

Effect of Exercise in the Prevention and Management of Type 2 Diabetes Mellitus

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Abstract

Physical activity (PA) is a key element in the prevention and management of type 2 diabetes but it is now well established that participation in regular PA improves blood glucose control and can prevent or delay the type 2 diabetes along with affecting lipids, blood pressure, cardiovascular events, mortality and quality of life. Structured interventions combining PA and modest weight loss have been shown to lower type 2 diabetes risks by up to 58% in high-risk populations. Most benefits of PA on diabetes management are realized through acute and chronic improvements in insulin action, gestational diabetes mellitus, and safe and effective practices for PA with diabetes-related complication.

Key word

Diabetes, blood glucose, PA (physical activity).

Introduction

Diabetes has become a widespread epidemic, primarily because of the increasing prevalence and incidence of type 2 diabetes. Moderate aerobic exercise can lower the risk for type 2 diabetes. Exercise has positive benefits for those who have diabetes. It can lower blood sugar levels, improve insulin sensitivity, and strengthen the heart. Strength training, which increases muscle and reduces fat, may be particularly helpful for people with diabetes. In this article, the broader term “physical activity” (defined as “bodily movement produced by the contraction of skeletal muscle that substantially increases energy expenditure”) is used interchangeably with “exercise,” which is defined as “a subset of PA done with the intention of developing physical fitness (i.e., cardiovascular (CV), strength, and flexibility training).” Insulin resistance, a reduction in the

rate of glucose disposal elicited by a given insulin concentration, is present in individuals who are obese, and those with diabetes mellitus, and may develop with ageing. Methods which are utilized to measure insulin sensitivity include the hyperinsulinaemic, euglycaemic and hyperglycaemic clamps and the intravenous glucose tolerance tests. Several hormones and regulatory factors affect insulin action and may contribute to the insulin resistance observed in obesity. In addition, abnormal free fatty acid metabolism plays an important role in insulin resistance and the abnormal carbohydrate metabolism seen in individuals who are obese or diabetic.

Thus, the mechanisms underlying the development of insulin resistance are multi factorial, and also involve alterations of the insulin signaling pathway. Ageing is associated

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with an increase in bodyweight and fat mass. Not only is abdominal fat associated with hyperinsulinaemia but visceral adiposity is correlated with insulin resistance as well. Modifications of the changes in body composition with ageing by diet and exercise training could delay the onset of insulin resistance. Lifestyle modifications including bodyweight loss and physical activity provide health benefits and functional gains and should be promoted to increase insulin sensitivity and prevent glucose intolerance and type 2 diabetes mellitus in older adults.

How Does Exercise Affect Blood Sugar Levels?

Normally, insulin is released from the pancreas when the amount of sugar (glucose) in the blood increases, such as after eating. Insulin stimulates the liver and muscles to take in excess glucose. This results in a lowering of the blood sugar level.

When exercising, the body needs extra energy or fuel (in the form of glucose) for the exercising muscles. For short bursts of exercise, such as a quick sprint to catch the bus, the muscles and the liver can release stores of glucose for fuel. With continued moderate exercising, however, your muscles take up glucose at almost 20 times the normal rate. This helps lower blood sugar levels. At the same time insulin levels may drop in anyone not taking insulin so the risks of hypoglycemia or low blood sugar is minimized.¹

Acute Effects of Exercise

- **Fuel metabolism during exercise**
- **Fuel mobilization, glucose production, and muscle glycogenolysis.**

The maintenance of normal BG at rest and during exercise depends largely on the coordination

and integration of the sympathetic nervous and endocrine system² contracting muscles increase uptake of BG, although BG levels are usually maintained by glucose production via liver glycogenolysis and gluconeogenesis and mobilization of alternate fuels, such as free fatty acids (FFAs).^{2,3} Early in exercise, glycogen provides the bulk of the fuel for working muscles. As glycogen stores become depleted, muscles increase their uptake and use of circulating BG, along with FFA released from adipose tissue.^{4,5} Intramuscular lipid stores are more readily used during longer-duration activities and recovery. Glucose production also shifts from hepatic glycogenolysis to enhanced gluconeogenesis as duration increases.^{2,3}

There are two well-defined pathways that stimulate glucose uptake by muscle. At rest and postprandial, its uptake by muscle is insulin dependent and serves primarily to replenish muscle glycogen stores. During exercise, muscle contractions increase BG uptake to supplement intramuscular glycogenolysis. As the two pathways are distinct, BG uptake into working muscle is normal even when insulin-mediated uptake is impaired in type 2 diabetes.^{7,8} Muscular BG uptake remains elevated post exercise, with the contraction-mediated pathway persisting for several hours. Glucose transport into skeletal muscle is accomplished via GLUT proteins; with GLUT4 however, trigger GLUT4 translocation at least in part through activation of 5AMP activated protein kinase. Insulin-stimulated GLUT4 translocation is generally impaired in type 2 diabetes. Both aerobic and resistance exercises increase GLUT4 abundance and BG uptake, even in the presence of type 2 diabetes.^{8,9}

Type 2 Diabetes and Exercise Tips

1. To reduce the risk of hypoglycemia if people have diabetes, they should follow a regular routine of exercising, eating meals, and taking medicines at the same time each day. Prolonged or strenuous exercise can cause body to produce adrenaline and other hormones that can counteract the effects of insulin and cause blood sugar to rise. If the people are participating in strenuous exercise (exercising at maximum capacity) or prolonged exercise (lasting for several hours or more), insulin and/or oral diabetic medicine or calories may need to be changed.
2. Wear a medical identification tag (for example, Medic Alert) or carry an identification card that states you have diabetes.
3. Wear good, protective footwear to help avoid injuries and wounds to the feet.
4. Glucose levels swing dramatically during exercise. People with diabetes should monitor their levels carefully before, during, and after workouts.
5. Patients should probably avoid exercise if glucose levels are above 300 mg/dL or under 100 mg/dL.
6. To avoid hypoglycemia (low blood sugar), people with diabetes should inject insulin in sites away from the muscles they use the most during exercise.
7. People with diabetes should drink plenty of fluids. Before exercising, they should avoid alcohol and certain medications, such as beta-blockers, which increase the risk of hypoglycemia.
8. Insulin-dependent athletes may need to decrease insulin doses, or take in more carbohydrates, prior to exercise. However, they may need to take an extra dose of insulin.

Treatment goals in type 2 diabetes

The goal of treatment in type 2 diabetes is to achieve and maintain optimal BG, lipid, and blood pressure (BP) levels to prevent or delay chronic complications of diabetes.^{10,11} Many people with type 2 diabetes can achieve BG control by following a nutritious meal plan and exercise program, losing excess weight, implementing necessary self-care behaviors, and taking oral medications, although others may need supplemental insulin.¹² Diet and PA are central to the management and prevention of type 2 diabetes because they help treat the associated glucose, lipid, BP control abnormalities, as well as aid in weight loss and maintenance. When medications are used to control type 2 diabetes; they should augment lifestyle improvements, not replace them.

Conclusion

Exercise plays a major role in the prevention and control of insulin resistance, pre diabetes, GDM, type 2 diabetes, and diabetes-related health complications. Both aerobic and resistance training improve insulin action. Exercise is important for people with diabetes especially type 2 diabetes because it helps regulate blood sugar and provide cardiovascular fitness that protects against heart and vascular disease.

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