

The Effect of 12-week Pilates Training and Ginger Supplementation on Polycystic Ovary Syndrome in Women

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Abstract

Background & Aims: Polycystic ovary syndrome (PCOS) is one of the most common endocrine disruptions. As a result, treatments with little or no side effects such as herbal medicines and exercise have received special attention. The purpose of this study was to investigate the effect of 12-week Pilates training and Ginger supplementation on polycystic ovary syndrome in women.

Materials & Methods: In this quasi-experimental study with pre-test and post-test design, 40 women with polycystic ovary syndrome participated in the study voluntarily and they were randomly divided into 4 groups including control, Pilates exercise, combined (Exercise + Ginger supplement), and Ginger supplementation. The exercise intervention groups performed Pilates exercises for 12 weeks and the supplementation group consumed 1 g of ginger capsules three times per day. Plasma levels of LH, FSH, SHBG, testosterone, and insulin were measured before and 12 weeks after intervention. Data were analyzed by SPSS software using covariance analysis and Tukey post hoc test at 5% significance level.

Results: The results showed that LH ($p < 0.05$), testosterone ($p < 0.05$), and insulin ($p < 0.05$) levels decreased in the intervention groups compared to the control group. The FSH ($p < 0.05$) and SHBG ($p < 0.05$) indices in the intervention groups were significantly higher than the control group. Also, the findings indicated the effect of treatments on the indices studied ($p < 0.05$). While the combined treatment had the greatest effect, there was no significant difference between the exercise group and ginger supplementation group ($p > 0.05$), except in the weight index that the superiority was observed with the exercise group ($p < 0.05$).

Conclusion: The results of this study showed that Pilates training and ginger supplementation can have beneficial effects on ovarian function and it is suggested as a therapeutic method to improve the status of patients with polycystic ovary syndrome.

Keywords: Pilates training, polycystic ovary syndrome, Ginger, women

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Introduction

Polycystic ovary syndrome is the most common endocrine disorder in reproductive age, in which 6 to 14 percent of women at childbearing phase suffer from this

disease (1). Clinical manifestations of this disease vary depending on the severity of it, so that important clinical manifestations can be related to menstrual disorders, symptoms associated with hyperandrogenism, and

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infertility associated with non-ovulation (2). In patients with polycystic ovary syndrome, the number of small antral follicles and the volume of theca ovarian follicle cells increase (3). The causes of polycystic ovary syndrome include a violation of the hypothalamic-pituitary axis, ovarian dysfunction, and insulin activity changes. In fact, polycystic ovary syndrome accompanies abnormal gonadotropin secretions, an increase in the production of steroids in the ovary, and insulin resistance. The level of lutein hormone (LH) secretion is increased, especially in women with polycystic ovary syndrome (4). The ovaries of women with polycystic ovary syndrome produce more androgens than normal. Androgens are male hormones that women produce and elevation of these hormones affects egg formation and release during ovulation (5). One of the abnormalities of endocrine disruption in women with polycystic ovary syndrome may be insulin elevation, increased luteinizing hormone (LH), and androgen levels, which may be associated with decreased fertilization rates and abnormal embryonic development (5). Increased luteinizing hormone and insulin cause androgen production, and insulin resistance leads to hyperinsulinemia, decreased sexual hormone-binding globulin (SHBG), and increased circulating testosterone and disrupts ovarian follicle development (6, 7). Insulin also inhibits the production of SHBG in the liver, and thus, hyperinsulinemia directly increases testosterone secretion from the ovary (7). Biochemical evaluations confirm that women with SHBG have lower serum levels and higher amounts of free testosterone (8). On the other hand, one of the major factors contributing to the emergence of oxidative stress polycystic ovary syndrome and reactive oxygen species is considered as a by-product of oxidative metabolism and physiological roles in many processes of the system⁹). Regular physical activity, health counseling, and drug therapy are among the ways that have been proposed to prevent polycystic ovary syndrome (6).

Today, physical activity and the use of herbal remedies are recommended by gynecologists for women with polycystic ovary syndrome (10). Pilates is a set of specialized and combined exercises of both body and mind, in this regard Mahmoodi et al. stated that Pilates exercises played an important role in improving physical fitness, body composition, metabolic disorders, and depression in women (11). Also, due to the side effects of chemical drugs, medical herbs play an important role in the treatment and control of the disease. Ginger, scientifically called *Zingiber Officinale* Roscoe, helps to treat various diseases such as nausea, gastrointestinal disorders, respiratory disorders, pain, and rheumatoid arthritis by preventing cellular infiltration. Also, Ginger has strong anti-inflammatory and antioxidant properties against free radicals (12). The chemical compound of Ginger contains sesquiterpenes and bisabolene which exerts its anti-inflammatory effect through direct inhibition of the cyclooxygenase and 5-lipoxygenase pathway (13). In line with the oxidative effects of this plant, numerous reports have shown that the active compound of this plant, such as gingerol, shogolol, and curcumin, is well capable of inhibiting the production of free radicals (13). Ginger is known for its ability to inhibit the synthesis of several pro-inflammatory cytokines including interleukin-1 and TNF α (14). Systematic review evidence suggests that exercise therapy combined with medicinal herbs is an effective treatment for patients (15). Therefore, Parseh et al. suggested that taking herbal supplements along with physical exercise would improve the symptoms of polycystic ovary syndrome in women, and the researchers believe that regular, not too heavy exercise is good for the health of women with polycystic ovary syndrome⁽⁶⁾. Dadfar et al. suggested that Ginger can play a major role in the health and prevention of various diseases and can be used as an alternative to chemical drugs (13). Gunalan et al. (2018) concluded in their study that lifestyle modifications such as exercise

training and the use of herbal supplements have a favorable effect on the treatment of patients with polycystic ovary syndrome (1). However, despite sufficient evidence on the effect of exercise and medicinal plants on improving disease and metabolic factors among different human populations, few studies investigated the impact of these interventions on the improvement of metabolic and hormonal disorders in patients with polycystic ovary syndrome. No study investigated the effect of Ginger and Pilates exercise on the polycystic ovary syndrome. The purpose of this study was to investigate the effect of 12 weeks of Pilates exercise and ginger supplementation on polycystic ovary syndrome in women.

Material and Methodology

Study Subjects:

The present study is a quasi-experimental study with pre-test and post-test design with three experimental and one control group. A total of 40 women (aged 20-25 years) with polycystic ovary syndrome who were referred to hospital in Bonab city participated in this research project after obtaining written consent. Subjects were selected on a voluntary basis with the necessary conditions and characteristics of the study including not having regular physical activity in the past 6 months, having at least one of three Rotterdam criteria.

1) Low ovulation

(Usually manifested as oligomenorrhea, amenorrhea, and polymenorrhea)

2) elevated circulating androgens, hirsutism and estrogen to progesterone ratio

3) polycystic ovaries (seen on ultrasound) which we consider the first and third criterion used to select subjects, thyroid disorders, cardiovascular disorders, addiction (to alcohol, drugs, and smoking), liver and kidney failure, taking contraceptive and hormonal drugs, and Ginger supplementation, as well as a diet

specific to Ginger. Has been regular for the past 3 months (6).

And exclusion criteria included the use of any medication that was effective on laboratory results and tobacco use, as well as being absent from the exercise intervention for more than 3 sessions. For this purpose, 40 women with polycystic ovary syndrome (age 20- 25 years) were selected by purposeful sampling. They were randomly divided into four groups of 10: Ginger supplementation group, exercise group (Pilates), combined group (exercise + supplement), and control group. During the volunteer meeting, participants were familiarized with the type of study, its goals, methods, benefits, and potential risks and the informed consent was obtained from each participant. The outline of the project and its implementation were approved by the Ethics Committee of the Institute of Physical Education and Sport Science under number IR.SSRT.REC.1398.485.

Training Protocol:

Initially, participants attended a training introduction session, the principles of safety training, and how Pilates exercises were performed. There were a nurse and a sports practitioner at all training sessions. Exercise intervention groups were trained for two weeks and three days per week from 10 am to 11 am. The training session lasted 40- 60 minutes, which included a warm-up, core Pilates exercises, and recovery. These exercises were divided into two: 1) exercises on the mattress (first 6 weeks), and 2) exercises using bandages and ball (second 6 weeks) (Table 1). The movements started from simple and then increased in complexity. The intensity of exercise was measured by the Borg RPE index (16). In this way, warm-up and recovery were used by the Stress Perception Index of 8-10 and in the main training phase, the intensity of training was gradually increased from the first week to the last week (Stress Perception Index 18-10). Exercises were first

performed in a standing posture, then seated and supine (16), and the Ginger supplementation and control groups were asked to maintain their usual lifestyle during the

study and report weekly on their physical activity and diet to the researcher.

Exercise Type	Week	Movements	Intensity
Exercises without tools	1 - 3	One foot balance with the bent foot, downward to the ground, single-leg circle and toe rotation, the palm of both hands to the ground, four limbs with hand and leg impact, mermaid, shoulder bridge with one movement Feet, Rhythmic Strain, Cobra, Darts, Superman, Knee Straight Leg, Single Leg Stretch, Two Leg Stretch, Upper Leg Stretch	10 - 12
	4 - 6	Going down to the ground, single-leg circle and toe rotation, palm of both hands to the ground, four limbs with hand and leg impact, mermaid, single-legged shoulder bridge, rhombic pressure, cobra with neck rotation, Full swim, Full star, Superman, Darts with waist rotation, Ken Ken straight foot, and two straight legs, bent sideways, Saw, Roll-up, Hundred, Ruler from behind, Ruler from the front, Foot kick from Side by side	12 - 14
Exercises with ball	7 - 9	Leg Stretching, Scott with Ball, Scott Single-Leg on the Ball, Lifting Legs on Ball, Breast lift with upper body rotation, shoulder-to-shoulder bridge on ball, single-leg shoulder bridge, Open Back, Front Ruler and Lifting one leg, swimming on the ball, rolling the ball forward, bending sideways, open arms and legs, single leg with a bent leg, single leg with a straight leg, teaser	14 - 16
Exercises with bondage	10 - 12	Single-leg Faced Balance, Single-Leg Circle and Toe Rotation, Four Legs with Leg and Ankle impact, Single-Leg Shoulder Bridge, Single-Leg stretch with bent Leg, Two Legs stretch with bent Leg, Single- Leg With Flat foot, single-leg extension with the upright screw, ruler from behind, front ruler, sidekick, power crunch, side lift	16 - 18

Ginger supplementation:

Members of the intervention group received supplementation (supplement + exercise) and the Ginger supplement group consumed daily 3 g of Ginger powder (poured in capsules) for 12 weeks with main meals (17). Patients were advised to refrain from altering their usual

diet, arbitrarily changing doses of medication and physical activity during the intervention period.

Blood obtaining:

In order to evaluate the effect of Ginger supplementation on hormonal changes in two phases, before and after the intervention, 5 ml of blood was collected from the brachial vein and sent immediately to

the laboratory with EDTA anticoagulant. Radioimmunoassay method was used to measure LH and FSH variables using commercial kits manufactured by Tehran Kavshiar Company. Testing for testosterone and insulin was performed by Roche's Elecsys Zolo device using a luminescence electrochemical fan. The concentration of SHBG was also measured using the radioimmunoassay method by DIAGNOSTICA ORION Finland's SPECTRA SHBG IRMA kit. Height indices were also measured by a Seca meter with 0.1 accuracy and weight indices were measured by a digital tire with an accuracy of 0.5.

Statistical Analysis

Data were analyzed using SPSS version 22. Shapiro-Wilk test was used to check the normality of data distribution. After making sure the distribution of data was normal, covariance analysis test was used to compare the mean of pre-test and post-test scores of experimental groups and control group and Tukey post hoc test was used to compare the difference between the data.

Results

The characteristics of the subjects in the experimental groups (combined, training, and supplementation) and the control group are presented in Table 1.

Table (1). Anthropometric characteristics of the participants of the four groups

Variables	Groups	Mean \pm SD	F	Sig
Age (Year)	Combined	32.18 \pm 0.26	----	
	Training	32.16 \pm 1.76		
	Supplementation	32.37 \pm 0.3		
	Control	32.22 \pm 0.34		
Weight (Kg)	Combined	77.05 \pm 0.47	0.425	0/74
	Training	78.19 \pm 0.53		
	Supplementation	78.24 \pm 0.72		
	Control	78.13 \pm 0.48		

In addition, descriptive findings regarding the evaluation indicators categorized by groups and in the two pre-test and post-test sets are reported in Table 2.

Table (2). The mean and standard deviation of the indicators categorized by the group in the pre-test and post-test

Variables	Groups	Pre-test	Post-test	Variables	Groups	Pre-test	Post-test
		Mean \pm SD	Mean \pm SD			Mean \pm SD	Mean \pm SD
Testosterone	Combined	0.5 \pm 0.01	0.44 \pm 0.01	Weight (Kg)	Combined	77.05 \pm 0.47	73.05 \pm 1.18
	Training	0.51 \pm 0.02	0.47 \pm 0.01		Training	78.19 \pm 0.53	75.84 \pm 0.46
	Supplementation	0.5 \pm 0.01	0.47 \pm 0.01		Supplementation	78.24 \pm 0.72	74.64 \pm 0.75
	Control	0.5 \pm 0.01	0.51 \pm 0.01		Control	78.13 \pm 0.48	78.27 \pm 1.12

Variables	Groups	Pre-test	Post-test	Variables	Groups	Pre-test	Post-test
		Mean ± SD	Mean ± SD			Mean ± SD	Mean ± SD
SHBG1	Combined	29.18±3.17	39.29±0.39	LH	Combined	12.57±0.26	12.24±0.02
	Training	30.19±0.03	34.72±0.64		Training	12.59±0.03	12.42±0.03
	Supplementation	30.19±0.05	36.57±0.59		Supplementation	12.59±0.03	12.42±0.03
	Control	30.20±0.04	30.07±0.39		Control	12.57±0.07	12.55±0.03
	Combined	31.27±0.37	20.23±0.26		Combined	6.42±0.02	6.93±0.03
Insulin	Training	31.56±0.57	20.56±0.08	FSH	Training	6.43±0.03	6.71±0.04
	Supplementation	30.93±0.52	20.67±0.03		Supplementation	6.45±0.06	6.73±0.05
	Control	31.54±0.36	31.65±0.49		Control	6.44±0.03	6.65±0.03
	Control				Control		

As mentioned above, for checking the normal distribution of the data in the pre-test scores, the Shapiro-Wilk test was used. The results exhibited that the distribution of the data was normal ($p > 0.05$). To this end, the analysis of covariance was used to analyze the

effect of treatments on the variables. Therefore, the pre-test scores and post-test scores were compared to evaluate the impact of each treatment. The results of the covariance test are presented in Table 3.

Table (3). The results of covariance analysis

Source of variation	Value	F	Degree of freedom of assumption	Degree of Freedom of Error	sig
Lambda wicks	0.488	4.374	6.00	25.00	0.004

The initial results of the covariance analysis test indicate that the F value is significant in the Lambda Wicks ($p=0.004$). The results of group comparison are presented in Table 4.

Table 4. The results of the covariance analysis test for measuring the impact of the intervention on the assessed indicators

Dependent variable	Sum of Squares	Degree of freedom	Mean squares	F	Sig	Eta Squared
LH	0.381	3	0.127	224.96	0.001	0.96
FSH	0.947	3	0.316	186.66	0.001	0.95
Testosterone	0.016	3	0.005	58.95	0.001	0.86
SHBG	375.27	3	125.09	441.68	0.001	0.98
Insulin	736.71	3	245.57	3759.39	0.001	0.99
Weight	115.92	3	245.64	49.59	0.001	0.83

The results of covariance analysis revealed a significant effect on the LH index ($P=0.001$ and

$F(30,3)=224/96$), FSH ($p=0.001$ and $F(30,3)=186.66$) Testosterone ($p=0.001$ and $F(30,3) = 58.95$), SHBG

($p=0.001$ and $F(30,3)=68/441$), insulin ($p=0.001$, and $F(30,3)=375.39$), and weight ($p=0.001$ and $F(30,3)=49.59$), which indicates the efficacy of three treatments on the research indicators. In other words, treatments have a significant effect on the indicators. As

a result, in order to determine the difference between the effects of treatments and the comparison between the four groups, a follow-up post hoc test was used to compare the pairs between the groups. The results are reported in Table 5.

Table (5). Post hoc test results for pairwise comparisons (the effect of the intervention on the indicators)

Index	Group	Group	Mean	Sig	Index	Group	Group	Mean	Sig
			differen					differen	
			ce					ce	
LH	Combined	Ginger	-0.165	0.001	SHBG	Combined	Ginger	2.67	0.001
		Training	-0.168	0.001			Training	2.81	0.001
		Control	-0.303	0.001			Control	9.23	0.001
	Ginger	Training	-0.003	0.77		Ginger	Training	0.139	0.58
		Control	-0.138	0.001			Control	6.56	0.001
		Control	-0.135	0.001			Control	6.42	0.001
FSH	Combined	Ginger	0.214	0.001	Insulin	Combined	Ginger	-0.365	0.006
		Training	0.196	0.001			Training	-0.489	0.001
		Control	0.477	0.001			Control	-11.43	0.001
	Ginger	Control	-0.018	0.35		Ginger	Control	-0.12	0.33
		Control	0.262	0.001			Control	-11.06	0.001
		Control	0.281	0.001			Control	-10.94	0.001
Testosterone	Combined	Ginger	-0.032	0.001	Weight	Combined	Ginger	-2.65	0.001
		Training	-0.028	0.001			Training	-1.35	0.007
		Control	-0.063	0.001			Control	-5.06	0.001
	Ginger	Training	0.003	0.49		Ginger	Training	1.29	0.004
		Control	-0.031	0.001			Control	-2.42	0.001
		Control	-0.034	0.001			Control	-3.72	0.001

The results of the pairwise comparison of the groups indicated that there was a significant difference between all the groups with the control group, which designated the efficacy of the treatments. Moreover, the results demonstrated that there was a significant difference between the three intervention groups, in which the combined group outperformed the two groups of training and Ginger supplementation in all indices.

There was no significant difference between the training group and Ginger supplementation group in the indices; however, in the weight index, the superiority was obtained with the training group. In fact, the findings indicate the effect of treatments on the indices which were under investigation in the study. While the combined treatment has the greatest effect, there is no significant difference between the training group and

Ginger supplementation group in the indices, except in the weight index that the superiority is with the training group.

Discussion

The results showed that serum LH, testosterone, and insulin levels decreased significantly in the three groups of combined intervention, Ginger supplementation, and Pilates training compared to the control group. There was no significant difference between Ginger supplementation and Pilates exercise group. The results also showed that serum FSH and SHBG levels increased significantly in all three intervention groups compared to the control group. This difference in the combined group was higher compared to supplementation and exercise group and there was no significant difference between Ginger supplementation and Pilates exercise group.

These results suggest that the combination of Pilates exercises with Ginger supplementation may have greater impact on factors associated with the improvement of the polycystic ovary syndrome. There was no significant difference between the two groups in all measured factors in the indices studied but in the weight indices was superior to the exercise group.

In general, no study was found to evaluate the effect of Pilates exercise and Ginger supplementation on the polycystic ovary syndrome in women. An experimental study found that overweight women with the polycystic ovary syndrome can improve with exercise (6). On the other hand, because of the natural modality and the presence of homologous medicinal compounds, medicinal plants are compatible with the body and usually have no unwanted side effects, and are therefore very suitable for long-term use (18). Ginger is a valuable medicinal plant and has many properties including cardiovascular, immune stimulant and digestive stimulant and it contains antioxidants such as Gingerol and Shogaols (18). This eliminates free radicals from

the body and prevents the production of active metabolites in the body (9). Therefore, it is likely to have a positive effect on ovarian tissue because the presence of high levels of reactive oxygen species (ROS) in ovarian follicles destroys the follicular fluid antioxidant system and directly damages the oocyte (19). As a result, the use of antioxidants, including Ginger, seems to be useful for the maintenance and growth of ovarian follicles and therefore the reduction of damaged follicles in the present study may be attributed to the strong antioxidants found in Ginger (9). The results of this study showed that exercise training and Ginger consumption increased serum levels of FSH and decreased LH in the intervention group compared to the control group, indicating the positive effects of Pilates exercise and Ginger consumption on this hormone. These findings were in line with the results of Attarzadeh et al., Heidarianpour et al., Siavashi et al. (20, 21, 22). In their study, Attarzadeh et al. concluded that exercise training reduced the hormone in women with polycystic ovary syndrome, which is consistent with the results of the present study (22). In their study, Pourrostem et al. concluded that Ginger consumption increased LH, which is not in line with the results of the present study because of the differences in subject type and type of exercises (23). Based on the mechanism of action, it can be deduced that the decrease in Gonadotropin secretion from the hypothalamus is one of the causes of hormonal abnormalities. Researchers believe that following exercise pressures and activation of the hypothalamic-pituitary-adrenal axis have detrimental effects on the function of the women's reproductive system. Therefore, GH inhibits the secretion of Gonadotropin-releasing hormone. Glucocorticoid, which is produced during exercise, also inhibits the secretion of the pituitary by the LH and the secretion of estrogen and progesterone from the ovary. Exercise activities can decrease LH (20) and exercise activities in humans increase beta-endorphin hormone,

which in turn decreases GnRH and subsequently decreases LH levels (20). In the present study, Pilates exercise and Ginger supplementation decreased weight in the intervention groups. Lax in his study pointed to the dependence of LH and body weight and linked this reduction to body fat changes, which correlated with the results of the present study (24). The findings of the present study showed that exercise training with supplement consumption increased FSH hormone, indicating the positive effects of exercise and Ginger consumption in the intervention groups, which is consistent with the results of Miri et al. (25). While Tofghi et al. concluded that doing one training session did not significantly alter FSH levels. This difference may be due to the length of training, the intensity of exercise used, and the type of exercise (8). The present study showed that the levels of testosterone after Pilates activity and Ginger consumption in women with polycystic ovary syndrome decreased significantly in the intervention group compared to the control group. In this regard, in the study of Ota et al. (2010), no decrease in testosterone was observed in women with polycystic ovary syndrome after 4 months of exercise (26). Also in another study, after 12 weeks of exercise, testosterone levels did not change significantly in women with polycystic ovary syndrome compared to pre-exercise (27). On the other hand, Gaine et al. (2012) in their study concluded that physical activity significantly reduced testosterone levels in women with polycystic ovary syndrome (28). Another study also found a decrease in serum testosterone levels in women with polycystic ovary syndrome after 20 weeks of exercise, with or without a combination of diet (29). Long-term exercise appears to decrease adrenal androgen synthesis and reduce serum androgens and reduce their adverse effects on ovarian follicles by reducing insulin and increasing insulin sensitivity (30). Another mechanism for decreasing testosterone levels following physical

activity in these patients is weight loss due to physical activity (31). Also, one of the reasons for this decrease can be attributed to the increase in FSH hormone and the positive effects of exercise and Ginger consumption in the intervention groups which is in line with the results of Miri et al. (25). Also, the results of this study showed that SHBG significantly increased in intervention groups compared to control group. Bruner et al. (2006) also reported an increase in SHBG following exercise in women with polycystic ovary syndrome. Khorram Jah et al. (2019) reported no significant changes in SHBG levels after 10 weeks of exercise and diet that was inconsistent with the results of the present study (32). One of the physiological explanations for the increase in SHBG levels following the intervention in the present study seems to be due to decreased insulin levels since insulin inhibits SHBG production in human hepatoma cells in addition to its direct effect on increased androgen production. Insulin production by hypoglycemic drugs as well as diet therapy significantly increases serum SHBG but does not alter androgen levels, indicating a direct effect of insulin on SHBG production (33). The results also showed that insulin levels in the intervention groups were significantly reduced compared to the control group. Decline in ovarian insulin levels leads to decreased androgen production and normalize follicle growth and development, which leads to more ovulation (34). In general, there is a direct relationship between fat percentage and insulin sensitivity, and a decrease in body fat in the intervention groups increased after 12 weeks of insulin sensitivity in this group and SHBG production increased and increased SHBG decreases androgen production (34). The findings of the present study also showed the positive effect of Pilates training and Ginger consumption on the hormonal levels of women with polycystic ovary syndrome. Limitations of the research can also be attributed to the lack of control

over the subjects' precise eating behaviors and physical activity, as well as the short duration of the intervention and the small sample size. Researchers are recommended to evaluate the long-term effect of herbs with more subjects for this purpose.

Conclusion

Based on the findings of the present study, it is concluded that 12 weeks of Pilates training and Ginger supplementation significantly improved the parameters related to polycystic ovary syndrome in women. Since Ginger has fewer side effects than chemical drugs, it can be an effective drug to reduce the side effects of the disease. Also, a period of Pilates exercise reduces ovarian androgens in women with polycystic ovary syndrome. Therefore, people with polycystic ovary syndrome are advised to experience good changes with long-term use of Ginger and Pilates exercises.

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