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Recommendations for Prescribing Exercise to Patients with Diabetes

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Effects of Exercise

Regular exercise has been shown to improve blood glucose control, reduce cardiovascular risk, contribute to weight loss, and improve well being. Furthermore, regular exercise may prevent Type 2 Diabetes Mellitus (T2DM) in high-risk individuals. Moderate-intensity (e.g. brisk walking) to vigorous-intensity exercises of ≥150 mins per week have been proven to confer significant benefits in the prevention of T2DM onset (a risk reduction of 46% in the Da Qing Study in mainland China, and by 58% in the Diabetes Prevention Program in the United States) (1-3). Recent follow-up studies suggest that this risk reduction can be sustained over a prolonged period (4). Structured exercise interventions of at least 8 weeks' duration have been shown to lower A1C by an average of 0.66% in people with T2DM, even with no significant change in body mass index (5). While higher levels of exercise intensity are associated with greater improvements in A1C and fitness, milder forms of physical activities, like yoga and tai chi, may also benefit control of blood glucose (6-9).

Progressive resistance exercise improves insulin sensitivity in older men with T2DM to the same or even greater extent as aerobic exercise (10). Clinical trials have provided strong evidence for the A1C-lowering value of resistance exercise in older adults with T2DM and for an additive benefit of combined aerobic and resistance exercise in adults with T2DM (11-13). Resistance exercise also enhances skeletal muscle mass and endurance, and hence may reduce the risk of fall in these elderly (14).

Recommendations for Exercise Prescription

The *Global Recommendations on Physical Activity for Health* published by the World Health Organisation in 2010 specify that adults over 18 years of age should perform at least 150 mins per week of moderate-intensity or 75 mins per week of vigorous-intensity aerobic physical activity or an equivalent combination of the two. The recommendations further suggest adults to perform muscle-strengthening activities involving all major muscle groups 2 or more days per week. Adults over 65 years of age are advised to follow the adult recommendations if possible or (if this is not possible) be as physically active as they are able. Studies included in the meta-analysis of effects of exercise interventions on glycaemic control had a mean number of sessions per week of 3.4, with a mean of 49 mins per session (5). The Diabetes Prevention Program lifestyle intervention, which involved 150 mins per week of moderate-intensity exercise, had a beneficial effect on glycaemic control in those with pre-diabetes (1). Therefore, it seems reasonable to recommend people with T2DM to follow the same physical activity recommendations for the general population.

The following table summarises the exercise prescription that is recommended for patients with T2DM.

	Recommendations*
Frequency	• Perform aerobic exercise spread out at least 3 days during the week, with no more than two consecutive days between bouts of activity (14). • Undertake resistance exercise at least twice weekly on nonconsecutive days, but more ideally 3 times a week, along with regular aerobic exercise (14).
Intensity	• Aerobic exercise should be at least at moderate intensity (e.g. brisk walking), corresponding approximately to 40%–60% of maximal aerobic capacity (VO_{2max}) (14). Relatively, moderate-intensity activity could be expressed as a level of effort of 5 or 6 on a scale of 0 to 10 (where 0 is the level of effort of sitting, and 10 is maximal effort) or 50–70% of maximum heart rate (15-17). • Additional benefits may be gained from vigorous-intensity aerobic exercise (i.e. >60% of VO_{2max}) (14). Relatively, vigorous-intensity activity could be expressed as a level of effort of 7 or 8 on a scale of 0 to 10 or 70–90% of maximum heart rate (15-16). • Resistance exercise should be moderate (>50% of 1-repetition maximum, i.e.1-RM – maximum amount of weight one can lift in a single repetition for a given exercise) or vigorous (75–80% of 1-RM) at intensity (14).

Time	• 20 to 60 mins per day of aerobic exercise should be performed continuously or intermittently in bouts of at least 10 mins accumulated to total 150 mins per week (14, 18). • 3 sets of 8–10 repetitions on 8–10 exercises involving the major muscle groups may be an optimal goal for resistance exercise (14).
Type	• A variety of modes of aerobic exercise is recommended but any form (including brisk walking) that uses large muscle groups and causes sustained increases in heart rate (HR) is likely to be beneficial (14). Exercises like walking, swimming or cycling that do not impose undue stress on the feet are some appropriate choices. • Each session of resistance exercise should involve the major muscle groups (legs, hips, chest, back, abdomen, shoulders, and arms). According to the literature, resistance exercise programme involving a combination of bench press, leg extension, upright row, lateral pull-down, standing leg curl (ankle weights), dumbbell seated shoulder press, dumbbell seated biceps curl, dumbbell triceps kickback, and abdominal curls has been shown to improve glycaemic control in older adults with T2DM (11).

* Given that many patients may present with comorbidities, it may be necessary to tailor the exercise prescription accordingly.

Initial instruction and periodic supervision by a qualified exercise trainer is recommended for most persons with T2DM, particularly if they undertake resistance exercise, to ensure optimal benefits to blood glucose control, blood pressure, lipids, and cardiovascular risk and to minimise injury risk (19).

Rate of Progression

Gradual progression of intensity of aerobic exercise is advisable to minimise the risk of injury, particularly if health complications are present, and to enhance compliance (14). Points to be taken into consideration in exercise prescription include age, ability, disease state, and individual preference of type of exercise. In general, the elderly and obese patients with T2DM take longer time for adaptation and may require slower progression, though it is advisable for the aged to be as physically active as possible.

Similarly, to avoid injury, progression of frequency and intensity of resistance exercise should occur slowly. Increases in weight or resistance are undertaken first and only once when the target number of repetitions per set can consistently be exceeded, followed by a greater number of sets and lastly by increased frequency (14). Early in training, each session of resistance exercise should minimally include 5–10 exercises and involve completion of 10–15 repetitions to near fatigue per set, progressing over time to heavier weights (or resistance) that can be lifted only 8–10 times. A minimum of one set of repetitions to near fatigue for each exercise, but as many as 3 to 4 sets, is recommended for optimal strength gains (14).

Evaluation of the Diabetic Patient Before Recommending an Exercise Programme

Medical practitioners should use clinical judgment in this area. Certainly, high-risk patients should be encouraged to start with short periods of low-intensity exercise and to increase the intensity and duration slowly. Medical practitioners should assess patients for conditions that might contraindicate certain types of exercise or predispose to injury, such as uncontrolled hypertension, severe autonomic neuropathy, severe peripheral neuropathy or history of foot lesions, and unstable proliferative retinopathy as well as take into consideration patients' age and previous physical activity levels (17).

Exercise stress testing is not routinely recommended to detect ischaemia in asymptomatic individuals at low coronary heart disease (CHD) risk (<10 % in 10 yrs.). It is advised primarily for sedentary adults with diabetes who are at higher risk for CHD and who would like to undertake activities more intense than brisk walking, e.g. age > 40, concomitant risk factors such as hypertension, microalbuminuria, etc., or presence of advanced cardiovascular or microvascular complications (e.g. retinopathy, nephropathy) (14).

Exercise in the Presence of Non-optimal Glycaemic Control

◢ Hyperglycaemia

When people with type 1 diabetes are deprived of insulin and are ketotic, exercise can worsen hyperglycaemia and ketosis; therefore, vigorous activity should be avoided in the presence of ketosis (20). On the other hand, T2DM subjects usually are not profoundly insulin-deficient. They do not have to postpone exercise simply because of high blood glucose (e.g. > 16.7 mmol/L), as long as they feel well, and are adequately hydrated without ketosis (14).

◢ Hypoglycaemia

In individuals with T2DM performing moderate exercise, blood glucose utilisation by muscles usually rises more than hepatic glucose production, and blood glucose levels tend to decline. Plasma insulin levels normally fall, however, making the risk of exercise-induced hypoglycaemia in anyone not taking insulin or insulin secretagogues very minimal, even with prolonged physical activities (14). In individuals taking insulin and/or insulin secretagogues (e.g. sulfonylureas like glyburide, glipizide, and glimepiride, as well as nateglinide and repaglinide), physical activity can cause hypoglycaemia if medication dose or carbohydrate consumption is not altered. For individuals on these therapies, added carbohydrate should be ingested if pre-exercise glucose levels are <5.6 mmol/l (21-22). Hypoglycaemia is rare in diabetic individuals who are not treated with insulin or insulin secretagogues, and no preventive measures for hypoglycaemia are usually advised in these cases.

Exercise in the Presence of Specific Long-term Complications of Diabetes

◢ Retinopathy

In the presence of proliferative diabetic retinopathy or severe non-proliferative diabetic retinopathy, vigorous aerobic or resistance exercise may be contraindicated because of the risk of triggering vitreous haemorrhage or retinal detachment (23).

◢ Peripheral neuropathy

Decreased pain sensation in the extremities results in increased risk of skin breakdown and infection and of Charcot joint destruction and this is why some prior recommendations have advised non-weight-bearing exercise for patients with severe peripheral neuropathy. Studies have shown that moderate-intensity walking may not lead to increased risk of foot ulcers or re-ulceration in those with peripheral neuropathy (24). Individuals with peripheral neuropathy and without acute ulceration may participate in moderate weight-bearing exercise (14). Comprehensive foot care including daily inspection of feet and use of proper footwear is recommended for prevention and early detection of sores or ulcers (14). Anyone with a foot injury or open sore should confine themselves to non-weight-bearing activities.

◢ Autonomic neuropathy

Autonomic neuropathy can increase the risk of exercise-induced injury or adverse events through decreased cardiac responsiveness to exercise, postural hypotension, impaired thermoregulation, impaired night vision due to impaired papillary reaction, and unpredictable carbohydrate delivery from gastroparesis predisposing to hypoglycaemia (25). Autonomic neuropathy is also strongly associated with cardiovascular disease in people with diabetes (26-27). People with diabetic autonomic neuropathy should be screened and receive physician approval and possibly an exercise stress test before embarking on physical activity levels more intense than usual. Exercise intensity is best prescribed using the HR reserve method with direct measurement of maximal HR (14).

◢ Albuminuria and nephropathy

Physical activity can acutely increase urinary protein excretion. However, there is no evidence that vigorous exercise increases the rate of progression of diabetic kidney disease and likely no need for any specific exercise restrictions for people with diabetic kidney disease (28). Exercise increases physical function and quality of life in individuals with kidney disease and may even be undertaken during dialysis sessions.

Special Precautions

- Encourage patients with T2DM to monitor their blood glucose level before and after exercise session, especially when beginning an exercise programme. This allows the patient to understand their glucose response to the particular physical activity.
- Encourage patients to keep log with the exercise intensity, duration and type. It helps them know their glucose response to the exercise sessions.
- Encourage patients to exercise with partners, especially when beginning an exercise programme until the patient know very well their glucose response to the exercise sessions.

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