Research Paper: Effect of Aerobic Exercise on Blood Pressure of Patients With Type 2 Diabetes: A Randomized Controlled Trial

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ABSTRACT

Background: Hypertension is one of the prevalent and dangerous complications of diabetes mellitus. As it is difficult to control hypertension, the necessity of using new techniques such as non-pharmaceutical methods and complementary therapy increased. This study aimed to determine the effect of aerobic exercise on the blood pressure of patients with type 2 diabetes.

Methods: This study was a quasi-experimental randomized trial conducted on 67 volunteered patients with type 2 diabetes. The participants were randomly assigned to aerobic exercise (n = 33) and control (n = 34) groups. The exercise group walked 30 minutes, 3 days a week for 8 consecutive weeks. Systolic and diastolic blood pressure of the samples were measured before and after the intervention. The data were analyzed by descriptive statistics, the Kolmogorov-Smirnov test, paired t test, Independent t test, and Chi-square test using SPSS (v. 16). P value less than 0.05 was considered significant.

Results: The difference between the systolic and diastolic blood pressure of the groups before the intervention was not significant (P > 0.05). After the intervention, there was no significant difference in terms of systolic and diastolic blood pressure of the exercise group compared with the baseline (P > 0.05). No significant difference was determined between groups in terms of systolic and diastolic blood pressure after the intervention (P > 0.05).

Conclusion: According to the findings, 8 weeks of aerobic exercise (walking) did not reduce systolic and diastolic blood pressure in patients with type 2 diabetes.

1. Background

Diabetes mellitus (DM), a metabolic disorder of carbohydrate, fat, and protein, is characterized by the lack of insulin secretion or reduced sensitivity of tissues to insulin (Gayton 2008). DM is referred to as "silent epidemic" and also considered as a public health problem worldwide, including Iran.

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The disease incurs direct costs to the amount of 5.2% to 15% of the total health budget and indirect costs for many times as direct ones. It may also cause other problems such as ischemic heart disease, high blood pressure, and retinopathy. Moreover, it is also responsible for many deaths in the world (Ahmann 2007; Wild et al. 2004).

The most common type of diabetes is type 2 diabetes, and its prevalence is increasing globally (Hu 2011). The World Health Organization has termed DM as a "hidden epidemic," based on the increasing trend of diabetes globally. In 2010, the prevalence of DM among adults (age range, 20-79 years) was 6.4%, which is equivalent to 285 million, and this prevalence is expected to increase to 7.7% in 2030, which is equivalent to 439 million people. The prevalence of the disease will increase to 69% in developing countries and 20% in developed countries between 2010 and 2030 (Shaw et al. 2010). In addition, the Iranian Health Ministry has reported 7.7% increase in the prevalence of diabetes type 2 in people aged 25 to 64 years, and the total number of people with diabetes has been reported to be 2 million (Ghorbani et al. 2008).

In a study conducted in 2008, it was found that 5.8% of Iranian women and 5.1% of Iranian men suffered from diabetics (Ghorbani et al. 2008). A common complication of diabetes is high blood pressure, which affects about 20% to 60% of patients with diabetes (American Diabetes Association 2003). In a study in Isfahan, it was reported that the prevalence of complications of diabetes such as high blood pressure is about 50% (Azizi et al. 2010).

In Iran, the prevalence of high blood pressure has increased significantly during the past few years. In the latest studies, a 23.3% increase in the prevalence of the disease has been reported. Due to lack of appropriate treatment, 50% of the patients die because of stroke, heart attack, or kidney failure (Azizi et al. 2010). High blood pressure is a silent killer and is often neglected by the patient. In 2000, despite having advanced and extensive education, only one-third of the patients with high blood pressure could control their blood pressure and keep it within the normal range (Yeh et al. 2009).

Nowadays, experts believe that diet and medications are not sufficient for the treatment and control of DM, but changing lifestyle and balancing known risk factors for diabetes should be done to control blood pressure. In other words, monitoring and controlling blood sugar and blood pressure and supporting health education and providing professional nursing care are necessary for preventing complications of this chronic and complex disease (Borhani et al. 2013; Nahin et al. 2012). Preventing the worsening of the patient's condition is a very important nursing intervention (Fetherston & Wei 2011).

With an emphasis on self-care and utilization of new relevant therapies such as non-pharmacological methods, nurses could have a significant contribution in improving the physical and mental conditions of diabetic patients (Delavari et al. 2005; Pena et al. 2009). Physical activity and exercise are among the non-pharmacological methods and can be considered as the most important changes in the lifestyle of people with diabetes (American Diabetes Association 2013). A research in 2006, showed that the mean systolic and diastolic blood pressures were significantly reduced after 8 weeks of exercise (Macfarlane et al. 2006).

Weight loss due to exercise leads to the reduction of triglycerides and low-density lipoproteins, loss of excess body fat, and regulation of blood pressure (Yosefi poor et al. 2015). The American Diabetes Association recommends 150 minutes of moderate-intensity aerobic exercise or 90 minutes of vigorous aerobic activity per week for patients with type 2 diabetes (Praet & Loon 2007). These exercises will also improve the maximum oxygen uptake in diabetic patients by 10% (due to the improvement in the cardiovascular and respiratory system), and at this rate, it is expected that the risk of cardiovascular disease reduces significantly (Boule et al. 2003). The best time to exercise is usually 1-3 hours after meals in patients with diabetes (Khaliqi 2009).

Aerobic exercise is the common type of exercise for people with diabetes (Bello et al. 2011). Many studies have confirmed the positive impact of aerobic exercise in lowering blood pressure (Macfarlane et al. 2006; Collier et al. 2008). A research, conducted in 2008, showed that 4 weeks of aerobic and power exercise has markedly decreased systolic and diastolic blood pressure (Macfarlane et al. 2006); however, some other studies have not verified the effect of aerobic exercise on the reduction of blood pressure (Andersson et al. 2008; Lin et al. 2009; Alizadeh et al. 2011).

Walking is also an excellent way to control type 2 diabetes and improve the health of patients with diabetes (Loretod et al. 2005). Walking or doing any aerobic exercise for 38 minutes (4400 steps) per day will significantly decrease hemoglobin A1C value in patients with diabetes. Moreover, walking 5 km a day that takes approximately 90 minutes can improve up to 1.1% he-

moglobin A1C (Karstoft et al. 2012). Reduction in glycosylated hemoglobin A1C has lots of benefits in reducing cardiovascular complications (Rizos & Mikhailidis 2001); each 1% increase in glycosylated hemoglobin is associated with 18% increase in cardiovascular disease risk. Therefore, aerobic exercise can be an ideal exercise for people with diabetes (Sigal et al. 2007).

Due to the increasing incidence and prevalence of DM and its impact on all aspects of life in these patients, it is important to further study the different aspects of DM. There is an increasing prevalence of high blood pressure in Iran, especially in people with type 2 diabetes (about 71%), which is two times more than that in the general population. Furthermore, 35% to 75% of cardiac complications such as cardiovascular and renal hypertension have been attributed to high blood pressure in patients with diabetes (Azizi et al. 2010; Farvid et al. 2010). Given this background, conducting multiple studies in this area seems necessary. Therefore, the aim of this study is to examine the effect of walking exercise on the blood pressure of patients with type 2 diabetes.

2. Materials and Methods

This randomized clinical trial was approved by the Ethics Committee of Iran University of Medical Sciences (Code No. IR.IUMS.REC.2015.9311686019), and the proposal was registered in Iran Clinical Trials (Code No. IRCT 201511197101N3). Permission was obtained to enter the research settings, i.e. hospitals affiliated to Iran University of Medical Sciences (Hazrat-e Rasool and Firouzgar), by explaining the aim of the study to the hospital authorities.

The inclusion criteria were as follows: having type 2 diabetes according to physician's diagnosis, lack of musculoskeletal disorders and cardiovascular problems, lack of limits on physical exercise, aged 20-60 years, and having blood pressure less than 220/120 mm Hg. Exclusion criteria were as follows: hospitalizations during the study, exercise intolerance (expressing discomfort, lethargy, imbalance, sweating, tachycardia, and severe dizziness), irregular participation in exercise, and developing any complications in the foot. According to the previous studies, the sample size was calculated.

In this study, 67 males and females (20-60 years old) with type 2 diabetes, were randomly assigned to walking (n = 33) and control (n = 34) groups. Both groups signed the consent form. The control group received no intervention and continued their normal life. The walking exercise group was asked to walk with moderate intensity for 30 minutes one to two hours after eating breakfast in the morning, 3 days a week, for 8 consecutive weeks. The experimental group was told to report the researcher in the case of severe and unbearable palpitations. In such a case, the patient's pulse rate was measured; if it was 60-70% of the maximum initial pulse rate, the patient would break up walking till the pulse rate returned to baseline. After returning pulse to baseline, they began walking the prescribed distance (2 km) over time prescribed (30 minutes) till the walking task was finished. Exercises were done in the gym and supervised by the researcher or research assistant and a coach. Blood pressure was measured by a reliable needle bounce manometer the day before and one day after the end of the intervention. The data was analyzed by descriptive statistics (the frequency, mean and standard deviation), the Kolmogorov – Smirnov test, t-test, and Chi-square test using SPSS (version 16). The significance level was considered as less than 0.05.

3. Results

The results showed that the mean age of the patients in the walking and control groups was 53.18 ± 4.99 years and 51.88 ± 7.83 years, respectively. There was no significant difference between the average age of the groups (P = 0.412) (Table 1).

There was no significant difference between groups with regard to sex (P = 0.729) (Table 2). Most participants were high school graduates, and there was no significant difference between the two groups in terms of educational level (P = 0.690) (Table 3). Most participants

Table 1. Comparing ages between two groups

Variable	Group	Mean ± SD	95% Confidence Interval		P Value
			Lower Limit	Higher Limit	
Age, y	Walking	53.18 ± 4.99	51.4123	54.9513	0.412
	Control	51.85 ± 7.83	49.1189	54.5870	

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Table 2. Comparing gender between two groups

Group	Gender	
	Male, No. (%)	**Female, No. (%)**
Walking	15(45%)	18(55%)
Control	14(41%)	20(58%)
P value	0.729	

Table 3. Comparing education degree between two groups

Group		Education Degree					P Value
		Elementary	**Guidance**	**Diploma**	**Associate**	**Bachelor**	
Walking	No.	7	5	10	7	4	
	%	21.2	15.2	30.3	21.2	12.1	0.690
Control	No.	4	7	11	9	3	
	%	11.8	20.6	32.4	26.5	8.8	

Table 4. Comparing type and dosage of diabetes pills between two groups

Group		Diabetes Pill			P Value
		Metformin	**Glibenclamide**	**Both**	
Walking	No.	9	8	16	
	%	27.3	24.2	48.5	0.574
Control	No.	13	5	16	
	%	38.2	14.7	47.1	

Table 5. Mean values of diastolic and systolic pressures in two groups before and after intervention

Group	Variable	Mean ± SD Before the Intervention	Mean ± SD After the Intervention	P Value
Walking	Systolic pressure	122.42 ± 14.79	122.36 ± 20.29	0.986
	Diastolic pressure	76.06 ± 12.48	80.00 ± 9.35	0.119
Control	Systolic pressure	125.29 ± 16.55	125.88 ± 16.16	0.815
	Diastolic pressure	78.82 ± 10.94	82.64 ± 12.38	0.062

Table 6. Comparing mean difference values of systolic and diastolic pressures between two groups before and after the intervention

Variable	Group		Mean Difference	P Value	95% Confidence Interval	
					Lower Limit	Upper Limit
Systolic pressure (before the intervention)	Walking	Control	-3.5187	0.435	-12.4569	5.4195
Systolic pressure (after the intervention)	Walking	Control	-2.8698	0.458	-10.5394	4.7997
Diastolic pressure (before the intervention)	Walking	Control	-2.7629	0.339	-8.4866	2.9608
Diastolic pressure (after the intervention)	Walking	Control	-2.6470	0.328	-8.0143	2.7209

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in the walking group (48%) used Metformin, and about 47% in the control group used Metformin and Glibenclamide. There was no significant difference between the groups in terms of the type of taking oral diabetes tablets (P = 0.574) (Table 4).

Before the intervention, the mean systolic and diastolic pressure of the groups was not significantly different. There was no statistically significant difference between walking and control group in terms of the mean systolic and diastolic pressure before and after the intervention (P > 0.05) (Table 5). The difference between mean systolic and diastolic pressure of experimental and control groups was not statistically significant (P > 0.05) (Table 6).

4. Discussion

Based on the results of this study, 8 weeks of walking exercise had no effect on reducing systolic and diastolic blood pressure of the patients with type 2 diabetes.

The results of this research are congruent with the findings of other related studies (Modeste et al. 2007; Lin et al. 2009; Alizadeh et al. 2011; Yosefipoor et al. 2015). In a research conducted by Alizadeh, 45 women were randomly assigned into 3 groups including intermittent exercise, continuous exercise, and control groups. The first group practiced 40 minutes of walking with the intensity of 64% to 76% of the maximum heart rate, 3 sessions a day for 5 days; the second group practiced 40 minutes of walking with moderate intensity 1 session a day, for five days, and the control group did not engage in any exercise.

No significant changes occurred in the systolic and diastolic blood pressure of the groups (Alizadeh et al.2011). In another research, 8 weeks of aerobic exercise, 3 times a week by 60% to 80% of maximum heart rate had no significant effect on blood pressure (Yosefipoor et al. 2015). However, other studies have shown that aerobic exercises have reduced participants' systolic and diastolic blood pressure. In Macfarlane's study and Collier's study, significant changes were seen in systolic and diastolic blood pressure after 8 weeks and 4 weeks of aerobic exercise, respectively (Macfarlane et al. 2006; Collier et al. 2008).

In Murphy's study, there was also a reduction in diastolic blood pressure over the 6-week intermittent and continuous exercise with moderate intensity (Murphy et al. 2002). Whelton has confirmed the positive impact of aerobic exercise on the reduction of blood pressure (Whelton et al. 2002). It seems that aerobic exercise reduces blood pressure by reducing the levels of triglycerides and low-density lipoprotein and loss of excess body fat (Yosefipoor et al. 2015). It also increases oxidation of total body fat and activates lipoprotein lipase (Mokhtari et al. 2014), which can play an important role in lowering blood pressure.

The different results of the above-mentioned studies could be due to the failure of interventions to reduce blood pressure (Lin et al. 2009; Alizadeh et al. 2011; Yosefipoor et al. 2015), lack of relationship between exercise and blood pressure (Modeste et al. 2007), increasing systolic or diastolic blood pressure after a period of aerobic exercise (Andersson et al. 2008; Fargad 2005), and failure of our intervention to reduce blood pressure. Other factors such as the type of exercise, intensity and frequency of daily exercise, diet, and body mass index could also be involved. Therefore, some researchers recommend and emphasize the concurrent use of exercise,

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appropriate diet, and certain drugs to control blood pressure (Jorgea et al 2011).

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Conflicts of Interest

The authors of this study declared no conflict of interests.

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