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2018 Clinical Practice Guidelines

Physical Activity and Diabetes

Diabetes Canada Clinical Practice Guidelines Expert Committee

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KEY MESSAGES

- Moderate to high levels of physical activity and cardiorespiratory fitness are associated with substantially lower morbidity and mortality in people with diabetes.
- Both aerobic and resistance exercise are beneficial, and it is optimal to do both types of exercise. At least 150 minutes per week of aerobic exercise and at least 2 sessions per week of resistance exercise are recommended, though smaller amounts of activity still provide some health benefits.
- A number of strategies that increase self-efficacy and motivation can be employed to increase physical activity uptake and maintenance, such as setting specific physical activity goals, using self-monitoring tools (pedometers or accelerometers) and developing strategies to overcome anticipated barriers.
- For people with type 2 diabetes, supervised exercise programs have been particularly effective in improving glycemic control, reducing the need for noninsulin antihyperglycemic agents and insulin, and producing modest but sustained weight loss.
- Habitual, prolonged sitting is associated with increased risk of death and major cardiovascular events.

KEY MESSAGES FOR PEOPLE WITH DIABETES

- Physical activity often improves glucose control and facilitates weight loss, but has multiple other health benefits even if weight and glucose control do not change.
- It is best to avoid prolonged sitting. Try to interrupt sitting time by getting up briefly every 20 to 30 minutes.
- Try to get at least 150 minutes per week of aerobic exercise (like walking, bicycling or jogging).
- Using a step monitor (pedometer or accelerometer) can be helpful in tracking your activity.
- In addition to aerobic exercise, try to do at least 2 sessions per week of strength training (like exercises with weights or weight machines).
- If you decide to begin strength training, you should ideally get some instruction from a qualified exercise specialist.
- If you cannot reach these recommended levels of activity, doing smaller amounts of activity still has some health benefits.

Types of Exercise

Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (1). Exercise is planned, structured physical activity (1) (see Table 1 for definitions of key exercise terms used in this article.) **Aerobic exercise** (like walking, bicycling, swimming or jogging) involves continuous, rhythmic movements of large muscle groups, normally at least 10 minutes at a time. In this chapter, we will refer to this type of exercise as "aerobic" for simplicity, even though when performed at a very high intensity, such as with high-intensity interval training, it also involves some anaerobic metabolism. **Resistance exercise** involves brief repetitive exercises with weights, weight machines, resistance bands or one's own body weight (e.g. push-ups) to increase muscle strength and/or endurance. **Flexibility exercise** (like lower back or hamstring stretching) aims to enhance the ability to move through fuller ranges of motion. Some types of exercise, such as yoga, can incorporate elements of both resistance and flexibility exercise.

Benefits of Physical Activity

Physical activity can help people with diabetes achieve a variety of goals, including increased cardiorespiratory fitness, increased vigour, improved glycemic control, decreased insulin resistance, improved lipid profile, blood pressure (BP) reduction and maintenance of weight loss (2–5).

Randomized trials have found that supervised exercise interventions improve glycated hemoglobin (A1C) (6–8), triglycerides (TG) and cholesterol (9) in people with type 2 diabetes when compared to no exercise comparison groups (10). Cohort studies have demonstrated that, in people with type 2 (11–13), and with type 1 diabetes (14,15), regular physical activity (11–13) and/or moderate to high cardiorespiratory fitness (16) are associated with reductions in cardiovascular (CV) and overall mortality.

Randomized trials have also demonstrated that aerobic exercise training increases cardiorespiratory fitness in both type 1 and type 2 diabetes (17), and slows the development of peripheral neuropathy (18). A meta-analysis (6) found that supervised exercise interventions improved A1C in people with type 2 diabetes when compared to no exercise comparison groups. In addition, interventions involving exercise durations of more than 150 minutes per week were associated with greater A1C reductions (mean change –0.89%) than interventions involving 150 minutes or less of exercise per week (mean change –0.36%) (6). A meta-analysis of head-to-head trials comparing the effects on A1C of aerobic exercise at higher vs. lower intensity found that the interventions with higher intensity reduced A1C more than those of lower intensity (mean A1C difference –0.22%) (8). It was unclear whether the greater

Conflict of interest statements can be found on page S60.

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Table 1
Definitions of terms

Physical activity	Any bodily movement produced by skeletal muscles that results in energy expenditure above resting (basal) levels. This term broadly encompasses exercise, sport and physical activities done as a part of daily living, occupation, leisure and active transport.
Exercise	Planned, structured physical activity typically performed with the intent of improving health and/or fitness.
Aerobic exercise	Exercise that involves continuous, rhythmic movements of large muscle groups, such as walking, bicycling, swimming or jogging, normally lasting for at least 10 minutes at a time. This type of exercise depends primarily on the aerobic energy-generating processes in the body (i.e. heart, lungs, cardiovascular system and the oxidation of fuels in skeletal muscle). Moderate-intensity aerobic activities range from 3–6 metabolic equivalents (METS) and include brisk walking, dancing, light cycling, gardening and domestic chores. Vigorous-intensity activities (>6 METS) include running, climbing stairs or hill walking, fast cycling or swimming, aerobics and most competitive sports and games.
Resistance exercise	Brief repetitive exercise using weights, weight machines, resistance bands or one's own body weight (e.g. push-ups) to increase muscle strength and/or endurance.
Flexibility exercise	A form of activity, such as lower back or hamstring stretching, that enhances the ability of joints to move through their full range of motion.
Aerobic training	Exercise training involving periods of predominantly aerobic exercise activities, such as running, cycling or swimming, performed for the purpose of enhancing cardiorespiratory fitness, performance and/or health.
Resistance training	Exercise training, involving brief repetitive exercises with weights, weight machines, resistance bands or one's own body weight (e.g. push-ups) performed for the purpose of increasing muscle mass and strength. This type of exercise uses predominantly anaerobic energy-generating systems in skeletal muscle.
High-intensity interval training	A type of aerobic exercise training based on alternating between short periods of vigorous intensity exertion and periods of rest or lower-intensity exercise; commonly performed using a predominantly aerobic exercise modality, such as running or cycling.
Cardiorespiratory fitness	A health-related component of physical fitness defined as the ability of the circulatory, respiratory and muscular systems to supply oxygen during sustained physical activity. Typically measured via a treadmill or cycle ergometer test and expressed as maximal oxygen uptake (VO_2max) relative to body mass or in metabolic equivalents (METS).
Musculoskeletal fitness	Ability of skeletal and muscular systems to perform work (exercise). Muscular strength and muscular endurance are components of musculoskeletal fitness.
Cardiorespiratory endurance	Ability of the heart, lungs and circulatory system to supply oxygen to working muscles efficiently.
Muscular strength	Maximal force or tension level produced by a muscle or muscle group.
Muscular endurance	Ability of muscle to maintain submaximal force levels for extended periods.
Physical fitness	Ability to perform occupational, recreational and daily activities without undue fatigue. A set of measureable health and skill-related attributes that include cardiorespiratory fitness, muscular strength and endurance, body composition, flexibility, balance, agility, reaction time and power.
Maximum oxygen uptake (VO_2max)	Maximum rate of oxygen utilization during exercise.
METS	The ratio of a person's working (exercising) metabolic rate to the resting metabolic rate. One MET is equivalent to the energy expended while sitting at rest.
Sedentary behaviour	An "activity" that involves little or no movement, with an energy expenditure ranging between 1-1.5 METS. Examples include sitting, watching TV, working on a computer, reclining while awake and driving.

benefits of higher-intensity exercise were limited to studies using high-intensity interval training (see next section on interval training).

In contrast to trials in type 2 diabetes, most clinical trials evaluating exercise interventions in adults with type 1 diabetes have not demonstrated a beneficial effect of exercise on glycemic control (19), but 2 recent meta-analyses found that aerobic training lowered A1C in children and youth with type 1 diabetes by 0.5% and 0.85% respectively (20,21), while also lowering body mass index (BMI), TG and total cholesterol levels. A recent large cross-sectional study of 18,028 adults with type 1 diabetes reported an inverse association between physical activity levels and A1C, diabetic ketoacidosis (DKA), BMI and a number of diabetes-related complications, including dyslipidemia, hypertension, retinopathy and microalbuminuria (22). There are no published trials evaluating the effects of exercise training on quality of life in type 1 diabetes.

Benefits of Interval Training

High-intensity interval training involves alternating between short periods of higher and lower-intensity exercise (see Exercise Prescription Examples). High-intensity interval training leads to greater gains in cardiorespiratory fitness in people with or without diabetes (23,24), and improves glycemic control in some studies of people with type 2 diabetes compared to continuous moderate-intensity exercise (24–26).

In people with type 1 diabetes, high-intensity interval exercise appears to be associated with less risk for hypoglycemia than continuous aerobic exercise, at least during the time of the activity (27,28,29). To date, the risks of high-intensity interval training seem comparable to moderate-intensity continuous exercise in previously screened participants with relatively good glycemic control; however, most studies have been small and underpowered (8). A small trial in women with type 2 diabetes (n=17) found that twice-weekly high-intensity interval training reduced abdominal fat (–8.3%) and visceral fat (–24.2%) significantly, but continuous aerobic exercise did not.

Benefits of Resistance Exercise

Resistance training in adults with type 2 diabetes improves glycemic control (as reflected by reduced A1C), decreases insulin resistance and increases muscular strength (30), lean muscle mass (31) and bone mineral density (32,33), leading to enhanced functional status and prevention of sarcopenia and osteoporosis. The optimal resistance training program has not been clearly established in terms of frequency, intensity, type and volume (34). The greatest impact