

Review Article

Effect of Physical Activity on Insulin Resistance in Diabetes Mellitus

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Abstract

Acquiring and sustaining physical activity as part of one's daily routine is an excellent approach to control the level of blood glucose and one's overall health, whether healthy as well as diabetic. We give guidelines for exercise as well as its effects on insulin resistance in diabetes patients in this review, which have been supported by numerous prior studies. A collection of movements structured according to a specified protocol that boosts energy consumption is referred to as physical exercise. Exercise improves blood glucose levels in T2DM patients, lowers or eliminates risk factors for metabolic as well as cardiovascular disease, facilitates weight loss, and lowers insulin resistance. The influence of physical exercise on insulin resistance differs based on the kind, intensity, and duration of exercise, so understanding the many types of physical activity and meeting personal requirements is important.

Keywords: diabetes mellitus, insulin resistance, glucose, physical activity

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Introduction

Diabetes Mellitus (DM) is a metabolic condition that results in excessive blood glucose levels due to insulin secretion deficiency, insulin action impairment, or even both¹. Retinopathy, nephropathy, neuropathy, and blood vessel and cardiac abnormalities are all consequences of diabetes². Diabetes is among the most widespread diseases in the world³.

According to the International Diabetes Federation (IDF), diabetes affects 387 million people globally in 2014, while 592 million people are predicted to be afflicted by 2035, a 55 percent rise⁴. There are three forms of diabetes: type 1 diabetes, type 2 diabetes, and type 3 diabetes. To begin, Type-1 Diabetes Mellitus (T1DM) is an insulin shortage induced by a cellular autoimmune process that destroys β -cells in the pancreas. Secondly, "insulin resistance and relative insulin insufficiency" are present in Type 2 Diabetes Mellitus (T2DM)².

Consequently, Gestational Diabetes Mellitus (GDM) is a kind of diabetes that develops during pregnancy⁵.

T2DM is the most common type of diabetes in the world, with an anticipated 642 million people suffering from it by 2040³. Insulin resistance, Obesity, and metabolic syndrome are often present before T2DM develops. Insulin resistance (IR) is a condition in which target tissues are less sensitive to insulin⁶. Insulin resistance is thought to be inherently associated with obesity and T2DM⁷. One of the most essential goals of diabetes treatment is to reduce insulin resistance by dietary restriction, exercise, medication therapy, as well as insulin secretion stimulation⁸.

Physical exercise is a non-pharmacological therapeutic option that improves insulin sensitivity by affecting physiological and metabolic processes⁹. High-intensity Training (HIT) is a type of exercise that involves exceeding 65 percent of

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maximum velocity for just an extended period of time as an alternative to typical workouts that involve moderate to moderate intensity for a longer length of time¹⁰. High-Intensity Interval Training (HIIT) is a training plan that alternates periods of high-intensity training with rest periods¹¹.

Cardio, respiratory fitness, obesity, as well as metabolic health indicators including glucose management and insulin sensitivity all benefit from HIIT⁸. Insulin resistance in women with diabetes diminishes after 12 weeks of aerobic activity as well as a combination of aerobic exercise and resistance¹². In persons with T2DM, found that resistance exercise improved glucose management, insulin resistance, fat mass, and blood pressure¹³. As a result, the goal of this review is to look into the effect of physical activity on insulin resistance in diabetics.

Types of High-Intensity Training

Aerobic training as well as resistance training, and a mix of the two are examples of high-intensity activities. The extent to which they affect insulin resistance in diabetic people varies. There are two types of high-intensity training: HIIT and HIT the degree of high-intensity training varies depending on its duration.

Aerobic Training (AT)

Aerobic training entails the movement of vast muscular groups in a continuous and repetitive manner¹³. Walking, running, and swimming are the most common examples. While continuing to conduct aerobic workouts, it is sufficient to keep and strengthen heart and blood vessel fitness¹⁴. At it for 10 weeks, three days per week, enhanced insulin sensitivity as well as blood glucose levels and became more successful than other regimens in lowering abdominal fat deposits¹⁵. After three months of aerobic exercise, Fabio et al.¹⁴ reported an improvement in metabolic parameters related to insulin resistance and blood cholesterol levels.

Resistance Training (RT)

Resistance, each training session is divided into three stages, the first of which is the warm-up stage, which comprises 20 minutes of stretching and jogging activities. Secondly, repetitions of weight training are the major stage, with the intensity of the exercise being 50 percent to 55 percent of a maximum of one repetition. Finally, there's the cool-down phase, which includes running, free-weight workouts, and stretching¹².

Changes in mental health, muscle mass, and insulin sensitivity are all advantages of RT. Improved glycemic control, insulin resistance, fat mass, blood pressure, and lean body mass strength are some of the key benefits of RT for people with type 2 diabetes¹³.

This form of exercise can help you build muscle and keep your skeleton in good shape. Blood pressure drops following a vigorous resistance exercise session, as previously mentioned¹⁶. Fasting glucose levels are reduced after 6 weeks of RT exercise¹⁷.

Combined Training (CT)

The combination of RT and AT is a joint workout in which AT is done in the morning and RT is done in the evening with such a 6-hour interval for 3 days per week¹⁵. This workout aids diabetic patients in reducing insulin resistance and boosting glucose levels. In addition, in response to CE, body fat percentage reduces¹².

Individuals with dyslipidemia benefit from combining resistance and aerobic activities, and people with prediabetes benefit from maintaining a normal blood glucose level¹⁸.

High-intensity exercises are divided into High-Intensity Training with rest periods, which are called High-Intensity Interval Training (HIIT) and continuous High-Intensity Training

Which is High-Intensity Training (HIIT):

High-Intensity Interval Training

Short, repeating sessions of jogging and cycling at 85-95 % of your maximum heart rate are alternated with periods of rest in this activity¹⁹. HIIT for 8 weeks with hard cycling exercise drastically enhanced glycemic control and abdominal fat mass loss in middle-aged type-2 diabetics¹¹.

In kids with insulin resistance, 6 weeks of HIIT training is beneficial in lowering fasting insulin and insulin resistance. It also has a 2.7 percent effect on body mass, a 2.6 percent effect on fat mass, and a 7% effect on waist circumference¹⁷. It's a good way to improve metabolic health, and it appears to help those with or at risk of T2DM improve their insulin sensitivity⁷.

HIIT is beneficial for cardiovascular health and insulin resistance improvements than regular training²⁰. He also believes that HIIT is a better

Table 1. Studies that show the difference in the effect of types of exercises with different intensity, duration and speed of training

Authors and year	Intensity	Duration & Velocity	Exercise time in weeks	Exercise type	Effects
Alizadeh et al.,2017 ⁸	Rats run on treadmill with 90% Vo_2	15-30 /s at 29-36m/min	8 weeks	HIIT	HIIT has proven effective in reducing fasting glucose and insulin resistance.
Mousavi et al.,2020 ⁹	65%-80% of Maximum heart rate (MHR)	45min/session	8 weeks	AT	8 weeks of AT led to decreased glucose, insulin, insulin resistance, and improved lipid profile (Tc, TG, HDL, LDL).
Badawy et al.,2020 ²⁷	Chronic swimming	60 min/day	20 weeks	Swimming Training	Useful for improving metabolic syndrome and this exercise can be used as a therapeutic
Fealy et al.,2018 ¹⁹	CrossFit- HIT > 85% MHR	8-20 min	6 weeks	F- HIT	Insulin sensitivity improves and metabolic risk decreases in T2DM patients after F-HIT
de Castro et al.,2019 ¹⁵	Running Climbing 75% In the morning RT and in the evening AT and between them 6 h of rest	30min at 20m/ min -----	12 weeks 12 weeks 12week	AT RT CT	AT is most efficient in reducing belly fat as well as preventing glucose and insulin excess and insulin resistance.
AminiLari et al.,2017 ¹²	50%-55% MHR 50%-55% MHR Combine RT&AT with half the execution time and the same intensity	25 min 3sets x8 repetitions	12 weeks 12 weeks 12 weeks	AT RT CT	AT & CT improve insulin resistance in diabetic women. CT reduces body fat. RT, AT have a role in improving insulin sensitivity.
Ouerghi et al., 2017 ¹¹	100-110% MHR of running	30 s 8-10 repetition	8 weeks	HIIT	HIIT led to an improvement in the health of the heart and blood vessels, as well as TG, TC, LDL, and insulin resistance, a significant decrease in the obese group.
Yazdani et al., 2020 ³	High- intensity training at 90% $\text{Vo}_{2\text{max}}$ Moderate intensity training at 50%-60% $\text{Vo}_{2\text{max}}$	2min with 60s rest at 20-30 m/min 20-30 m/min	8 weeks 8 weeks	HIIT MICT	MICT is superior to HIIT in reducing blood glucose in mice with DM and improving diabetic cardiomyopathy

option than continuous training for improving metabolic health and weight loss, particularly in people with type 2 diabetes or metabolic syndrome. When compared to prolonged medium intensity exercise, HIIT again for the elderly is successful on all fronts in enhancing aerobic fitness, cardiac function, contractility, as well as insulin resistance, according to a study²¹.

High-Intensity Training

HIT is a 5-week routine that comprises two 5-minute heating and cooling phases, as well as 60 minutes of treadmill jogging at a speed of 34 m/min for five days²². In T2DM patients, CrossFit -Functional HIT (F- HIT) is beneficial in enhancing insulin sensitivity and lowering the risk of cardiac metabolism¹⁹. The lowering of insulin, glucose, and triglycerides is influenced by continuous activity that includes active intervals of sitting²³.

Although insulin resistance has indeed been believed to be the major cause of endothelial and β -cell dysfunction in the pancreas, continual moderate-intensity exercise provides a stimulus to promote endothelial and pancreatic beta-cell function. Insulin resistance decreases as a result of HIT²⁴.

Although no changes in body mass, found that after 10 weeks of high or medium-intensity training, body fat mass BFkg reduced by around 2kg and waist circumference by 3 cm²⁵. Because the visceral fat gain is connected to health problems like high blood pressure as well as insulin resistance, high-intensity training is a good approach to lose weight. After one hour of moderate-intensity training, there was a decrease in body fat mass in mice due to a high-fat diet²⁶.

Discussion

Insulin resistance has long been thought to be a precursor of T2DM. It's thought to be a risk factor for heart disease²⁰. Adopting an effective plan can help to lower the risk factors for T2DM and cardiovascular disease²³. Physical activity can help with T2DM as well as cardiovascular disease treatment and prevention¹⁹. Obesity and metabolic illnesses are caused by lifestyles defined by a lack of mobility and exercise²⁷.

Because 80 percent of diabetic patients are fat or overweight, exercise and diet are regarded as the cornerstones of obesity and diabetes management, as the usefulness of exercises for patients with T2DM as well as insulin sensitivity has been well

established²⁰. According to Tine Kartinah et al., (2018), consideration should be taken from the exercise formula in respect of frequency, intensity, kind, and time to achieve the best result for an activity²⁶.

HIIT and moderate-intensity continuous training improve glucose, insulin, and insulin resistance. However, insulin resistance is more affected after HIIT, and insulin resistance and HDL primarily improve with HIIT in patients with metabolic syndrome²¹. HIIT has been demonstrated in several trials to be equally beneficial as a continuous exercise in lowering body weight²⁶. Insulin resistance can be reduced, and glucose management can be improved by high-intensity interval training²⁰. Following HIIT, found considerable reductions in weight, insulin, and insulin resistance¹¹.

When compared to continuous medium-intensity training, HIIT has a larger effect on visceral fat adiposity in women with T2DM²⁵. Obesity caused by a high-fat diet and a sedentary lifestyle improves more quickly with HIIT than with continuous exercise¹⁵. The evidence for HIIT's impact on IR in people with T2DM and metabolic syndrome is mixed. HIIT has been demonstrated to be more beneficial than CAE in treating IR in studies²⁰. However, no differences were found between the two training procedures²⁸. In those with T2DM, F-HIIT following 6 weeks of CrossFit activity lowers body fat, insulin resistance, and heart metabolic risk¹⁹. Cardiovascular metabolic risk factors associated with T2DM prevention and therapy are improved by HIIT and short and long RT. In terms of lowering fasting glucose, insulin, and HOMA-IR, both HIIT and RT are similarly beneficial²⁹. IR reduces the responsiveness to AT, which is a preventative and therapeutic treatment for metabolic syndrome and alters risk factors²⁸.

Insulin sensitivity improved significantly after aerobic training without calorie restriction or weight reduction. It is thought to be a useful way to reduce abdominal obesity and fatty liver in obese teenage girls, as well as improve insulin resistance³⁰.

RT has no effect on blood glucose or insulin levels³⁰. When compared to RT, moderate AT is a more beneficial and time strategy to lose weight, improve insulin resistance, and improve liver enzymes. Weight, insulin resistance, and liver enzymes are unaffected by RT and AT involvement³¹. There was

no considerable link between endurance training and IR in women, according to a study provided by³². In men, however, there is a substantial link between strength training and IR. This could be attributed to men and women having different degrees of strength training and IR, with males doing more strength training than women.

Conclusion

Physical activity is a beneficial non-pharmacological approach to losing weight, lowering glucose levels, and decreasing insulin resistance in T2DM patients, according to the findings of this study. However, the impact of exercise varies depending on the type, intensity,

and duration. Insulin resistance has been shown to be improved by HIIT and HIT. Individuals should be encouraged to incorporate high-intensity physical activity into their daily routines in order to keep their physical as well as mental health in check.

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