5 ± 5.7	35.5 ± 7.7	0.001*
Total FAs (kcal/ day)	908.7 ± 325	738.3 ± 307	0.001*
SFAs (g/d)	25 ± 6.8	22.4 ± 13.1	0.01*
SFAs (kcal/d)	196.9 ± 60.7	201 ± 117.5	0.82
MUFAs	30 ± 19.8	23.6 ± 13.3	0.55
PUFAs	11.1 ± 5.3	10.5 ± 5.8	0.51
Total fiber (g/d)	16.3 ± 7.3	17 ± 7.5	0.71
Soluble fiber (g/d)	1.5 ± 0.9	2.3 ± 1.5	0.01*
Insoluble fiber (g/d)	4.5 ± 2.4	5.5 ± 3.6	0.13
Sugar (g/d)	73.3 ± 27.4	86 ± 52.4	0.14

Data are presented as mean ± SD. P value is considered significant for values < 0.05.
PCOS: Polycystic ovary syndrome, kcal/d: Kilocalorie per day, CHO: Carbohydrate, FAs: Fatty acids, Saturated fatty acids: SFAs, MUFAs: Monounsaturated fatty acids, PUFAs: Polyunsaturated fatty acids.

who fasted lost weight (9.2 ± 4.5kg), body mass index (3.8 ± 2.8), body fat mass (6.9 ± 3.7kg), fat mass % (4.6 ± 3.4), and visceral fat (2.3 ± 2.1 kg), while gaining muscle mass (2.2 ± 2.4 kg). However, non-fasting women with polycystic ovarian syndrome showed significant differences ($P<0.05$) from baseline values at the end of the intervention. The study found a reduced body weight (2.4 ± 0.4 kg), body mass index (0.8 ± 0.6), body fat mass (1.9 ± 1.7 kg), fat mass% (1.2 ± 1.1), and visceral fat (0.5 ± 0.7).

Table 4. presents the impact of intermittent fasting on anthropometrics and body composition using the linear regression model. The highest impact of intermittent fasting was found in weight, fat-free mass, and muscle mass, which explained 95% of the observed changes. Body fat mass showed a change of 93% under the effect of intermittent fasting. Specifically, intermittent fasting, respectively, explained 88% and 86% of changes in fat mass percentage and visceral fat level. Additionally, intermittent fasting explained 57% of changes in the waist-to-hip ratio.

DISCUSSION

Obesity is a medical condition where the body accumulates excess body fat, which can cause negative health consequences and increase the risk of various diseases such as endocrine and reproductive disorders[18]. Women with polycystic ovarian syndrome often experience changes in their body composition resulting in differences in the amount and distribution of body fat[6,19]. The current study found that women with polycystic ovarian syndrome have a high body mass index, waist-hip ratio, body fat mass, and visceral fat. Overweight or obesity affects around 40%-60% of women with polycystic ovarian syndromes. Abdominal obesity and an increase in waist-hip ratio normally lead to an increase in visceral fat in women with polycystic ovarian syndrome, which may lead to insulin resistance[20]. Insulin resistance is a significant factor in the development of polycystic ovarian syndrome, which results in increased free androgen circulation from the ovaries. Moreover, the increase in body fat mass appears to be the result of hyperinsulinemia, as body

Tabla 3. Differences between anthropometric and body composition measurement among participant groups at baseline and end of intervention

Variable	Fasting- PCOS women (n= 57)	Non-fasting PCOS women (n= 29)	P- value	P' value	P'' value
Weight (kg)			0.77	0.01	0.01
Baseline	92.6 ± 18.2	84.7 ± 15.1			
End of treatment	83.5 ± 18.5	82.3 ± 15.1			
Mean differences	9.2 ± 4.5	2.4 ± 0.4			
BMI (kg/m^2)			0.70	0.01	0.01
Baseline	34.6 ± 5.7	32.1 ± 5.3			
End of treatment	30.8 ± 5.3	31.3 ± 5.4			
Mean differences	3.8 ± 2.8	0.8 ± 0.6			
BFM (kg)			0.53	0.01	0.01
Baseline	37.5 ± 11.9	34 ± 11.3			
End of treatment	30.5 ± 11.7	32.1 ± 11.2			
Mean differences	6.9 ± 3.7	1.9 ± 1.7			
FM%			0.19	0.01	0.01
Baseline	40.1 ± 7.1	39.2 ± 7.5			
End of treatment	35.5 ± 8.2	37.9 ± 7.8			
Mean differences	4.6 ± 3.4	1.2 ± 1.1			
FFM (kg)			0.29	0.01	0.29
Baseline	54.8 ± 10	50.7 ± 7			
End of treatment	52.5 ± 10	50.3 ± 7			
Mean differences	2.3 ± 2.1	0.4 ± 1.9			
Visceral Fat			0.64	0.01	0.01
Baseline	11 ± 4	8.6 ± 3.2			
End of treatment	8.5 ± 4	8.1 ± 3.2			
Mean differences	2.5 ± 1.7	0.5 ± 0.7			

Data are presented as mean ± SD. P value is considered significant for values < 0.05.
PCOS: Polycystic ovarian syndrome, BMI: Body mass index, BFM: Body fat mass, FM: Fat mass, FFM: Fat-free mass, MM: Muscle mass, WHR: Waist hip ratio.
P- Value between groups; P' value: within fasting PCOS women, P'' value: within non-fasting PCOS women.

Tabla 3 continuation. Differences between anthropometric and body composition measurement among participant groups at baseline and end of intervention

Variable	Fasting- PCOS women (n= 57)	Non-fasting PCOS women (n= 29)	P- value	P' value	P'' value
MM (kg)			0.001	0.001	0.97
Baseline End of treatment Mean differences	51.2 ± 9.6	48.1 ± 6.6			
	53.5 ± 9.5	48.1 ± 6.7			
	2.2 ± 2.4[a]	0.01 ± 1.5			
WHR			0.85	0.15	0.52
Baseline End of treatment Mean differences	0.88 ± 0.01	0.88 ± 0.01			
	0.75 ± 0.06	0.87 ± 0.04			
	0.14 ± 0.07	0.01 ± 0.04			

Data are presented as mean ± SD. P value is considered significant for values < 0.05.
PCOS: Polycystic ovarian syndrome, BMI: Body mass index, BFM: Body fat mass, FM: Fat mass, FFM: Fat-free mass, MM: Muscle mass, WHR: Waist hip ratio.
P- Value between groups; P' value: within fasting PCOS women, P'' value: within non-fasting PCOS women.

Tabla 4. Effect of IF on anthropometrics and body composition

Variables	R Square Change	% of Change	F	*p*-value for Change*
Weight (kg)	0.954	95%	58.142	<0.001
BFM (kg)	0.927	93%	46.078	<0.001
FM (%)	0.876	88%	26.604	<0.001
FFM (kg)	0.95	95%	15.548	<0.001
Visceral fat level	0.862	86%	26.572	<0.001
MM(kg)	0.946	95%	22.533	<0.001
WHR	0.567	57%	108.022	<0.001

BFM: Body fat mass, FM: Fat mass, FFM: Fat-free mass, MM: Muscle mass, WHR: Waist hip ratio. P value is considered significant for values ≤ 0.001.

fat mass correlates significantly with circulating insulin and insulin resistance[21].

Energy-dense foods, refined sugar, fast food, and foods with a high glycemic index can all contribute to weight gain and insulin resistance[22]. Fast food is rich in saturated fat, which promotes fluctuations in glucose levels and insulin resistance, increasing the likelihood of developing polycystic ovarian syndrome. The current study's findings demonstrated that polycystic ovarian syndrome women consume more fat, particularly saturated fat, and more carbohydrates as a proportion of their overall calorie intake, and a low-fiber diet, which are all considered key risk factors for developing polycystic ovarian syndrome. Such a diet causes a rapid surge in blood glucose levels, followed by increased insulin release, promoting insulin resistance, and greater androgen levels[23].

Women with polycystic ovarian syndrome are treated with medication, lifestyle adjustments, nutritional support, and weight loss. Several studies have been undertaken to determine the efficacy of various dietary regimens on weight loss in women with polycystic ovarian syndrome. The dietary intervention in this study was modified by considering energy restriction if necessary and altering nutritional composition by emphasizing unrefined carbs and soluble fiber to accomplish weight loss and improve insulin resistance, and reproductive function. Diet composition is critical for weight loss and treating insulin resistance[24]. Furthermore, a diet high in unrefined carbs and soluble dietary fiber has been associated with weight loss and increased insulin sensitivity by delaying stomach emptying and boosting satiety, which aids in lowering glycemic load, postprandial glucose levels, and hyperinsulineamia[9]. The findings of our study revealed that by the end of the intervention trial, both intervention groups had lost weight, body mass index, body fat mass, and visceral fat. Polycystic ovarian syndrome women with insulin resistance, on the other hand, had the greatest results in reducing weight, body fat mass, and increased muscle mass. Insulin resistance has been linked to weight loss and improved insulin sensitivity[25]. Similarly, intermittent energy restriction may help with weight loss, adipocyte storage, ectopic and visceral fat storage, and insulin resistance[26].

A randomized control study conducted on obese adolescent women with polycystic ovarian syndrome found that dietary restriction and behavioral modification might improve menstrual regularity, weight loss, and body mass index[27]. However, insulin resistance with intermittent energy restriction may be more effective than continuous restriction in treating overweight and obesity and improving glucose metabolism and insulin sensitivity[28]. Insulin resistance benefits may include increased cell metabolic activity during the period of fasting and feeding state. During the fasting state, glycogen storage is depleted and the body switches its energy source to fatty acids and ketone bodies which strengthen mitochondria function and upregulate autophagy of stressed cells that develop insulin resistance[29]. This will reduce insulin signaling and protein synthesis. During the feeding period, the body will shift its energy source toward glucose and the ketone bodies will be cleared. This will activate protein synthesis for growth and repair toward more efficient cellular signaling[24]. On the other hand, consuming a single meal per day exhibited elevated morning fasting glucose levels and impaired glucose tolerance associated with delayed insulin response when compared with consuming three meals per day[30].

CONCLUSION

Intermittent fasting may improve health outcomes, reduce body fat, maintain muscle mass, and aid weight loss in women with polycystic ovarian syndrome. Therefore, more attention is needed to the role of lifestyle and dietary modification in the treatment of metabolic disease and insulin resistance in polycystic ovarian syndrome. Conducting large-sample randomized controlled trials can expand our understanding of the effect of intermittent fasting in polycystic ovarian syndrome.

ACKNOWLEDGMENT

The authors would like to thank Jerash University for their support during the conduction of this research.

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