

Physical Activity in Control of Diabetes Mellitus: An Underrated Entity

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ABSTRACT

Glycaemic control and reduction in mortality among diabetes can be easily achieved by a cost-effective intervention, Physical activity. Moderate to vigorous intensity activities are usually recommended for diabetics. Structured engagement of diabetics by combining physical activity and modest weight loss activities their risk can be reduced by 58%. But most of the diabetics prefer to remain inactive. Hence this article highlights the importance of physical activity, acute and chronic effects of physical activity on diabetics, recommended level of activity, recommended type of activity and ways to adhere and maintain those activities.

Key words: Diabetes, Physical activity, Glycemic control

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INTRODUCTION

Diabetes, is one of the fastest growing global health emergencies of the 21st century. According to IDF's estimate, India ranks second among the countries with approximate prevalence of 74.2 million adults (20-79 years) in the year 2021.¹ With India having 1 in 7 of all adults living with diabetes worldwide, it is also called as diabetic capital. The major problem with the diabetes is, most of them remain undiagnosed. Almost 1 in 2 adults with diabetes are unaware that they are suffering from the disease. By the time they get diagnosed their mortality and morbidity rises posing a challenge. It is estimated that 53.1% of the Indian adults are living without knowing the truth that they are suffering from diabetes.¹ It is a well-known fact that type 2 diabetes is the major factor behind mortality and morbidity due to cardiovascular disorders, kidney and nerve disease, blindness and amputation.² Physical activity is said to prevent or postpone diabetes and its complications.³ But only 40% of the diabetics are found to be engaged in exercise therapy.⁴ Among them, the recommended level of activity is achieved only by 28.2%.⁵ This review is intended to highlight the fact that daily physical activity may have a positive impact on mortality and morbidity in individuals who are suffering from type 2 diabetes.

PHYSICAL ACTIVITY ON DIALY BASIS

Increasing the day-to-day energy expenditure by moving the body which leads to contraction of skeletal muscle is known as physical activity. The term physical activity is often used interchangeably with the term exercise. Exercise is a type of physical activity which involves structured, planned and repetitive physical movements that improves physical fitness.⁶ Intensity and duration are the variables which are used to describe the adequacy of physical activity. While the duration can be measured using minutes, intensity is represented by measuring metabolic equivalent (MET). MET is described as the oxygen uptake while sitting at rest. 1 MET is equal to oxygen uptake of 3.5 mL/kg per minute at basal resting metabolic rate.⁷ Our day to day activities like walking, gardening, washing vessels, cooking, cleaning etc will also produce varying intensity of METs according to the activity and the situation in which it is performed.⁸ Hence, it is to be noted that exercise is just a part of physical activity done to cover the required METs and if there is enough physical activity then there won't be a need for any structured exercises.

SEDENTARY LIFESTYLE

Industrialization has introduced sedentary behaviour in our life. Low expenditure of energy due to the tendency to remain seated while awake is referred to

as sedentary behaviour. It is to be noted that physical activity is inversely proportional to the duration of sitting. If the duration of sitting for a person is more then he/she is not physically active and he is prone for morbidity and mortality due to type 2 diabetes.⁹ Sedentary lifestyle is also an independent risk factor for other non-communicable diseases.¹⁰ It is to be noted that exercise and sedentary lifestyle are inconsistent. Someone can't be healthier by doing recommended amount of exercise during their free time but is extremely inactive during their working time.¹¹ The American Diabetes Association has suggested that, those patients who are diagnosed to have diabetes should reduce their sedentary time and not to sit for more than 90 min.¹²

PHYSICAL ACTIVITY IN DIABETES

Physical activity can be classified as light, moderate and vigorous. Activity which rises the heart rate from 55 to 64% from the maximum heart rate is said to be a light intensity activity. A rise of 65-74% from the maximum heart rate due to an activity, then it is moderate intensity activity. While if an activity rises the maximum heart rate to 75-90% from the maximum heart rate then it would be a vigorous activity.¹³ Physical activity can also be classified based on MET. Activity producing MET less than 3 are light intensity activity, MET between 3 to 6 are moderate intensity activity, and MET more than 6 are categorized as vigorous intensity activity.¹⁴ Slow walking, cooking, taking care of children, washing dishes are some examples of light intensity work. Brisk walking, climbing stairs, gardening, mopping, bicycling is some of the moderate intensity activities. Vigorous activity includes hiking, shoveling, jogging, playing basketball, soccer, tennis, etc.⁸ For those with type 2 diabetes, the American Diabetes Association and the American College of Sports Medicine have recommended at least moderate to vigorous activity for 150 mins/wk.¹⁵ But this recommended physical activity is difficult to be achieved by the diabetics as they have lower physical performance threshold compared to the normal counterpart. Through researches it is found that they have shown a lower energy expenditure, number of steps, duration of physical activity and cardiorespiratory fitness than the normal person.^{16,17} And it proved that muscle strength is inversely associated with the degree of diabetic complications. Hence it is understood that progression of diabetes can make a person physically inactive.¹⁸

IMMEDIATE EFFECTS OF PHYSICAL ACTIVITY

Fuel supply during exercise: Liver through glycogenolysis, gluconeogenesis, and mobilization of alternate fuels like free fatty acids it maintains the

blood glucose level. But during physical activity, with the contraction of muscle there is an increase in the uptake of blood glucose.¹⁹ The quantity of glucose needed is affected by several factors, of which intensity and duration of physical activity are the most important factors.²⁰ At rest our body uses free fatty acids (FFAs) for fuel production, but with any activity there is a shift from FFAs to glucose, fat, glycogen, amino acids, etc.²¹ When the intensity of the exercise increases carbohydrates in the body will be utilized to provide energy. During the beginning of the workout session glycogen will be utilized for energy production, but when the stores of glycogen get depleted, the muscles will make use of blood glucose and FFAs.²² As the duration of physical activity increases the liver shifts from producing fuel through glycogenolysis to gluconeogenesis.¹⁹

Glucose uptake of muscle during exercise: Glucose uptake by the muscles happens through two pathways: One is insulin dependent which takes place when a person is at rest or after food, while the other pathway is insulin independent and takes place when the person is physically active.²³ When it comes to those affected by type 2 diabetes, due to lack of insulin their insulin dependent pathway is not going to function properly. The existence insulin independent pathway serves as an advantage to them, as they can increase the glucose uptake by being physically active.²⁴ The transport of glucose into the skeletal muscle requires GLUT proteins, of which GLUT 4 is an essential protein. This GLUT 4 is activated by insulin through signals and also by exercise through 5-AMP-activated protein kinase.²⁵ Hence doing physically active helps diabetics to open up an alternate pathway for the uptake of glucose by the muscles.

Change in insulin resistance in muscles: Physical activity prevents or helps in managing diabetes mellitus by affecting insulin resistance and its effects last both acute and chronic. Blood glucose level drops acutely for 2-72 hours after mild to moderate intensity exercise. But this reduction is affected by the state of physical training, pre-exercise control, and by the intensity and duration of the exercise.²⁶ Another important acute action of physical activity is reduction of fat content in the body. Type 2 diabetes and the fat content on liver seen in obesity are strongly associated with each other and leads to increased insulin resistance, at both peripheral and hepatic level. While physical activity decreases the peripheral insulin resistance it also aids in weight loss. With the loss of fat around the liver there will be a decrease in the insulin resistance at hepatic level also.²⁷

Glycemic control after exercise: Effects of aerobic exercise: The effect of physical activity differs in diabetic and non-diabetic. When a non-diabetic does moderate intensity activity, their glucose uptake will increase which is compensated by glucose production by liver. Whereas, in diabetics the hepatic glucose production cannot compensate the increased

glucose uptake by the peripheral tissues.²⁸ An action which remains common for both of them is decrease in insulin levels, leading to exercise induced hypoglycemia.²⁹ Transient hyperglycaemia can occur after intense aerobic exercise due to increased production of glucose from the released catecholamines.³⁰

Effects of resistance exercise: Resistance exercises don't have acute effect on type 2 diabetics but some have reported a decrease in fasting blood glucose level for at least 24hrs in those with impaired fasting glucose levels.³¹

Role of type of exercises: Resistance exercise results in increase in the muscle mass which in turn leads to increase in the glucose uptake. On the other hand, aerobic exercises without affecting the muscle mass increases the glucose uptake through insulin action.³² Hence it is evident that when both the exercises are combined, they results will be better than sticking on to a particular type.³² Among the other type of exercises, certain mild intensity exercises like tai chi and yoga have reported mixed results. While tai chi is reported to have led to short term decrease in the blood glucose level, yoga results in reducing fasting blood glucose, lipids, oxidative stress markers, and improving antioxidant status.³³

LONG TERM EFFECTS OF PHYSICAL ACTIVITY

Change in insulin resistance: Physical activity in any form, aerobic or resistance exercise enhances insulin action and facilitates glycaemic control by improving the responsiveness of skeletal muscles to insulin as there is an increased expression and/or activity of proteins engaged in glucose metabolism and insulin signalling, fat oxidation and storage of glucose in muscle.³⁴

Lipid metabolism: There is mixed response seen with blood lipid level and physical activity. A small reduction in LDL cholesterol with no change in HDL cholesterol or triglycerides is observed in most of the studies.³³ Combining weight loss with physical activity may be more efficient than doing aerobic exercise alone for controlling lipids.

Blood pressure: The most common comorbidity seen among diabetics is hypertension. About 60% of the diabetics also suffer from hypertension.³⁵ It is observed that both aerobic and resistance exercise reduces blood pressure.³⁶ Whereas in diabetics a slight reduction in systolic blood pressure seen with aerobic exercises. But the diastolic blood pressure is least affected by physical activity.³⁷

Mental Health: Depression, common problem among diabetics can be controlled with the help of physical activity.³⁸ Physical activity results in the rise in norepinephrine transmission, serotonin synthesis and endorphins with change in the hypothalamic adrenocortical system which results in increased

self-efficacy, change in self-concept, a sense of mastery, and distraction.³⁹

RECOMMENDATION OF TYPES OF PHYSICAL ACTIVITY TRAINING

Aerobic exercise: non-insulin dependent uptake of glucose can be achieved by doing aerobic exercise of moderate to vigorous intensity for at least three days/week with no more than two consecutive days.⁴⁰ Through studies it is found that intensity of exercise brings better glycaemic control over the volume of exercise. Hence for a greater benefit those who are doing moderate intensity exercise should consider doing some vigorous intensity exercises. The minimum recommended duration is 150mins/week. Exercise volume suggested by the U.S. federal guidelines is 500 – 1,000 MET min/week. In order to achieve that either the person has to walk 150 min/week at a speed of 6.4 km/h or he/she should jog for 75 min at a speed of 9.6 km/h. But this would be not possible with our diabetic patients as their maximal aerobic capacity is 22.4ml/kg/min or 6.4 METs. So, it is better to concentrate on intensity of exercise rather than its volume. Any form of aerobic exercise that involves large muscles and causes gradual and sustained increase in heart rate will be better.⁴¹

Resistance exercise: Muscle building resistance exercise which aids in the storage of glucose in the muscles should be done along with aerobic exercise for 2-3 times/ week at moderate - vigorous intensity. Each session should include 5–10 exercises involving the muscles in the upper body, lower body, and core and should be carried out for 10 –15 repetitions to near fatigue per set during the early training periods. Weights can be lifted in the later periods for 8-10 times as it improves the insulin action and glycaemic control. It is advised that the intensity, frequency and duration of exercise to progress slowly to avoid injuries.⁴²

Combined exercise and other types of exercises: Diabetics are recommended to do both aerobic and resistance exercise for three days per week to achieve better glycaemic control. It is also observed that when both the exercises are undertaken on the same day, the duration of exercise and caloric expenditure is more. Some of the milder form of physical activity like yoga and tai chi, may help glycaemic control but there is no enough evidence to support it.⁴³

Unstructured movements: In order to get addition health benefits, diabetics should increase their daily unstructured movements. Calorie deficit can be bought only with the help spending energy for day-to-day activities, which is called as Nonexercised activity thermogenesis.⁴⁴ It is advisable that diabetics cover at least 10000 steps per day.

Flexibility exercises: older adults are at high risk of mortality due to fall; hence it is recommended for them to do flexibility exercises as a part of physical activity as it helps in maintains and improves the balance.⁴⁵

ADHERENCE AND MAINTENANCE OF REGULAR EXERCISES

Through observations it is seen that diabetics or those at risk for acquiring diabetes are not physically active and additional interventions are required to make them active. Self-efficacy is observed as the strongest predictor of physical activity. When a person believes in his ability then he/she will be physically active.⁴⁶ Social support is another strong predictor of physical activity. Mobilizing the community through social media helps in motivating the diabetics, but it can also cover population beyond target individuals.⁴⁷ Health education through health care professionals can also make a change in the physical activity of the diseased. When the consultants also suggest the ways to meet the recommended physical activity, the participation is still going to be better.⁴⁸ Walking is the preferred method for many, hence availability of safe and pleasant space for them to walk can make many achieve the recommendations. Certain lifestyle interventions like self-monitoring, goal setting, stepped-care protocols and frequent contact are suggested by large scale trials like DPP and look AHEAD. Though cost-effective they require access to resources, staff, and space.⁴⁹

CONCLUSION

Physical activity serves as a solution to prevent and control prediabetes, type 2 diabetes, gestational diabetes mellitus, insulin resistance, diabetes related complications. Greater benefits can be enjoyed by combing aerobic and resistance exercise. But being physically active one can relish improved insulin action acutely. And management of blood glucose levels, hyperlipidaemia, hypertension, cardiovascular risk, QOL, etc when continued from prolonged period of time. One can enjoy the benefits of physical activity safely by following certain precautions. It is optimal for type 2 diabetics to include some kind of exercise or physical activity to stay healthy.

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