ORGINAL ARTICLE

The Combined Effect of Aerobic Activity and Ginger Supplementation on Blood Glucose and Lipid Profile in Overweight Girls

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Abstract

Objective: The purpose of this study was to investigate the combined effect of aerobic activity and ginger supplementation on blood glucose and cardiovascular risk factors in overweight girls.
Materials and Methods: In this semi-experimental study, 24 overweight female students were randomly divided into two groups; supplement group (n: 12, age: 25.88 (±0.46), Body Mass Index (BMI): 28.53 (±0.43)) and placebo group (n: 12, age: 26.23 (±0.77), BMI: 28.31 (±0.62)). The supplement group consumed 2 grams of ginger powder daily for two weeks before meals. Aerobic activity included two sessions of exhausting eccentric activity (negative slope on treadmill, one session before and one session after two weeks of supplementation). For data analysis, covariance analysis method with repeated measures and dependent T-test were used.
Results: The results showed that one session of aerobic activity induced the significant decrease of fasting blood glucose (FBS) in supplement group (*P*-value: 0.001), placebo (*P*-value: 0.001), and no significant changes of lipid profile, LDL (*P*-value: 0.45), HDL (*P*-value: 0.57), triglyceride (*P*-value: 0.42), total cholesterol (*P*-value≥ 0.61) in supplement group. Also, result of between-group comparison showed that compared to placebo group, using ginger supplementation for two weeks after aerobic activity caused the significant reduction in FBS (*P*-value: 0.001), triglyceride (*P*-value: 0.001) and total cholesterol (*P*-value: 0.01) levels in the supplement group.
Conclusion: Regarding the effects of physical activity and ginger supplement on FBS and lipid profiles, it is recommended to use ginger supplement along with physical activity to control blood glucose and lipids levels.
Keywords: Aerobic activity, Ginger, Blood glucose, Lipid profile, Overweight

Introduction

The prevalence of type 2 diabetes (T2DM) is increasing around the world, parallel to the increase of obesity and reduction of physical activity and dietary changes. In 2011, world health organization estimated 366 million people had diabetes and increased to552 million by 2030 (1).
Low physical activity and poor nutrition reduced the body metabolism. One of the serious concerns in today's societies is the

lipid profile, high blood glucose and the prevalence of cardiovascular disease. The relative risk of cardiovascular disease in patients with diabetes is 2-4 times more than people with normal blood glucose (2). Cardiovascular diseases have the highest mortality rates in the world, and by 2020, it would still be the first cause of death in the world (3).

In Iran, cardiovascular disease is the main cause of adult mortality (accounting for 46% of all deaths) (4). T2DM is one of the most important coronary artery disease risk factors, which is diagnosed by fasting blood glucose (FBS) and 2 hours post-fasting blood glucose (2hpp) (5). Cardiovascular diseases can be prevented by having a healthy lifestyle and modifying the known risk factors. Along with the emphasis on chemical drug treatments, using non-pharmacological approaches for controlling and treating diabetes and consequently reducing cardiovascular disease are important (6).

Exercise activity reduces coronary artery disease with effect on blood lipids. Regular exercise can reduce risk of coronary artery disease up to 50% (7). Therefore, lifestyle modification and doing physical activity are effective as drug use. This is the main focus of cardiovascular disease prevention, especially in people with diabetes and cardiovascular disease; it also delays the progression of disease (8). Considering this issue is importance because by controlling blood glucose level as one of the most important risk factors for cardiovascular disease in these patients, progression of coronary artery disease can be delayed. Based on past studies, patients with coronary artery disease after discharging from the hospital do not regular physical activity and exercise (10,9).

Ginger (Zingiber Officinale Roscoe, Zingiberaceae) is used extensively as a spice throughout the world (11). For centuries, this plant has been used as an important part of Chinese medicine, traditional medicine and Greek herbal medicine for the treatment of common cold, rheumatism, neurological diseases, gum inflammation, asthma, stroke, constipation and diabetes (12). Possibly, the blood glucose reducing effect of ginger and its other pharmacological activities is due to phenols, polyphenols and flavonoids (13). It seems that Ginger reduces glucose absorption through the inhibition of the activity of the enzymes involved in glucose metabolism, including the α-glucosidase enzymes and amylase in the intestine (14). In the study by Mahlouji et al., After taking 2 grams of ginger powder daily for two months in diabetic patients, the levels of triglyceride (TG) and low density lipoprotein (LDL) decreased significantly, but no significant changes were observed in total cholesterol (TC) and high density lipoprotein (HDL) (11). In addition, due to the controversial results of studies, the aim of this study was to determine the aerobic exercise and ginger supplementation on blood glucose and lipid profiles in overweight girls.

Materials and Methods

This study was semi-experimental. Among 80 overweight girl students of Shahid Chamran University of Ahwaz, 24 subjects were randomly selected. The mean (±SD) age of studied sample was 25/60 (±.35), and body mass index (BMI) 28/42 (±0/56). After explaining the aim and protocol of study, written consent was received from all subjects. Subjects were divided into two groups of supplement (n= 12) and placebo (n= 12) according systematic randomization. Daily for two weeks, supplement group took 2 grams of ginger powder and placebo group took 2 grams of starch powder in same capsule form, in 2 servings (1 gram per serving) before lunch and dinner meal (80 calories in 100 grams of ginger). Ginger capsules were prepared in pharmaceutical company flowering plants medicine health permits 1228022777IRC, the Division of the Ministry of Health prepared food. The nutritional status was studied by 24-hour record keeping questionnaire. For the measurement of body fat percentage was done by vampdans body composition analysis machine Electric (Model 3/3 OLYMPIA, now Javvn, South Korea).

Blood sampling was taken in four stages and at each stage 5 cc from brachial vein. Before the supplementation stage, two blood sampling stages were performed on subjects; the first stage was done before physical activity and the next stage immediately after physical activity. To evaluate the effect of eccentric aerobic exercise on blood glucose and lipid profiles in the absence of supplements, blood sampling was done before the onset of the supplementation phase. Then the supplement group consumed ginger supplement for two weeks.

The placebo group used starch (placebo) capsules over these two weeks. Both groups did not use any chemical medicines during these two weeks, and did not exercise at all. After the end of two weeks of supplement-giving, blood sampling was carried out in two steps before physical activity and immediately after physical activity. Blood samples were taken in pre-test and post-test, and after collecting in the laboratory, were centrifuged at 3500 rpm. The samples were placed at -20° C until the work was done. In the present study, blood glucose levels were measured using enzyme-calorie metric method and Pars test kit. HDL, TG and TC were also measured using the Pars test kit and measured by spectro-photometric device. LDL was calculated using formula:

LDL= TC- HDL- (TG / 5)

Exercise training programs

The exercise test used in this research was a researcher-made one and included two sessions of exhausting aerobic exercise with a negative slope on a treadmill (one session before supplements and one session after supplements). At the beginning of the session, the subjects warmed up on treadmill for 5 minutes. The test started at a speed of 4 km/ h and a negative slope of -2°, and every 3 minutes, -2° was added to the slope and 1 km was added to speed, And the test was done in a negative slope (eccentric) until it reached the exhausting state. The last 5 minutes of the test was also dedicated to cooling down. Blood sampling was also done before and after the activity. This protocol has been placebo and supplement for both groups. Exercise intensity was controlled using Pollard pulse rate and Borg index. This study was approved by Ethical Code: IR.SSRI.REC.1396.133 and Clinical code: IRCT2017090217756N26.

Statistical analysis

Descriptive statistics were used to determine the mean and standard deviation (SD) of each variable and Shapiro-Wilkes test to determine the normal distribution of data. In order to evaluate intra-group variations, dependent T-test was used and to compare between-group variations the covariance analysis method with repeated measure with inter-group factor were used. All calculations were performed with SPSS -23 software and significant level of (*P*-value≤ 0.05). G*power software was used to determine the sample size.

Results

The mean (SD) of anthropometric indices and body composition were presented in Table 1. The results showed that LDL (*P*-value: 0.45), HDL (*P*-value: 0.57), TG (*P*-value:0.42),TC (*P*-value:0.61) levels in both supplement and placebo groups did not change significantly after a session of exhausting eccentric aerobic

Table 1. Physical and anthropometric characteristics of the subjects

Variables	Groups		*P*-value
	Supplemental group	Placebo group	
Age (year)	25.88 (±0.46)	25.33± (0.15)	0.741
Height (cm)	163.12 (±2.24)	162.31± (1.98)	0.864
Weight (kg)	73.25± (2.35)	72.38± (2.33)	0.715
Body fat (%)	35.56± (0.68)	35.47± (0.86)	0.910
BMI (kg/m^2)	28.53 (±0.43)	28.31± (0.62)	0.883
VO_{2MAX} (ml/Kg/min)	24.98± (1.14)	25.02± (1.23)	0.672
Recipes for 24-hour food			0.86

exercise, regardless of ginger supplement. However, blood glucose levels decreased immediately after activity (*P*-value≤ 0.001). The intra-group variations in the supplement group are shown in figure 1 and the intra-group variations in the placebo group are shown in figure 2. The steps before supplement consuming are shown with number 1, and the stage, after 2 weeks of consuming the ginger supplement, is shown by number 2, and Pre and Post, signs express blood sampling activity (Pre) before and immediately after the activity (Post). Also, the results of this study showed that two weeks consumption of ginger supplement following one session of exhaustive aerobic exercise had significant effect on blood glucose (*P*-value≤ 0.001), TC (*P*-value≤ 0.001) and TG (*P*-value≤ 0.01). However, it had no significant effect on HDL (*P*-value≥ 0.5) and LDL (*P*-value≥ 0.21) levels (Table 2). Also, the results of post-hoc independent T-test showed that most between-groups differences occurred in the third and fourth stages of blood sampling (after supplementation). Also the results of the food interpretation show that there was no significant difference in food frequency questionnaire between groups (*P*-value: 0.86).

Discussion

The results of the first stage of the study showed that doing one session of eccentric aerobic activity caused a significant decrease in blood glucose level but did not have a significant effect on triglyceride, blood cholesterol, HDL, and LDL levels. Eccentric activity causes muscle contraction and body fat percentage reduction, which it increases insulin sensitivity and decreases insulin resistance. Reducing levels of free fatty acids,

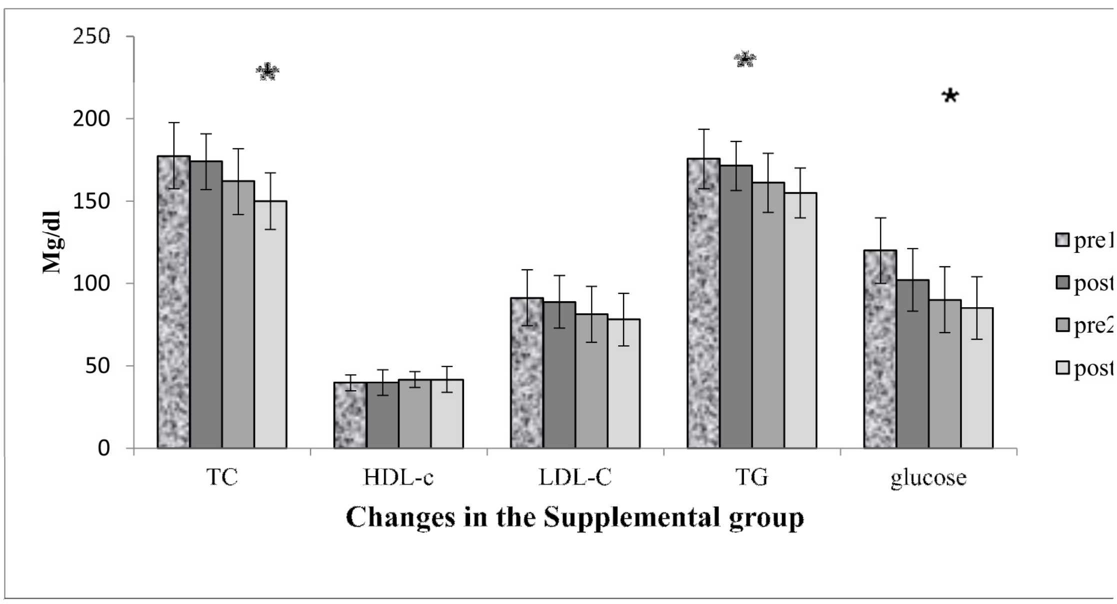

Figure 1. The results of intra-group variations in the supplement group

*Indicates a significant difference between the indices' intergroup, pre: The steps are before physical activity (pre1. step before work and before consuming ginger supplement and pre2 second stage before and after exercise ginger supplement). post: The steps are after physical activity (post 1. step after physical activity and before consuming ginger supplement and post2 second stage after physical activity and after exercise ginger supplement).
TC: In the first (pre 1) neighborhood, blood collection with the fourth (post 2) stage of blood collection was significantly decreased (*P*-value≤ 0.001).
HDL-c: There was no significant difference between the four measurement steps (*P*-value≥ 0.42).
LDL-c: There was no significant difference between the four measurement steps (*P*-value≥ 0.23).
TG: In the first (pre 1) neighborhood, blood collection with the fourth stage (post 2) of blood collection was significantly decreased (*P*-value≤ 0.01).
Glucose: The difference was observed between the first (pre 1) and second stages (post 1) and the third (pre 2) and fourth stages (post 2), and a significant decrease. (*P*-value≤ 0.001).

which have a significant effect on the function of beta cells, reduce the disruption of insulin synthesis and inhibit insulin secretion cells, and the effect of exercise activity is a mechanism for reducing blood glucose (15). Also, aerobic exercise, In addition to increasing the body's ability to use fat as a substrate, increases total fat oxidation during exercise. Also, there is a high correlation between the content of the muscles and insulin resistance. Aerobic exercise activates lipoprotein lipase, and increasing lipoprotein lipase activity may play an important role in reducing insulin resistance during exercise (16). Decrease in triglyceride at the onset of exercise can be achieved by increasing the removal of triglyceride by increasing LDL or decreasing triglyceride secretion from the liver (17). It seems that the reason for the lack of significant changes in lipid profile indicators after activity is the difference in intensity, type and duration of activity protocols, and the difference in body fat distribution among participants (16). The results showed that in the second phase of the study, aerobic activity along with the use of ginger supplement resulted in a significant decrease in glucose, triglyceride cholesterol levels, but did not have a significant effect on HDL and LDL levels. Consuming Ginger can lower fasting blood glucose. According to the results of the second phase of the study in the complement group, the levels of measured indices were reduced both in the resting stage and in the post activity stage. Ginger probably reduces blood glucose level with its antagonistic activity against serotonin receptors and blocking them. Ginger can also increase glucose uptake in insulin-dependent peripheral tissues (18). The results of this study are consistent with the findings of Akhani et al (2004) and Kar et al (2003), which examined the effect of ginger

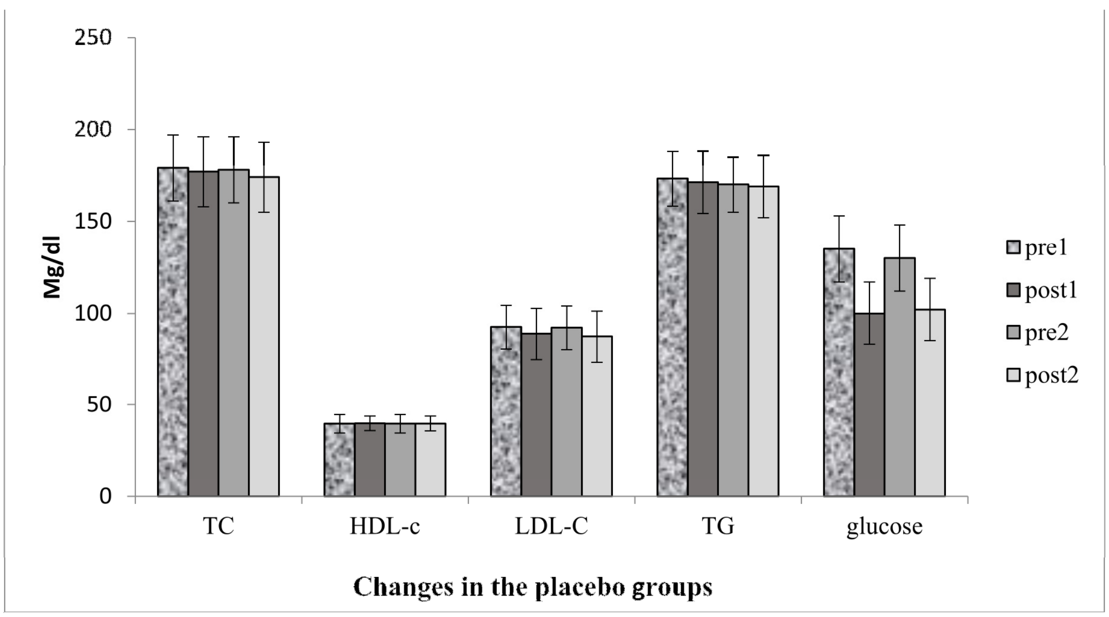

Figure 2. The results of intra-group changes in the placebo group

*Indicates a significant difference between the indices' intergroup, pre: The steps are before physical activity (pre 1. step before work and before consuming ginger supplement and pre 2 second stage before and after exercise ginger supplement). post: The steps are after physical activity (post 1. step after physical activity and before consuming ginger supplement and post 2 second stage after physical activity and after exercise ginger supplement).
TC: There was no significant difference between the four measurement steps (P-value≥ 0.05).
HDL-c: There was no significant difference between the four measurement steps (P-value≥ 0.05).
LDL-c: There was no significant difference between the four measurement steps (P-value≥ 0.05).
TG: There was no significant difference between the four measurement steps (P-value≥ 0.05).
Glucose: The difference was observed between the first (pre 1) and second stages (post 1) and the third (pre 2) and fourth stages (post 2) and a significant decrease. (P-value≤ 0.01).

Table 2. Results of covariance analysis with repeated measurements in the supplement and placebo groups

Variable	Groups	Mean (±SD)				*P*-value°
		Pre 1	Post 1	Pre 2	Post 2	
TC	Supplement	177.61 (±23)	174.28 (±21)	160.12 (±18)	152.63 (±16)	0.001
	Placebo	179.50 (±21)	177.00 (±24)	178.00 (±24)	175.50 (±18)	
HDL	Supplement	39.50 (±5)	39.00 (±4)	41.50 (±3)	41.50 (±5)	0.5
	Placebo	39.60 (±6)	39.80 (±4)	39.60 (±5)	39.70 (±5)	
LDL	Supplement	91.20 (±12)	88.70 (±11)	81.20 (±14)	78.20 (±13)	0.21
	Placebo	92.40 (±15)	88.75 (±12)	92.10 (±15)	87.25 (±10)	
TG	Supplement	175.62 (±17)	171.45 (±21)	161.20 (±19)	155.15 (±17)	0.01
	Placebo	173.2 (±22)	171.3 (±19)	170 (±20)	169 (±16)	
FBS	Supplement	134.00 (±13)	103.50 (±11)	90.00 (±9)	85.50 (±7)	0.001
	Placebo	135.50 (±18)	100.00 (±14)	130.55 (±13)	102.01 (±10)	

°- Intergroup

consumption on glucose (20,19). Also it has been shown that Ginger, with effect on the liver, reduces biosynthesis of cholesterol and triglycerides (21). ElRokh et al. (2010) examined the effect of ginger supplementation on lipid profile in rats. The results showed that consuming ginger supplementation for 4 weeks caused a significant decrease in cholesterol, triglyceride, HDL, and LDL levels. In the current study, compared with mentioned study, duration of supplementation can be noted as reasons for the lack of significant changes in HDL and LDL indices. The duration of supplementation in this study was 2 weeks (22). According to the findings of most of the given studies, ginger may increase the bowel movements of intestine, and on the other hand by inhibition of lipase enzyme, it can reduce the absorption of fat in the intestine (23). Another mechanism for the effect of this plant on the reduction of serum triglyceride is possibly by increasing the expression and activity of the vascular lipoprotein lipase enzyme. This leads to an increase in breakdown of the triglycerides in the arteries and, consequently, causes reduction in blood levels (24). Also it seems that ginger reduces the expression of the gene (ChREBP Response Element Binding Protein). This protein regulates the metabolism of lipids and glucose and plays an important role in transmuting excess carbohydrates to triglycerides. Reducing the gene expression of this protein causes reduction of glucose and lipogenic protein gene expression and glucose 6-phosphatase enzyme get involves in glycogenolysis and gluconeogenesis, and thereby reduces fat accumulation in the liver, decreases serum triglyceride, and improves insulin resistance (25). In this regard, Mahluji et al (2013) showed that taking 2 and 3 g of ginger per day for 2 months resulted in a significant decrease in cholesterol and LDH levels in patients with type 2 diabetes (26). In a research study, Bordia et al. Showed that ginger consumption did not result in significant change in the blood lipids of any of the healthy people, patients with coronary artery disease with or without T2DM. Supplement quality and type of participants can be pointed as the reasons for non-conformity of this research with the present study (27). Mokhtari et al (28) investigated the combination of 12 weeks of aerobic training and consumption of barley β-glucan on glucose and lipid profiles of type 2 diabetic women. The results showed that blood glucose was reduced, while in experimental group, compared to supplement group, there was no significant difference in lipid profile changes. The type of supplement which was used and its compounds and mechanism on blood lipids can be the reason for the difference in the findings of this research with the present study (28). Some studies show that aerobic exercise program improves blood parameters, and some other studies express doing aerobic exercise alone has no effect on lipid profiles, so dietary interventions are needed (16).

Conclusions

The results of this study indicated that a session of eccentric aerobic activity caused a significant decrease in blood glucose levels but had no significant effect on cardiovascular risk factors. Also, using ginger supplement for 2 weeks along with aerobic activity caused a significant decrease in blood glucose level before and immediately after exercise, and lowered the levels of cholesterol and triglyceride, but had no significant effect on HDL and LDL levels before and after the exercise. It seems that having a greater effect on the levels of HDL and LDL and reducing these indices requires doing activity with longer duration and using supplement with longer duration (of supplement-giving) period.

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Conflict of Interest
All authors declare there were no conflicts of interest.

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