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Original Article

Effects of Pomegranate Juice with and without Aerobic Training on Glycemic Control and Lipid Profile in Women with Type 2 Diabetes

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Abstract

Background and Aim: Type 2 diabetes is a common metabolic disease, which is associated with obesity and inactivity. Plant-based dietary patterns are recommended for the treatment of type 2 diabetes. On the other hand, the effect of aerobic training on the improvement of type 2 diabetes is also highly emphasized. The purpose of this study was to investigate the effects of 2-months of pomegranate juice consumption with and without aerobic training on the levels of HbA1c, fasting blood glucose (FBG), lipid profile in women with type 2 diabetes.

Methods: In this study, 58 women with type 2 diabetes who were referred to Tehran Lorzadeh clinic were randomly divided into four groups: control, pomegranate juice, aerobic training, combined pomegranate juice with aerobic training. The aerobic training plan consisted of 2-months and three times per week (training time from 20 minutes to 45 minutes). Three days before and after this interventional study, serum levels of FBG, total cholesterol (TC), triacylglyceride (TG), and low-density lipoprotein (LDL) were measured by colorimetric methods.

Results: Results showed that combined pomegranate extract consumption with aerobic exercise training significantly decreased the levels of FBG, HbA1c, and TG in women with type 2 diabetes compared to the control group after the intervention ($P<0.01$), while TC, LDL-c, and BMI remained unchanged. There was no statistically significant difference in the levels of TC, TG, HbA1c, and FBG in pomegranate extract or aerobic training groups compared to the control group after intervention.

Conclusion: The results of this study indicate that combined pomegranate juice with aerobic training has beneficial effects on type 2 diabetes and could be recommended in their therapeutic program.

Keywords: Type 2 diabetes; Pomegranate extracts; Aerobic exercise; Body mass index; Lipid profile.

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Introduction

Type 2 diabetes is the most common type of diabetes, the leading cause of which is obesity and inactivity (1). Research has shown that up to 80% of cases of type 2 diabetes can be controlled through a healthy diet and physical activity (2). Diet plays a beneficial role in controlling and managing type 2 diabetes (3). Meanwhile, one of the elements that have always been of interest to researchers has been the extract of various fruits, including pomegranate (4). Over the past decades, pomegranate products from various parts of the fruit have been used to prevent and treat a wide

range of disorders and diseases, including cardiovascular disease, cancer, Alzheimer's, male infertility, arthritis, obesity, and diabetes (5-7). The therapeutic potential of different parts of pomegranate is due to the presence of unique biological compounds with antioxidant, anti-inflammatory, antiseptic, and anti-hyperglycemic effects. According to studies, fasting blood sugar levels are significantly reduced with Punicic acid, methanolic extract, and pomegranate peel extract (8, 9). Pomegranate known compounds such as Punicalagin are known to be anti-diabetic (9). Also, pomegranate extract products contain unique antioxidant polyphenols (such as tannins and anthocyanins) that can help control type 2 diabetes (9-11).

Another factor in preventing and controlling type 2 diabetes has regular physical activity (12). Studies show that the combined effect of physical activity and weight loss reduces the risk of diabetes by up to 50%. Most physical activity that leads to the improvement and control of diabetes includes aerobic and resistance exercises (12-14). According to studies, the importance of pomegranate extract and physical activity in people with type 2 diabetes has been well established (9, 12). To date, however, the increasing effect of pomegranate juice and physical activity in controlling blood sugar and fat has not been studied in women with type 2 diabetes. In this study, we aimed to investigate the increasing effect of combined pomegranate juice and regular physical activity in women with type 2 diabetes.

Methods

In this case-control study based on previous investigations, 58 women with type 2 diabetes who went to the clinic were selected for the study. The inclusion criteria included: the diagnosis of T2DM since at least 6 years' prior, the use of oral hypoglycemic drugs (Glybenclimide or/and Metformin), the use of anti-hypertensive drugs (losartan), no other underlying diseases such as heart, skin, and nerve, overweight ($25<BMI<29$ kg/m^2), vitamin B1 intake (300 mg). Exclusion criteria included: smoking, alcohol abuse, and underlying diseases such as heart, skin, and nerve.

After a thorough explanation of the research for each individual and obtaining written consent from the patients, their names were registered to enter the study. They were then randomly divided into four groups (control, pomegranate juice, aerobic training, combined pomegranate juice with aerobic training). The aerobic training plan consisted of 2 months and three times per week (training time from 20 minutes to 45 minutes, with an intensity of 60 to 75 percent of the heart rate stored). Three days before and after exercise (12 hours of fasting), blood was drawn from the vein of the arm and sitting. The levels of fasting blood glucose (FBG), total cholesterol (TC), triacylglyceride (TG), and low-density lipoprotein (LDL) were measured via colorimetric methods (Pars Azmoon, Tehran, Iran). The serum level of HbA1c was measured using a commercial kit (NycoCard, England).

Statistical Analysis

Statistical analysis was analyzed using paired-samples t-test and one-way analysis of variance (ANOVA), LSD post hoc test. The results are expressed in the form of mean±standard deviation (SD). Data were calculated in the SPSS program (version 20). $p\leq0.05$ and $p\leq0.01$ were considered statistically significant differences.

Results

In the present study, we investigate the effect of pomegranate juice with and without aerobic training on serum FBG, HbA1c, and lipid profile in 58 women with type 2 diabetes. Patients were randomly divided into four groups: control group, pomegranate juice, aerobic training, and combined pomegranate juice with aerobic training. The physical characteristics of subjects (age, the mean+ SD of body mass index (BMI), and weight) at the beginning are provided in table 1 and the mean+ SD of TC, TG, LDL-c, FBG, and HBA1c in different groups are shown in Table 2. Results also showed that the changes in the mean+SD of FBG, HbA1c, LDL-c, TC, and TG after training with pomegranate juice consumption compared to before their consumption showed a significant decrease ($p< 0.01$) (Table 2). After the experimental period,

pomegranate extract or aerobic training alone decreased LDL level compared to the control group (p=0.001 and p=0.000, respectively). The results of mean difference of biochemical profile was depicted in Figure1and 2.As shown in these figures, there was no statistically significant difference in the levels of TC, TG, HbA1c, FBG, and BMI in pomegranate extract or aerobic training groups compared to the control group after intervention. The combination of aerobic training with pomegranate juice significantly reduced the levels of TG (p=0.04), FBG (p=0.005), and HbA1c (p=0.03), while TC and BMI remained unchanged.

Table1. Physical characteristics of the subjects

Groups		Control	pomegranate extract	Training	Training-pomegranate extract
Gender	**Female**	N=14	N=14	N=14	N=16
	Male	0	0	0	0
Age (Years)		51.5±8.06	58.32±3.6	50.06±6.03	53.24±569
Weight (Kg)	**Before**	66.51 ±10.2	68±13.09	70.38±11.3	69.68±10.73
	After	66.14±9.64	68±15.32	70.3±9.6	68.01±8.6
BMI (kg/m^2)	**Before**	26.87±1.5	26.08±1.26	26.99±2.16	39.61±3.63
	After	26.42±1.73	26.12±1.48	27.08±2.16	27.66±3.15

The data are presented as mean±SD. * P<0.05 is considered significant differences. BMI: body mass index.

Table2. Effect of pomegranate juice consumption with and without aerobic training on lipid profile and glycemic parameters in patients with diabetes mellitus Type 2

Index		Control	pomegranate extract	Training	training-pomegranate extract
FBG (mg/dL)	**Before**	208.72±45.93	185.85±68.66	199.28±63.18	210.52±54.23
	After	199.29±51.41	193.73±68.36	201.35±58.93	128.73±38.54**
HBA1c (%)	**Before**	7.49±1.23	7.10±1.96	7.16±1.69	8.01±2.47
	After	7.29±1.73	7.51±2.56	7.45±1.81	5.77±1.43*
TC (mg/dL)	**Before**	213.35±33.45	196.57±34.71	196.57±34.71	219±27.73
	After	211.28±34.19	196.77±34.16	201.35±31.24	197.21±22.94
TG (mg/dL)	**Before**	214.07±60.05	232.42±74.91	231.28±75.94	229.12±43.66
	After	211.00±64.95	232.85±73.58	225.57±75.85	180.93±25.73*
LDL-c (mg/dl)	**Before**	106.92±11.14	126.28±15.04	126.07±15.19	115.31±19.48
	After	105.21±11.64	126.07±15.19**	127.50±15.81**	106.12±16.12

All results are expressed as mean±SD. * *P*<0.05 and ** *P*<0.01 show significant differences between study groups. TC: total cholesterol; TG: triglyceride; HBA1c: hemoglobin A1c; LDL-c: low-density lipoprotein

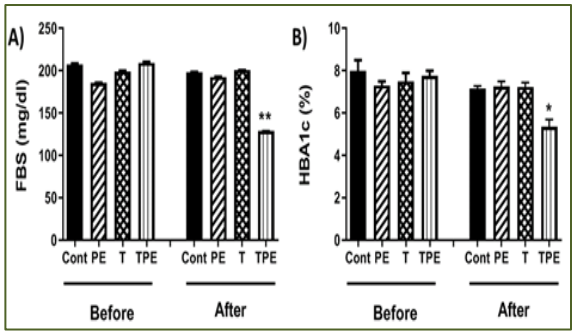

Figure 1. Comparison between the mean±SD of FBG and HBA1c in different groups. FBG: fasting blood glucose, HbA1c: hemoglobin A1c, PE: pomegranate extract, T: training, TPE: training+pomegranate extract. *p< 0.05 and **p< 0.01compated to control group after intervention.

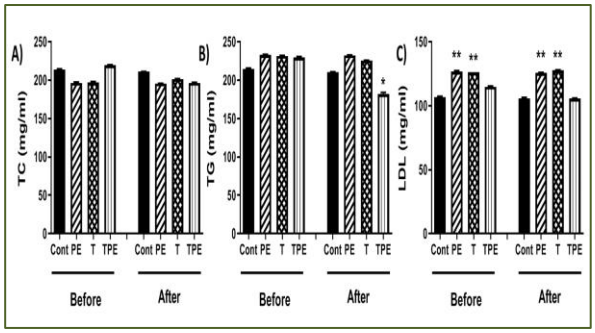

Figure 2. Comparison between the mean±SD of TC, TG, and LDL-C in different groups. TG: triglyceride, TC: total cholesterol, LDL-c: low-density lipoprotein-cholesterol, PE: pomegranate extract, T: training, TPE: training+pomegranate extract. *p< 0.05 and **p< 0.01 compared to control group after intervention.

Discussion

In the current research, the results showed that the serum FBG, HbA1c, and TG in combined aerobic training with pomegranate juice, revealed a significant decrease compared to the control group after the intervention, while TC, LDL-c levels and BMI remained unchanged. There was no significant difference in the levels of glycemic markers and lipid profiles in pomegranate extract or aerobic training groups compared to the control group after intervention.

T2DM prevalence is globally growing because of increasing obesity and a decrease in physical activity worldwide. Studies have shown that up to 80% of cases of T2DM can be managed through a healthy diet and regular physical activity (15). Over the last decade, plant-based dietary patterns are used for the treatment of various metabolic diseases like type 2 diabetes (16). In 2007, Katz et al. showed that pomegranate extracts and their bioactive compounds are effective for the management of diabetes mellitus (17). One of the primary mechanisms by which pomegranate supplementation affects type 2 diabetes is to reduce oxidative stress and lipid peroxidation (18, 19). This reduction may be due directly to the scavenging of free radical compounds, an increase in specific antioxidant enzymatic activities, inhibition, or activation of some transcription factors (18). Some studies have reported that pomegranate fruit extract may reduce blood lipid levels and improved glucose status in patients with metabolic disorders (18, 20). In 2019, G. Sohrab et al. found that the consumption of pomegranate juice significantly decreased the plasma levels of TC, TG, and LDL in type 2 diabetic patients (20). The consumption of pomegranate juice by type 2 diabetic patients showed a significant decrease in blood glucose (21).

In 2017, Masoomeh Yarmohammadi et al. investigated the effects of pomegranate juice with and without aerobic exercise on antioxidant markers in postmenopausal women with type 2 diabetes. Based on their results, aerobic exercise training with pomegranate extract consumption increases the levels of plasma antioxidants and improves the body's antioxidant defense system (22). Pomegranate juice with aerobic training can more effectively improve serum TC, TG, and LDL levels (23).

In the present study, we investigate the effect of pomegranate juice, aerobic training, and combined pomegranate juice and aerobic training on weight, body mass index, serum FBG, HbA1c, and lipid profile in women with type 2 diabetes who were referred to Tehran Lorzadeh clinic. The weight and BMI of the in the experimental groups after the intervention period showed a non-significant reduction. Concerning lipid profile, after intervention with pomegranate juice or aerobic training, there was no statistically significant difference in the plasma levels of TG, TC and LDL-C compared to before pomegranate juice consumption or training. In the post-experimental period, pomegranate extract or aerobic training declined LDL level alone, but no change in plasma TC and TG compared to the control group. Our results showed that the potential of pomegranate juice supplementation positively modulates the blood lipids profile following aerobic training. The combination of aerobic training and pomegranate juice significantly reduced the levels of TG, but no change in plasma TC. Regarding glycemic parameters, in response to pomegranate juice or aerobic training, there was no statistically significant difference in the plasma levels of FBG and HbA1c compared to pre-treatment with pomegranate juice consumption or training. After the experimental period, the combination of pomegranate juice and aerobic training significantly reduced HbA1c and FBG levels compared to the pre-experimental period.

Conclusion

Regular aerobic training and pomegranate juice, as a safe and available compound, could improve glucose and lipid metabolism in patients with type 2 diabetes. Compared to pomegranate juice or aerobic training alone, the combined effects of pomegranate consumption with aerobic training could more effectively improve the glycemic markers in T2DM patients. However, the widespread and clinical use

of pomegranate extract as a treatment strategy requires further study.

Conflict of Interest

The authors declared that they have no conflict of interest.

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Ethics

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