Physical activity and type 2 diabetes:  
A narrative review

Eskandar Rahimi*

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(*) Associate Professor in Exercise Physiology, Department of Physical Education and Sports Science, Zand Institute of Higher Education, Shiraz, Iran. E.mail: erahimi58@gmail.com

Abstract

Type 2 Diabetes (T2D) is a metabolic disease that is brought about by either insufficient production of insulin or the inability of the body to respond to the insulin formed within the system. The prevalence of T2D is increasing worldwide in the 21st century. The main reason for the increase is the changes in lifestyle, specifically doing less exercise and consuming excessive calories. Physical activity is an important component of T2D treatment plan, because it improves glycemic control and reduces the risk of cardiovascular disease. Just as the main reason for the increased prevalence of T2D is lifestyle changes, the cornerstones of treatment must also incorporate lifestyle changes to control and reduce the complications of T2D.

Physical activity has been recommended as one of the alternatives. This review focuses on the association between physical activity [Aerobic training (AT), Resistance training (RT) and Concurrent training (CT)] and metabolic syndrome.
Keywords: Type 2 diabetes, Aerobic training, Resistance training, Concurrent training, Metabolic syndrome

1. Introduction

Type 2 Diabetes (T2D) is a metabolic disease that is brought about by either insufficient production of insulin or the inability of the body to respond to the insulin formed within the system. Obesity and lack of physical activity are two of the most common causes of this form of diabetes (1).

The prevalence of T2D is increasing worldwide in the 21st century (2). The main reason for the increase is the changes in lifestyle, specifically doing less exercise and consuming excessive calories. According to World Health Organization (WHO), the number of people diagnosed with diabetes in the year 2014 was 422 million (3-5). This number may rise up to 600 million in the year 2030-2036 if appropriate measures are not taken to prevent and cure this disease (4,5).

T2D accounts for approximately 90%-96% of all diabetes cases in adults aged over 25 (6) and is followed by some complications such as eye, neural and renal problems and also cardiovascular failures (7,8).

The four main tools for T2D management are exercise, diet, medication and control of stress (9-11). In relation to structured exercise, many studies were conducted and significant reductions were found in the glycaemia responses of individuals who suffer from this disease (12,13). Just as the main reason for the increased prevalence of T2D is lifestyle changes, the cornerstones of treatment must also incorporate lifestyle changes to control and reduce the complications of T2D. Physical activity has been recommended as one of the alternatives (14-16).

Researches Show that physical activity such as aerobic training, resistance training and concurrent training result in reduction of metabolic syndrome (11,17). Metabolic syndrome is a cluster of conditions – increased blood pressure, high blood sugar, excess body fat around the waist, and abnormal cholesterol or triglyceride levels – that occur together, increasing risk of heart disease, stroke and diabetes. Having just one of these conditions doesn't mean one has metabolic
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syndrome. However, any of these conditions increase one risk of serious
disease. Having more than one of these might increase risk even more
(18). Blood glucose control is determined by reducing Hb A1C, a
measure to monitor the effectiveness of therapeutic interventions and
any reduction in Hb A1C is associated with a reduction in the
complications of the disease. A review of the literatures suggests that
physical activity in T2D patients reduces Hb A1C levels by 6% (19).
Most of the researches done so far have displayed the effects of aerobic
and resistance training alone on metabolic syndrome. Little research has
been carried out on the effects of CT on metabolic syndrome (4,20,21).

In recent decades, different types of physical activity have been
investigated with varying intensities, and the results indicate the effect
of AT, RT, or CT on T2D. Proving the effectiveness of physical activity
on T2D requires the final examination of the exercises in terms of
severity, duration, frequency, and number of sessions per week (22).
However, in the meta-analysis of Schwingshackl et al. (2014), the effect
of CT was greater than AT and RT alone (23).

2. Effects of physical activity on metabolic syndromes
Physical activity is defined as any bodily movement produced by skeletal
muscles that require energy expenditure. Physical inactivity (lack of
physical activity) has been identified as the fourth leading risk factor for
global mortality (6% of deaths globally). Moreover, physical inactivity is
estimated to be the main cause for approximately 27% of diabetes and
approximately 30% of ischaemic heart disease burden (24).

3. Aerobic training
The American College of Sports Medicine (ACSM) defines AT as "any
activity that uses large muscle groups, can be maintained continuously,
and is rhythmic in nature." It is a type of exercise that overloads the
heart and lungs and causes them to work harder than at rest.

AT is a part of ally in the treatment of T2D by reducing insulin
resistance and increased metabolic rate improvement. Investigators show
that training such as walking, bicycling, jogging, running and resistance
training like weight lifting result in reduction of HbA1c. A decrease in
the amount of HbA1C up to 1% diminishes the danger of cardiovascular disease up to 15 to 20 percent and eventually results in a reduction of the complications of microvasculature up to 37 percent (24). Some researchers have demonstrated that training (either AT or RT alone) causes a drop in HbA1c level from 7.9% to 7% and the fasting plasma, blood glucose dropped from 8.3m mol to 7.9 m mol, (25-27), and when performed with adequate intensity and frequency, it could reduce blood pressure, overweight, obesity, increased peripheral blood flow, reduced atherosclerosis progression, and decreased oxygen demand of the myocardium and also reduces risk of developing anxiety, and depression (28-30). Plasma insulin level and total cholesterol decrease significantly and HDL increases via AT (31,32).

4. Resistance training
RT is included in anaerobic exercise defined by the ACSM as intense physical activity of very short duration, fueled by the energy sources within the contracting muscles and independent of the use of inhaled oxygen as an energy source (33). RT is a growing therapeutic tool that has the potential for increased muscle strength, endurance, flexibility, body composition and reducing cardiovascular disease (34). Also, RT with sufficient intensity and duration can reduce glucose and HbA1C alone (35). Based on the findings of studies, RT resulted in a significant increase in the level of HDL and a significant reduction in glucose, fructosamine, HBA1c, plasma insulin and Resistance to insulin (36,37). Recent studies suggest increased fat free mass and decreased fat mass after RT, which can affect insulin resistance (38,39). Blood lipid disorders are one of the undesirable changes in type 2 diabetic patients, which lead to the development of vascular complications and increased risk of cardiovascular disease in these individuals. Therefore, therapeutic goals are to improve lipid disorders in patients with this disease. Most studies have shown that glycemic index and higher blood glucose levels are associated with lower HDL levels and higher LDL levels (40,41).

5. Concurrent training
The report of the American Association for Diabetes suggests that CT have a greater impact on blood glucose levels in people with T2D.
Although AT is a suitable method for diabetic patients, some diabetic patients do not have the ability to perform large amounts of AT. As a result of CT with less time is an appropriate alternate. CT is known as a more effective form of physical activity to control of blood sugar, body composition and cardiovascular risk factors (42,43).

Base on the studies concurrent training has more effect on glucose metabolism, body composition, insulin resistance adjustment and increasing insulin sensitivity (44). Based on a meta-analysis that examined the effects of different kinds of physical activity, CT has more superior on metabolic syndrome than resistance and aerobic training alone (45).

The results of a clinical investigation on 251 adult patients during 26 weeks of training showed that in comparison with AT and RT alone, CT decreased HbA1c more prominently (46-48). Baldoucci et al. (2004) monitored effects of concurrent training on the level of HbA1c and certain other metabolic factors in type 2 diabetic patients for one year. Change in the amount of HbA1c revealed that the CT and the RT had produced a more significant decrease in blood sugar compared with the control (49). In addition, LDL and total cholesterol also decreased significantly in CT, while HDL level increased (4,50,51). But the research results are inconsistent with the effects of CT on A1C, although its effect is greater than the effect of AT or RT (47,51-53).

6. Conclusion

Physical activity is a strong toll to prevent and treatment of T2D. With regard to the articles selected for this review, it can be said that all three types of physical activity (AT, RT and CT) affect the metabolic syndrome. But the CT seems to be more effective. Unfortunately, information about the effects of varied intensities and durations of CT on metabolic syndrome is limited.

It can also be concluded that the effect of continuous activity is 3-4 sessions per week and 30-45 minutes each session, and between 60-75% VO$_{2\text{max}}$ in the aerobic section and with 60-80% 1RM in the training section resistance and with 10-12 repetitions each exercise has the most effect on metabolic syndrome.
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