Effect of Zinc Supplementation on Cardiometabolic Risk Factors in Women with Polycystic Ovary Syndrome

Fatemeh Pourteymour Fard Tabrizi MS 1, Beitollah Alipoor Ph.D1, Mahzad Mehrzad Sadagiani MD 2
Alireza Ostadrahimi Ph.D 1*

1. Dept. of Nutrition in Faculty of Health and Nutrition. Nutrition Research Center, Tabriz University of Medical Sciences, Tabriz, Iran.
2. Gynecologist, Fellowship in Infertility, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran

(Received 21 Dec 2009; Accepted 30 Feb 2009)

Abstract

Background: Studies suggest that polycystic ovary syndrome (PCOS) is associated with increased cardiovascular risk. Dyslipidemia, insulin resistance, hypertension, and central obesity are known as potent cardiovascular risk factors that tend to cluster in women with PCOS. This study was aimed to determine the effect of zinc supplementation on cardiometabolic risk factors in women with PCOS.

Methods: Sixty subjects with polycystic ovary syndrome were randomly divided into two groups to receive 50mg/d of zinc as zinc sulphate or placebo for 8 weeks, as an adjunct to their pre-study oral estrogen-progestin compounds therapy. Measurements of insulin resistance, systolic-and diastolic blood pressure, serum zinc, lipids, and androgens levels, anthropometric indices and dietary intake, were taken at baseline and after 8 weeks.

Results: After 8 weeks, results were obtained by comparison of the change in the Zn group to the change in the placebo group. The Zn group showed a significant increase in serum Zn compared to the placebo group (p<0.0001) and there was a significant reduction in homeostasis model of assessment-insulin resistance score (mean change -15.3%) compared with the placebo group (mean change 0.5%, P<0.0001). Significant reductions were also seen in levels of fasting serum total cholesterol (P<0.01), LDL-C (p<0.01), triglyceride (P<0.0001), testosterone (p<0.05), and TG/HDL-C ratio (P<0.05) in the zinc group. Both groups showed insignificant changes in anthropometric indices and systolic-and diastolic blood pressure.

Conclusion: This study demonstrates that zinc supplementation may represent an effective adjunctive nutritional therapy with the potential for improving lipid metabolism and insulin resistance in PCOS women.


Keywords: Cardiovascular risk factors “ Polycystic Ovary Syndrome “ Metabolic risk factors” Zinc

*Corresponding Author: Alireza Ostadrahimi Ph.D. Nutrition Research Center, Tabriz University of Medical Sciences, Tabriz, Iran. Tel: +98- 9143135845 Fax: +98 411- 3363430 Email: ostadrahimi@tbzmed.ac.ir
**Introduction**

Polycystic ovary syndrome (PCOS) is a common endocrinopathy affecting 1 out of 16 reproductive aged women and is one of the most widely studied and controversial areas in gynecologic endocrinology. In addition to hyperandrogenism, oligomenorrhea, and infertility, women with PCOS often manifest multiple metabolic abnormalities such as impaired glucose tolerance, type 2 diabetes, cardiovascular disease, dyslipidemia, hypercoagulable state, and hypertension. Obesity, particularly visceral obesity, affects more than 50% of these women, and exacerbates the reproductive and metabolic manifestations of the syndrome. Evidence suggests that insulin resistance and its compensatory hyperinsulinemia play an important pathogenic role in PCOS. Insulin resistance is present in both obese and lean women with PCOS, and administration of insulin sensitizers, ameliorates hyperandrogenemia and increases ovulation frequency. Although pharmacological options for the management of PCOS have been increasing not all patients have benefited, as the cost and adverse effects of new pharmacologic agents preclude their use in many patients. Therefore, there is a need to identify and evaluate adjunctive therapies to available medications that are safe, cost-effective, and efficacious in improving metabolic risk factors in these women. The primary strategy to improve metabolic control in women with PCOS consists of lifestyle modification combined with pharmacologic intervention. Alternative strategies, e.g., nutritional supplementation with over-the-counter agents, particularly zinc supplements have attracted considerable clinical interest. Zinc is an essential trace element, critical for the function of over 300 enzymes including members of all enzyme classes, and is closely involved in general metabolism of lipids, carbohydrates, and proteins. Zinc plays an important role in the synthesis, storage, secretion, conformational integrity of insulin monomers, and function of insulin. It is capable of modulating insulin action, and improving hepatic binding of insulin. Zinc is recognized as an integral component in a variety of glucose metabolism reactions, and enhances glucose uptake into fibroblasts and adipocytes. Disturbances of zinc homeostasis have been observed in diabetes and obesity, and also have been contributed to glucose intolerance, hyperglycemia, and hypertriglyceridemia as well as dyslipidemia. It has been reported that zinc deficiency is a risk factor of cardiomyopathy and myocardial infarction. Both animal and human studies have reported the therapeutic benefits of zinc supplementation on insulin sensitivity, lipid metabolism, and amelioration of glycemic control in patients with different features of insulin resistance such as diabetes and obesity. These findings suggest that dietary supplementation with zinc is an effective adjunctive therapy in the management of insulin resistance and its related metabolic complications. Previous studies showed that Zinc supplementation is successful in improving the glucose, insulin, and lipid profile in select obese and type II diabetes populations. These encouraging results and lack of information available for about zinc supplementation of women with PCOS, provided the rationale for conducting this 8-weeks trial to evaluate the effects of zinc on cardiometabolic risk factors in women with PCOS, based upon supplementation previously shown to be successful in improving the glucose, insulin, and lipid profile in selected obese and type II diabetes populations.

**Methods**

**Study design**

This study was a randomized, double-blind, placebo-controlled parallel groups trial of 8wk duration, conducted at the infertility and gynecology departments at Alzahra University Hospital in Tabriz, Iran from Spring 2009 to Autumn 2009. The study was approved by the Institutional Review Board and Ethical Committee at Tabriz University of Medical Science, Iran (IRCT138803212017N2). Informed written consent was obtained from each participant before enrollment in the study. Study subjects were assigned to the zinc or placebo group using a 1:1 randomization.

**Patients**

A total of 200 women with PCOS were screened for inclusion into the study and 135 women were excluded, because they did not fulfill the inclusion criteria for participation in the study. After face to
face interview and explanation of the objectives of the trial, 65 women with confirmed PCOS consented to participate in the study. They were randomly assigned into zinc (n =35) or placebo group (n =30), receiving 50 mg of zinc in the form of zinc sulphate (220 mg zinc sulphat Alhavi Inc., Iran), or placebo, taken once daily as an adjunct to their stable oral mono-drug therapy, and were followed up for 8 weeks. Placebo capsules contained corn sturch and were identical to the zinc capsules in size, shape, and color. Polycystic ovary syndrome was defined according to the Rotterdam criteria. Two of the following three features have to be present for the PCOS diagnosis: [1] oligomenorrhea with eight or fewer menstruations in the previous 12 months or amenorrhea; [2] clinical and/or biochemical signs of hyperandrogenism and [3] polycystic ovaries on ultrasound examination (>12 follicles 2 to 9 mm in diameter and/or increased ovarian volume >10 mL). Diagnosis of PCOS also implied that no evidence of thyroid disease (normal serum-TSH level), adrenocortical dysfunction (normal 17-hydroxyprogesterone level), or hyperprolactinemia (prolactin <30 mg/mL) was present. Inclusion criteria for the study were confirmed PCOS, age 20 to 45 years, body mass index (BMI) ≥ 25 kg/m², unchanged moderate level of physical activity, and consent to participation after written and oral information. Exclusion criteria were chronic or acute illnesses, psychiatric disorder in need of medical treatment, pregnancy or lactation, smoking, current or previous (within the last 2 months) use of statins, thiazolidinediones, corticosteroids, insulin, antiobesity, and antidiabetic drugs (including metformin), or vitamin and mineral supplements, any history of neoplastic, metabolic, and cardiovascular disease, coronary heart disease, heart failure, arrhythmia, tachycardia, peripheral arterial disease, stroke or a transient ischemic attack, uncontrolled hypertension (>140/90 mm Hg), renal or hepatic insufficiency, impaired liver function, and abuse of drugs (illegal or otherwise) or alcohol. Patients were allowed no change in lifestyle modification, no new medication and no change in dosage of their drugs during the study.

Measurements
At study entry and after 8 weeks, from each patient 10cc venous blood sample was taken, and immediately was centrifuged. Sera were stored at −70°C until hormonal and biochemical assays. Blood samples were obtained in the morning between 8:00 am and 9:00 am after an overnight fast and resting in bed during the early follicular phase (d 2–5) of a spontaneous or P-induced menstrual cycle. During the same visits, all subjects underwent anthropometric measurements, and dietary assessments for three days (two workdays and one holiday) using Food Record questionnaire. Dietary data were analyzed by Nutritionist III software.

Laboratory analyses
Serum Zinc was analyzed using atomic absorption spectrophotometer (Model CTA-2000, Chem Tech, USA) in the laboratory of Nutrition research center (Faculty of Health & Nutrition). Serum glucose was measured by an enzymatic colorimetric method using glucose oxidase. Serum total cholesterol and Triglyceride (TG) concentration were measured by commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran) adapted to an autoanalyzer (model Alcyon 300 Abbott, USA and Germany). High-density lipoprotein cholesterol (HDL-C) was measured after precipitation of the apolipoprotein B–containing lipoproteins with phosphotungustic acids. Low-density lipoprotein cholesterol (LDL-C) was determined indirectly using the Friedewald formula: (i.e. LDL = total cholesterol - HDL - TG/5). Fasting serum insulin levels were measured using an immunoenzymetric assay (ELISA; BioSource INS-EASIA, Rue de Industrie, Belgium), and intra- and interassay CVs were 5.3% and 9.5%, respectively. Homeostasis model of assessment–insulin resistance (HOMA-IR) was calculated using the following formula: fasting serum insulin (µU/ml) × fasting serum glucose (mg/dl) /405. Serum concentrations of testosterone(T) and dehydroepiandrosterone sulphate (DHEAS) were measured by ELISA (DRG Testosterone ELISA EIA-1559 and DRG DHEA-S ELISA EIA-1562; DRG Inc, Germany; interassay CV 6.71% and 6.5%; intra-assay CV 3.28% and 4.6% respectively).

Blood pressure and Anthropometric measurements
The systolic and diastolic blood pressure (SBP and DBP) at baseline and after two months’ supplementation, were measured twice in the right
arm in a sitting position after 10 minutes resting using a mercury sphygmomanometer, and the average of the 2 measurements was used in the analysis. Weight was measured without shoes and in light clothing using a digital scale with a precision of 0.1 kg (SECA 707; HH, Modena, Italy). Standing heights was measured without shoes, and using a stadiometer to the nearest 0.1 cm precision. The mean body mass index (BMI) was calculated as weight (kg) per the square of height (m). Waist circumference (WC) was measured to the nearest 0.1 cm at the narrowest level over light clothing, with the use of an unstretched tape measure, without any pressure to body surface. Hip circumference was determined as the maximum value over the buttocks. The waist/hip ratio was calculated as the waist circumference divided by the hip circumference.

**Statistical analysis**

Statistical analyses were performed by SPSS software (version 13.0). Only data from patients who had baseline and final data and who were not protocol violators were used in the calculations. All values are expressed as mean ± SEM (Standard Error of Mean). The Kolmogorov-Smirnov test was used to detect the normality of distribution (P>0.05). Changes in each parameter from baseline to 8 weeks were compared (between the Zinc group and the placebo group) by the unpaired t-test (Normally distributed values) and by the Mann–Whitney U-test (non-Normally distributed values). The same tests were used for comparison of baseline values between the placebo and Zinc groups. Bivariate correlations were performed calculating the Spearman coefficient (non-Normally distributed values) and the Pearson's coefficient (Normally distributed values). A p-value of less than 0.05 was considered statistically significant (two-tailed).

**Results**

Two hundred women were screened, sixty-five women who fulfilled the inclusion/exclusion criteria, were randomized to zinc or placebo groups, and five subjects from the zinc group did not return for the final study visit. Therefore, sixty participants (zinc group, n = 30; placebo group, n =30) completed the study and provided evaluable data, (Figure.1).

![Fig 1 - The Progress of the Subjects Through the Study.](image)

The baseline characteristics of the subjects allocated to zinc or placebo groups are presented in Table 1. There were no significant differences in age, BMI, treatment, and dietary intake. None of the groups showed significant changes in their diets and drugs during the study (P>0.05). Table 2 presents data for the hormonal and metabolic parameters measured at baseline and at the end of the zinc treatment; these values were not significantly different at baseline between the two groups (P>0.05).

**Table 1- Baseline characteristics of study subjects**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Placebo (n=30)</th>
<th>Zinc (n=30)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>26.93±0.87</td>
<td>27.17±0.83</td>
<td>0.84</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>75.61 ± 0.82</td>
<td>76.13 ± 0.80</td>
<td>0.65</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>160.60 ± 0.19</td>
<td>160.62 ± 0.17</td>
<td>0.94</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>29.28 ± 0.30</td>
<td>29.50 ± 0.30</td>
<td>0.61</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>97.20 ±1.27</td>
<td>97.28 ± 1.08</td>
<td>0.96</td>
</tr>
<tr>
<td>Hip (cm)</td>
<td>109.11 ±1.83</td>
<td>109.58 ±1.15</td>
<td>0.82</td>
</tr>
<tr>
<td>WHR</td>
<td>0.89 ± 0.006</td>
<td>0.88 ± 0.007</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Nutritional intake:

| Energy (kcal/d) | 1729.91±11.79 | 1737.84±14.40 | 0.67 |
| Carbohydrate (g/d) | 210.45±1.76 | 214.42±2.33 | 0.18 |
| Protein (g/d)   | 62.11±0.75   | 62.05±0.78   | 0.95 |
| Fat (g/d)       | 71.07±0.99   | 70.21±0.80   | 0.50 |
| Zinc (mg/d)     | 5.54 ± 0.14  | 5.36±0.15    | 0.39 |

SBP (mmHg) 132.31±0.92 131.08±0.88 0.33
DBP (mmHg) 87.40±0.38 87.39±0.43 0.97

Concurrent medications (n):

| Provera | 7 | 8 |
| LD | 20 | 20 |
| Yasmine | 3 | 2 |

Data are means ± SEM and were analyzed by the Student’s t-test. n = number of subjects; No significant differences were in the baseline characteristics of the study participants. Abbreviations: BMI, body mass index; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; WC, waist circumference; WHR, waist to hip ratio.
At the outset, the two groups were similar based upon serum levels of zinc. During the study, the zinc group showed significant increase in serum zinc compared to the placebo group ($p<0.0001$; Table 2). The effects of zinc supplementation on cardiometabolic risk factors were evaluated comparing of mean anthropometric measurements, BP, fasting serum levels of insulin, glucose, androgens, lipid profile, as well as HOMA-IR score and TG/HDL-C ratio after 8-wk therapy. Table 2 documents significant declines in the mean serum levels of TC, LDL-C, TG, testosterone, insulin, as well as HOMA-IR and TG/HDL-C in the zinc group after 8weeks ($P<0.05$) (Fig. 2), but changes in fasting serum LDL-C and testosterone levels in the zinc v.s. the placebo group were not significantly different ($p>0.05$; Table 2). In both groups changes in anthropometric measurements including weight, BMI, waist and hip circumferences and waist/hip ratio were insignificant ($P>0.05$) and there were no difference in these measurements between the two groups ($P>0.05$; Table 2). The changes in systolic and diastolic blood pressure in the zinc group compared to changes in the placebo group after 8wk therapy were not significantly different ($p > 0.05$; Table 2).

**Discussion**

This 8-wk study was designed to determine whether the zinc supplementation, as an adjunct to a stable regimen of oral estrogen-progestin compounds, could affect cardiometabolic risk factors in women with PCOS. This syndrome is associated with insulin resistance and features in common with the metabolic syndrome (MetS)-factors shown to predict cardiovascular risk and type II diabetes. An approximate 4-fold increase in the prevalence of the MetS in women with PCOS compared with the general population, implies greater risk of cardiometabolic disease in women with PCOS. Therefore prevention of cardiovascular disease and type II diabetes is known to be key to the PCOS management. We found that zinc as a nutritional supplementary had beneficial effects on features of the metabolic syndrome and improved some cardiovascular disease risk factors, at least in the short term, in PCOS women. In a large clinical study, both low consumption of dietary zinc and low serum zinc levels were associated with an increased prevalence of diabetes, hypertension, hypercholesterolemia, and coronary artery disease. Although some studies have assessed the effects of zinc supplementation on the metabolic factors in non-pcos conditions, to our knowledge, this is the first study in which such an effect has been evaluated in PCOS. Dyslipidaemia may be the most common metabolic abnormality in PCOS, with a prevalence of up to 70% by the National Cholesterol Education Program criteria and also PCOS is classically associated with an atherogenic lipoprotein profile, characterised by elevated triglyceride-rich lipoproteins, accumulation of small dense LDL-C and depressed HDL-C. All these changes are closely related to insulin resistance. We found that zinc had beneficial effects on serum concentrations of total cholesterol, LDL-C, and triacylglycerol. The triglycerides/HDL-C ratio, a proposed metabolic marker of insulin resistance, was significantly decreased in the zinc group. In Partida-Hernandez et al survey on type II diabetic patients,100mg zinc sulphate treatment for 12 weeks significantly reduced total cholesterol and triglyceride and increased HDL-C concentrations, but but did not decrease LDL-C concentration significantly. Bonham et al.33

![Fig 2 - Changes in serum lipids (8-wk values minus baseline values) in the zinc and placebo groups; results are expressed as mean± SEM. The mean changes in serum Tg and Chol in the two groups were significantly different ($p < 0.05$), with an improvement in favor of the zinc group.](image-url)
Significant difference when compared with the baseline values by the paired *t*-test: *p* < 0.05; **p** < 0.0001

Significant difference of the change during the study (8-wk value minus baseline value) between the zinc group and the placebo group: †p < 0.0001;

Data are fasting values, expressed as means ± SEM and were analyzed by the Student’s *t*-test (Normally distributed values) and by the Mann–Whitney *U*-test (non-Normally distributed values).

a : At baseline this parameters were similar between two groups and not significantly different.

**Abbreviations**: BMI, body mass index; WC, waist circumference; WHR, waist to hip ratio; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; FBS, Fasting serum glucose; HOMA-IR, Homeostasis model of assessment–insulin resistance; HDL, high density lipoprotein cholesterol (serum); LDL, low-density lipoprotein cholesterol (serum); TC, total cholesterol (serum); TG, triglycerides (serum). T, testosterone; DHEAS, dehydroepiandrosterone sulphate.

Clinical and laboratory data suggest that zinc participates in blood pressure regulation and in the pathogenesis of hypertension.\(^{36}\) In the current study, zinc supplementation had insignificant effect on systolic and diastolic blood pressures compared with placebo and no statistically significant differences were found prior to and after 8 weeks zinc sulphate therapy in these parameters. The influence of zinc on the regulation of arterial blood pressure is not a simple process, but the one that involves several systems at different physiological levels.\(^{36}\) Evidence includes the negative correlation between arterial blood pressure and zinc content in serum in patients suffering from primary arterial hypertension.\(^{36,37}\) In this study, dietary intake and drug therapy during the study were presumed as confounding factors; how ever, neither change in dietary intake nor drug therapy, show the lack of these variables effects on measured parameters. Zinc status modulates obesity and the metabolic syndrome.\(^{13}\) Kennedy et al.\(^{15}\) suggested that the chronic alterations in both tissue and cellular zinc distribution in obese rodents and possibly also in obese humans, would have adverse effects on
physiological functions. The suggestion might mean an explanation for the fact that zinc supplementation facilitates weight loss of obese children\(^{38}\), and enhances the action of insulin in obese mice.\(^ {18}\) In this trial, zinc therapy was observed not to induce significant changes in anthropometric indices (P > 0.05). However, literature reports state, in general, that some parameters of adiposity such as BMI and skinfolds are anthropometric indices inversely correlated with plasma and serum zinc concentrations.\(^ {13,19,39}\) We observed significant increase of serum zinc level in the supplemented group compared to the placebo group (p=0.0001). These results agreed with those of other authors that showed an increased zinc concentration after its supplementation.\(^ {21,22,34,35}\) An alternative explanation that has been postulated for the increased cardiovascular risk in PCOS, is hyperandrogenism. Possible underlying pathophysiological mechanisms include a correlation between free testosterone and systolic blood pressure, and a link between increased androgens and abnormal lipid metabolism.\(^ {40}\) However, the association between hyperandrogenism and cardiovascular risk is not universally accepted\(^ {31,40}\) and results from male or female study subjects were different.\(^ {41}\) To our knowledge, there are few studies that have evaluated the effect of Zn supplementation or zinc status on androgens, with inconclusive results.\(^ {42-44}\) We found that in subjects receiving zinc, serum testosterone was significantly decreased by approximately 8% but this change was not significant compared to placebo. In addition, a significant decrease in serum DHEAS was observed in the zinc compared to the placebo group (P<0.05). Gómez et al.\(^ {45}\) reported that during one month supplementation of 100 mg/day zinc sulfate orally, leptin concentrations increased, but insulin sensitivity and androgens were not modified in obese males. Insulin resistance may in part contribute indirectly to cardiovascular risk in PCOS by amplifying androgen excess.\(^ {7}\) Elevated insulin levels in the portal circulation decrease circulating sex hormone–binding globulin, thus resulting in higher levels of free androgens.\(^ {5}\) Over all, hyperinsulinemia appears to play a major role in the pathogenesis of the hyperandrogenism of PCOS.\(^ {55}\) In this study the decline in T levels may be is explained by the improvement of insulin level in subjects. So correction of insulin resistance and its compensatory hyperinsulinemia is central to the treatment of PCOS. In this trial Zn\(^ {2+}\) therapy produced a significant change in metabolic profile measured for fasting serum insulin level and HOMA-IR score. We observed insignificant reduction in fasting serum glucose levels in the zinc group, but there were significant improvements in serum insulin levels as well as HOMA-IR score as a consequence of zinc supplementation (p = 0.0001). There are some studies, that have demonstrated the antidiabetogenic properties of zinc supplementation in both diabetic laboratory animals and in humans.\(^ {46,47}\) Some investigators have also speculated that zinc supplementation could improve insulin sensitivity in type II diabetes.\(^ {48}\) Tobia et al.\(^ {49}\) reported that zinc may be an effective approach in preventing the onset of diabetes. Ohly et al.\(^ {50}\) demonstrated that pre-treatment with zinc prevented diabetes induced by multiple low doses of STZ in mice. In another study,\(^ {19}\) nutritional zinc supplementation improved fasting insulinemia and glycemia in genetically obese ob/ob mice. Zinc status influences insulin sensitivity, and it is possible that insulin resistance would be related to abnormalities in Zn homeostasis such as Zn deficiency.\(^ {51}\) Zinc has numerous potential targets to modulate insulin activity. Some mechanisms proposed for the insulin resistance during zinc dishomeostasis are as following:\(^ {52}\) Impaired insulin secretion by the pancreas, interference in insulin receptor binding, decrease in insulin receptor synthesis, and abnormality in glucose carrier structure and/or translocation inside the cell (as a consequence of increased lipid peroxidation). A review of the literature reveals that zinc can replace insulin in mammalian cells cultured in serum-free media.\(^ {53}\) In addition; zinc is known to have an insulinomimetic action by increasing peripheral glucose disposal and by stimulating lipogenesis. Indeed, protein tyrosine phosphatase 1B activity, a key regulator of the phosphorylation state of the insulin receptor, is inhibited reversibly by low concentrations of zinc ions. Therefore, the insulin signal transduction and the phosphatase cascade leading to translocation of the glucose transporter GLUT-4 are affected.\(^ {51,52}\) The assumption that zinc impairment may represent a risk factor for atherosclerosis is strengthened by the evidence that
a higher intake of this trace element decreases CVD mortality risk. Nevertheless, the benefits of simple Zn supplementation in prevention and treatment of type II diabetes are still debated. Indeed, a systematic review of the Cochrane database concluded that evidence supporting the provision of Zn supplementation in the prevention of type II diabetes is still very poor, and differences in study designs, subjects evaluated, doses administered, statistical power, and the forms of zinc supplemented may explain the difference in outcomes. The sample size and duration of the study preclude conclusions on long-term use, but identify trends for further investigation.

Conclusion

As the results of this study show, zinc supplementation seems to be an effective dietary adjunctive therapy to manage cardiometabolic risk factors in PCOS patients. Our data also support the concept that zinc supplementation might be useful in improving metabolic complications in women with PCOS.

Acknowledgment

This work was supported by a grants from Nutrition Research Center and Research vice chancellor, Tabriz University of Medical Sciences. We thank the participants of this study for their enthusiastic support.

References


