



Effect of aerobic exercises on circulating leucocytes in obese women with polycystic ovarian syndrome

Marwa F. ElFaham¹, Amel M. Youssef¹, Mohamed R. Sulieman², Asmaa M. Elbandrawy^{1*}

¹ Department of Physical Therapy for Women's Health, Faculty of Physical Therapy, Cairo University, Cairo, Egypt.

² Department of Obstetrics and Gynaecology, Hosh Issa Hospital, Beheira, Egypt.

*Correspondence: Asmaa M. Elbandrawy; Asmaa.Elbandrawy@gmail.com

ABSTRACT

Objective: To investigate the effect of aerobic exercises on leucocytes in obese polycystic ovarian women.

Methods: Thirty obese women diagnosed with obesity and PCOS, aged 20 to 30, participated in this study from the Outpatient Clinic of Hush-Issa Central Hospital. They were randomly assigned to two equal groups: Group A, which participated in an aerobic exercise program (weight-bearing treadmill exercise) three times per week for 6 weeks alongside a diet program, and Group B, which followed only the diet program. Both groups were evaluated before and after the 6-week study by measuring weight, body mass index (BMI), waist-hip ratio, and leucocytes.

Findings: The results of this study showed a statistically significant decrease ($p < 0.001$) in weight, BMI, and waist-hip ratio in both group (A) and group (B). A significant decrease in leucocytes was observed in group (A) ($p < 0.001$), with no significant difference in group (B) ($p > 0.05$). Comparisons between both groups revealed no significant difference before the study ($p > 0.05$), but post-treatment, group (A) showed a significant decrease in weight, BMI, and WHR compared to group (B) ($p < 0.05$). Additionally, leucocytes decreased significantly in group (A) compared to group (B) post-treatment ($p < 0.001$).

Conclusions: It could be concluded that the aerobic exercise program was an effective method for decreasing the leucocytes in obese polycystic ovarian syndrome women.

KEYWORDS

Aerobic Exercises; Circulating Leucocytes; Polycystic; Ovarian; Women

1. INTRODUCTION

Polycystic ovarian syndrome (PCOS) is the most common reproductive endocrine disorder in the world and affects approximately 4%-18% of all reproductive-aged women. PCOS has adverse impacts on female endocrine activity, metabolism, and reproduction and is generally associated with chronic anovulation that results in a persistent progesterone deficiency [1].

The principal features are anovulation, resulting in irregular menstruation, amenorrhea, ovulation-related infertility, and polycystic ovaries; and excessive amounts or effects of androgenic (Masculinizing) hormones resulting in acne, hirsutism, and insulin resistance, often associated with obesity, type 2 diabetes, and high cholesterol levels. The symptoms and severity of the syndrome vary greatly among affected women [2].

An aerobic exercise program and a hypocaloric high-protein diet improve both menstrual cyclicity and fertility in overweight PCOS patients. The exercising subjects have higher ovulation rates and menses frequency, as well as greater improvements in waist circumference (WC), sex hormones, and insulin levels. There is an inverse association between markers of inflammation and physical activity; exercise training has an effect on inflammation [3].

Lifestyle recommendations, in terms of dietary composition, propose a high carbohydrate, moderate protein, and low-fat intake. Increasing dietary protein and decreasing carbohydrate intake to increase weight loss and improve insulin sensitivity [4].

This study is conducted to investigate the effect of aerobic exercises on leucocytes in obese polycystic ovarian women.

2. METHODS

2.1. Participants

This study was carried out on thirty obese women diagnosed as having obesity and polycystic ovarian syndrome (PCOS). They were selected from an outpatient clinic at Hush-Issa Central Hospital on the following criteria:

Inclusion criteria: Their age ranged from 20 to 30 years, and their body mass index (BMI) ranged from 30 to 34.9 kg/m². They were medically stable and able to follow instructions. All participating women had amenorrhea (no menses in the last 6 months) or oligomenorrhea (fewer than four cycles in the last 6 months). Additionally, all participants had a typical ultrasonographic

presentation of PCOS, characterized by multiple subcapsular follicles and a thickened ovarian stroma. Their LH/FSH ratio was above 2 [5]. Women who had not received any medications or engaged in aerobic exercise in the last 3 months were included to avoid factors that could affect the study results.

Exclusion criteria: Women with hepatic diseases, cardiac diseases, chest diseases, severe life limiting illnesses (cancer, renal failure), diabetes, and obesity of the classes 2 and 3.

All participants were assigned randomly into two equal groups (A&B):

Group A (study group) consisted of 15 women. They received a program of aerobic exercises in the form of walking on the treadmill for 40 min per session, with a routine of 3 sessions a week for 6 weeks, in addition to a hypocaloric diet.

Group B (control group) consisted of 15 women. They received their hypocaloric diet (1200-1500 kcal/day) for 6 weeks. The same hypocaloric diet was provided to both groups A and B. Each woman in both groups (A&B) signed a consent form before entry in the study.

2.2. Materials

- A weight and height scale was used to measure the weight and height of all women in both groups (A&B) before starting the study and weight only after the end of the study (6) weeks to calculate their BMI.
- An ultrasound machine was used to confirm the PCOS diagnosis of each woman in both groups (A&B) before starting the study. The study used a LOGIC P3 ultrasound machine with the model number 2401359 and the serial number 302179 wx7.
- A treadmill was used to perform aerobic exercises for women in group (A) for 40 minutes/session per week for 18 sessions. The machine had the following characteristics: an input power voltage AC 220-240 (50/60 Hz), a motor power 2.0 hp, a speed of 1-10 km/h, a running surface of 400*1100 mm, a max user weight 120 kg, and expand dimensions of 1490*64591210 mm.
- Syringes, cotton, alcohol.
- Stopwatch.

2.3. Procedures

2.3.1. Evaluative Procedure

All participants of both groups (A&B) were examined primarily to confirm the PCOS diagnosis. Before beginning the study, a detailed medical history of the participants was taken and recorded, and they were required to sign a consent form.

History taking

All the data and information for each participant in this study were recorded in recording data sheet.

Body mass index (BMI)

Before starting the study, weight, and height were measured for each member of both groups (A&B), while wearing light clothes and being barefooted, to calculate the body mass index (BMI) by calculating the body mass divided by the square of the body height (mass in kilograms and height in meters). Only their weight was measured at the end of the study (after 6 weeks).

Waist-hip ratio (WHR)

The dimensionless ratio of the circumference of the waist to that of the hips was measured for each woman in both groups (A&B).

Ultrasound assessment

All women in both groups (A&B) underwent ultrasonographic examination to confirm their PCOS condition.

Leucocytes level

A sample of 5 ml venous blood using a serum separator tube was taken from each member of both groups (A&B) at the third day of menstrual cycle.

Laboratory analysis were performed to detect the level of leucocytes and in their blood before and after the study for both groups (A&B).

2.3.2. Treatment

Aerobic exercises for group (A)

Fifteen women diagnosed with obesity and PCOS participated in an exercise program on program that involved exercises on an electronic treadmill in addition to their prescribed diet, 3 times per week for 6 weeks.

Prior to each session, each participant was instructed to empty her bladder to make sure that she was comfortable and relaxed throughout the treatment session, and asked to wear a comfortable outfit and flexible shoes. At the start of each session, the therapist prepared the equipment and plugs in the treadmill and then explained to the patient the sequence of exercises for the session, always starting by instructing her to begin by standing up straight with one foot on each side of the treadmill holding the handrails to improve the participant's stability, and to keep her head up and eyes looking ahead without leaning forwards or backwards. The treadmill has extended sides designed to allow the participants to stand on them for security until the treadmill starts. The treadmill always started with a slow rate of speed, in which the participant was asked to walk on the treadmill's running deck by hitting it with the heel first, then rolling through the step from heel to toe, and pushing off with the toe bring the back leg forward and repeat the process, with the speed gradually increasing throughout the session.

The exercise on the treadmill was divided into 3 stages:

1. First stage (warm up):

Each participant started each session with 5 minutes at slow speed and zero inclination on the treadmill as a warm-up exercise, employing this slow progressive exercise to enhance patient performance by facilitating circulatory adjustment, minimize the formation of lactic acid, and decrease the risk of hypotension, musculoskeletal, and cardiovascular complications.

2. Second stage (active phase):

The speed of the treadmill was increased gradually to achieve at least 70% of maximum heart rate (HR max) for each participant over the course of 20 minutes.

3. Third stage (cooling down or recovery period):

At the end of the second stage, the speed of the treadmill was gradually decreased until it reached zero over the span of 5 minutes to allow the heart rate to return nearly the resting level.

Hypocaloric diet for both groups (A&B)

Each participant in both groups (A&B) followed a restricted diet program (1200-1500 kcal/day) which depended on decreasing calories by 500-1000 kcal per day from the total daily energy requirements.

Each participant's weight was recorded in the first session, then their total daily energy requirement was calculated, and the patient followed a diet program of 500 kcal less than the total energy requirement for the first 2 weeks and 1000 kcal less for the last 2 weeks of treatment. A consultation session and a follow-up of the participant was done every week in order to reassess her

new body weight after following the restricted diet, and based on it a new total daily energy requirement was measured every week until the end of the study in order to readjust the diet accordingly. The composition of this diet consisted of 55% carbohydrates, 15% protein and 30% fat, the participants were asked to maintain this diet composition throughout their study duration (6 weeks).

2.4. Statistical analysis

An unpaired t-test was conducted for comparison between age between groups and the mean values of weight, BMI, WHR and leucocytes between the group A and B. The normal distribution of data was checked using the Shapiro-Wilk test. A Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. A paired t-test was conducted to compare between pre- and post-treatment in each group. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analyses were conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

3. RESULTS

3.1. Subject characteristics

Thirty women with obesity and polycystic ovarian syndrome participated in this study. The mean \pm SD age of group A was 29.4 ± 3.45 years and that of group B was 30.66 ± 2.96 years. There was no significance difference between groups in the mean age ($p = 0.29$).

3.2. Effect of treatment on weight, BMI, WHR and leucocytes

Within group comparison

There was a significant decrease in weight, BMI, WHR post treatment in both groups compared with that of pre-treatment ($p > 0.001$). The percent of decrease in weight, BMI, WHR in group A was 10.98, 10.9 and 7.53% respectively while that for group B was 5.74, 5.72 and 2.13% respectively. (Table 1).

There was a significant decrease in leucocytes (29.05) post treatment in group (A) compared with the same group in pretreatment ($p > 0.001$). There was no significant difference in leucocytes of the group B between pre- and post-treatment ($p > 0.05$) (Table 2).

Between groups comparison

There was no significant difference between groups in pre-treatment ($p > 0.05$). Comparisons between groups post treatment revealed a significant decrease in weight, BMI and WHR for group A compared with that of group B ($p < 0.05$). Also, there was a significant decrease in leucocytes of the group A compared with that of the group B post treatment ($p < 0.001$) (Table 1-2).

Table 1. Mean weight, BMI and WHR pre- and post-treatment of group A and B.

| | Group A | Group B | MD | t- value | p value |
|-------------------------------|------------------|------------------|-------|----------|---------|
| | $\bar{x} \pm SD$ | $\bar{x} \pm SD$ | | | |
| Weight (kg) | | | | | |
| Pre-treatment | 87.4 \pm 6.42 | 87.06 \pm 5.45 | 0.34 | 0.15 | 0.87 |
| Post-treatment | 77.8 \pm 4.72 | 82.06 \pm 4.58 | -4.26 | -2.51 | 0.01 |
| MD | 9.6 | 5 | | | |
| Percentage of change | 10.98 | 5.74 | | | |
| T-value | 11.88 | 13.22 | | | |
| | $p = 0.001$ | $p = 0.001$ | | | |
| BMI (kg/m²) | | | | | |
| Pre-treatment | 32.65 \pm 1.51 | 32.7 \pm 1.41 | -0.05 | -0.08 | 0.93 |
| Post-treatment | 29.09 \pm 1.27 | 30.83 \pm 1.17 | -1.74 | -3.89 | 0.001 |
| MD | 3.56 | 1.87 | | | |
| Percentage of change | 10.9 | 5.72 | | | |
| T-value | 13.59 | 14.01 | | | |
| | $p = 0.001$ | $p = 0.001$ | | | |
| WHR | | | | | |
| Pre-treatment | 0.93 \pm 0.08 | 0.94 \pm 0.09 | -0.01 | -0.27 | 0.78 |
| Post-treatment | 0.86 \pm 0.07 | 0.92 \pm 0.09 | -0.06 | -2.2 | 0.03 |
| MD | 0.07 | 0.02 | | | |
| Percentage of change | 7.53 | 2.13 | | | |
| T-value | 12.97 | 9.72 | | | |
| | $p = 0.001$ | $p = 0.001$ | | | |

* \bar{x} , Mean; SD, Standard deviation; p value, Probability value

Table 2. Mean leucocytes pre- and post-treatment of the group A and B.

| | Group A | Group B | MD | t- value | p value |
|---------------------------------------|------------------|------------------|-------|----------|---------|
| | $\bar{x} \pm SD$ | $\bar{x} \pm SD$ | | | |
| Leucocytes (10⁹ /L) | | | | | |
| Pre-treatment | 8.33 \pm 1.15 | 8.3 \pm 1.28 | 0.03 | 0.06 | 0.95 |
| Post-treatment | 5.91 \pm 1.1 | 8.05 \pm 1.22 | -2.14 | -5.03 | 0.001 |
| MD | 2.42 | 0.25 | | | |
| Percentage of change | 29.05 | 3.01 | | | |
| T-value | 10.9 | 1.46 | | | |
| | $p = 0.001$ | $p = 0.16$ | | | |

* \bar{x} , Mean; SD, Standard deviation; p value, Probability value; **, Significant

4. DISCUSSION

Polycystic ovary syndrome is a common endocrine disorder, affecting 8-12% of women. It is one of the most prevalent causes of infertility in women. The disorder is also called Leventhal and Stein syndrome; the main clinical features of this syndrome are obesity, hyperandrogenism, menstrual cycle disorders and infertility, which occur individually or simultaneously. Obesity and anovulation are associated with cardiovascular disease, hypertension and altered cholesterol and lipoprotein profile. Reproductive outcomes in women affected by PCOS are intensely dependent on the body weight and metabolic condition [6].

PCOS is regarded as a vicious circle, where both insulin resistance and abdominal obesity cause production of ovarian and adrenal androgen, or inversely, an elevation of testosterone levels elevation could increase abdominal obesity [7].

It may advance into a metabolic syndrome, leaving a remarkable negative impact on body functions with serious long-term consequences. Yet, it's considered as the most common endocrine abnormality for females of reproductive age [8].

Higher circulating levels of inflammatory mediators is a prominent risk factor for several chronic diseases, as well as ageing-related disability. As such, the inflammatory pathway is a potential therapeutic target for lifestyle interventions designed to reduce disease and disability. Physical exercise is well recognized as an important strategy for reducing the risk of chronic disease, and research has focused on its role in the improvement of the inflammatory profile and diminishing inflammation [3].

The results of this study revealed that there was a significant decrease in weight, BMI, WHR and leucocytes in group (A). This comes in agreement with Covington et al. [10] who found that women with PCOS had higher circulating WBC compared with BMI matched female controls. They investigated circulating leucocytes and insulin sensitivity by euglycemic-hyperinsulinemic clamp. They found that 16 weeks of aerobic exercise reduced WBC counts, and that the changes in total WBC as well as neutrophils correlated inversely with changes in glucose disposal rate. The 8 women with PCOS underwent a 16-week aerobic exercise regimen with the same measures performed post-intervention. Compared to controls, white blood cell counts (WBC) were 30% higher ($p = 0.04$) and circulating total adiponectin levels were 150% lower ($p = 0.03$) in women with PCOS at baseline or pre-exercise conditions. SAT gene expression of macrophage migration inhibitory factor (MIF, $p < 0.01$) and interleukin-6 (IL-6, $p < 0.05$) were also lower in women with PCOS. In response to 16 weeks of aerobic exercise, insulin sensitivity improved ($p < 0.01$) and WBC counts decreased ($p = 0.02$). The

exercise-induced change in WBC and circulating neutrophils correlated inversely with changes in glucose disposal rate ($r = -0.73$, $p = 0.03$; and $r = -0.82$, $p = 0.01$, respectively).

The results of Taghavi et al. [11] study comes in acceptance with the results of the present study. They have conducted an intervention on twenty obese PCOS patients aged 15-30 underwent a 12-week aerobic training program. Anthropometric parameters (weight, height, maximum oxygen consumption, waist circumference, waist to hip ratio, and body fat percentage), metabolic and hormonal profiles (glucose and insulin) were assessed and compared at the baseline and after the 12-week training program. The results recorded that body weight decreased from 76.9 ± 11.69 kg to 74.01 ± 11.82 kg, body fat percentage decreased from $37.01\% \pm 4.16$ to $35.57\% \pm 4.13$ and waist circumference decreased from 86.4 ± 8.75 cm to 82.29 ± 6.59 cm ($P < 0.05$).

The results of the current study are in agreement with Abazar et al. [6], who studied the effect of aerobic exercise on women affected by PCOS, with BMI (29.86 ± 3.22) kg/cm², and average age of 26.87 ± 4.43 years. Twenty-four women affected by polycystic ovary syndrome (PCOS) after medical screening were divided into two groups: Experimental group ($n = 12$) and control group ($n = 12$), with the average age, weight, height, BMI and WHR of 26.87 ± 4.43 years, 75.71 ± 10.65 kg, 159.29 ± 6.44 cm, 29.86 ± 3.22 kg/m² and 91.75 ± 5.86 cm respectively. The exercise consisted of 12 weeks of aerobic exercise at a moderate level (60 to 70% of maximum heart rate), for 3 sessions a week, each session for 60 min. The results showed that after 12 weeks of exercise, there was significant reduction in BMI, waist/hip ratio, weight and fat mass.

The findings also agree with the study of Dantas et al. [12] who conducted a systematic review and identified three trials, including 231 participants with PCOS that examined the effect of structured, supervised exercise on cardio-metabolic outcomes. Analysis of pooled data indicated statistical favourable effects of exercise on total cholesterol, fasting glucose, waist circumference, waist-to-hip ratio, systolic blood pressure, C-reactive protein, total testosterone, and sex hormone binding globulin using post-intervention scores. This study applied moderate aerobic exercise interventions ≥ 3 months in duration, with a frequency of 3/week for at least 30-min. The results showed improvements of WC and WHR, shown to be associated with insulin sensitivity in PCOS.

Jafari et al. [13] conducted a study which supports the present study. In this quasi-experimental study was conducted on a total of 24 women with diagnosed PCOS in Isfahan, Iran, within May 22nd to September 21st 2018. Participants were randomly assigned into two groups of experimental ($n=12$) and control groups ($n=12$). The experimental group underwent 12-week aerobic exercise training, and

the control group was only followed in the study. Biochemical markers, including fasting blood glucose, insulin, interleukin-6 (IL-6), C-reactive protein (CRP), tumor necrosis factor- α (TNF- α) were measured in the two groups. Insulin resistance index was also determined by the calculation of the homeostasis model assessment of insulin resistance (HOMA-IR). All the variables were assessed and compared after 12 weeks. The independent t-test was used for comparing the two groups ($P < 0.05$). There was a significant difference between the experimental and control groups in terms of IL-6 ($P = 0.003$), CRP ($P = 0.001$), insulin ($P = 0.008$), and HOMA-IR ($P = 0.04$) and all were at lower level in intervention than control group.

The results of this study agree with Vigorito et al. [14], who conducted a randomized, controlled study with 90 overweight women with PCOS. They reported that a 3-month structured aerobic exercise program (40 min cycling at 60- 70% VO_{2max} 3 times per week) improved cardiopulmonary functional capacity and physical fitness, insulin sensitivity, and BMI, and reduced C-reactive protein in young overweight PCOS women. After 3-month ET, PCOS-T showed a significant improvement in peak oxygen consumption (35.4%; $P < 0.001$) and in maximal workload (+37.2%; $P < 0.001$). In PCOS-T we also observed a significant reduction in body mass index (-4.5%; $P < 0.001$) and in C-reactive protein (-10%; $P < 0.001$), and a significant ($P < 0.001$) improvement in insulin sensitivity indexes. After 3 months, no changes were observed in PCOS-UnT.

Also, this study's results revealed that there was a significant decrease in weight, BMI and WHR in group (B) while there was a non-significant difference in leucocytes after participation in the same diet program as group (A). This comes in acceptance with de Luis et al. [15] who proved that hypocaloric diet can cause reduction of anthropometric measures (weight, body mass index, waist circumference and waist/hip (ratio) together with an improvement in metabolic profile. Concerning weight and BMI, the results revealed that there was a reduction in both weight and BMI post study when compared to pre-study results in both groups (A&B) after the end of study. More than a few mechanisms can explain that reduction. One of them includes the fact that caloric restriction is often associated with depletion of glycogen storage as well as a decline in body-fat especially in the central body region.

5. CONCLUSIONS

Balance exercise might be an effective method to improve bone mineral density in postmenopausal osteoporotic women. Accordingly, it could be concluded that the aerobic exercise program was an effective method for decreasing the leucocytes in obese polycystic ovarian syndrome

women.

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AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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