

Physical activity in type 1 diabetes mellitus

Assessing risks for physical activity clearance and prescription

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Diabetes mellitus is a multifaceted condition of metabolic dysregulation, manifesting as a chronically elevated blood glucose concentration with associated disturbances in carbohydrate, lipid, and protein metabolism. In contrast to type 2 diabetes, which is caused primarily by an obesity-associated reduction in secretion of and sensitivity to insulin, type 1 diabetes is characterized by insulin deficiency that results from disruptive autoimmune-based lesions of the pancreatic beta cells. Type 1 diabetes accounts for some 10% of the 2 million to 2.5 million Canadians with diabetes.¹ There is currently no known cure for type 1 diabetes; disease management requires regular exogenous insulin injections and careful dietary management throughout everyday life. Physical activity (PA) has clear beneficial effects on glycemic control in patients with prediabetes or type 2 diabetes, and it is a recommended component of preventive and management therapies.² But most clinical trials of exercise interventions in type 1 diabetes do not demonstrate equally favourable effects on glycemic control.³ Nevertheless, all-cause mortality rates across a 7-year period were approximately 50% lower in patients with type 1 diabetes who reported more than 8 MJ per week of PA (equivalent to about 7 hours a week of purposeful walking) than in those who reported less than 4 MJ per week of PA.⁴ It is likely that regular PA has a positive effect on overall health in individuals with type 1 diabetes through modification of elevated comorbid risk factors that predispose to cardiovascular disease, cerebrovascular disease, kidney disease, neuropathy, retinopathies, blindness, and limb amputations. Recent Canadian Diabetes Association guidelines stress the importance of regular PA in the management of type 1 diabetes, as it improves cardiorespiratory fitness and psychological status.⁵

Cardiovascular and cerebrovascular events and sudden death while engaging in vigorous PA are important concerns for patients with type 1 diabetes who are seeking to initiate PA programs or to increase PA greatly beyond their habitual levels. Some anecdotal evidence suggests that vigorous exercise might aggravate any underlying microvascular disease (retinopathy, nephropathy, etc). Limited epidemiologic evidence suggests that, when exercising, patients with diabetes have at least twice the average age-related risk of mortality and morbidity from myocardial infarction⁶; however, data on the true risks of exercise in this patient population appear incomplete. Typically, patients with type 1 diabetes tend to be leaner, younger, and more physically active compared with patients with

type 2 diabetes, but the risk of coronary artery disease nevertheless appears to be similarly high.^{7,8} The extent of glycemic control is highly predictive of cardiovascular risk: glycosylated hemoglobin levels greater than 7% are associated with a magnification of risk.⁸ Moreover, as longevity has increased in all patient populations, it is unclear if the risks of exercise might increase with disease duration or age in type 1 diabetes.

This article provides an executive summary of findings from a systematic review of the risks of PA in type 1 diabetes.⁹ It is one in a comprehensive series of reviews examining the risks of PA in patients with various chronic diseases. The evidence thus obtained provides the foundation for new tools that will simplify the tasks of exercise clearance and prescription: the revised Physical Activity Readiness Questionnaire (PAR-Q+) and the electronic Physical Activity Readiness Medical Examination (ePAR-med-X+).¹⁰ We present decision trees that facilitate the family physician's tasks of screening patients for PA participation and providing risk-appropriate PA prescription.

Discussion

Comprehensive examination of the literature on type 1 diabetes mellitus shows that the most common PA-related adverse event is hypoglycemia; this might develop either during or up to 24 hours following a bout of PA. The effects are potentially serious, with a risk of loss of consciousness and even death, but the severity of most reported cases has been mild. A number of tactics can be adopted to reduce the likelihood of exercise-induced hypoglycemia, including nutritional supplementation and insulin dose adjustments⁵; moreover, the frequency of events seems to decrease with physical training.¹¹ Our review offered no evidence of any PA-related deaths in those with type 1 diabetes and a very low incidence of non-life-threatening adverse events (dysglycemia, musculoskeletal injury, etc), suggesting that the commonly adopted prescriptions of mild to moderate PA present a low level of risk. However, the number of published investigations examining physical training for patients with type 1 diabetes mellitus remains quite small, and by far most participants included

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in these studies underwent careful pre-activity screening (with a particular emphasis on cardiovascular risk). This limitation of the current evidence base does not allow for the categorical assertion that PA is “risk free” for those with type 1 diabetes, but the rarity of reported adverse events provides some degree of evidence that, to date, prescreening has been effective. Owing to the increased possibility of underlying macrovascular and microvascular disease, patients should be screened for specific signs and symptoms of cardiovascular disease, and they might require further evaluation by a specialist before beginning a PA program. Individual risk factors are determined by such characteristics as age, disease progression, overall glycemic control, medications, and current lifestyle. **Table 1** presents specific recommendations about the risk of adverse events during PA in type 1 diabetes. The decision tree for PA screening and general risk classification (**Figure 1**) is based on these recommendations and specific contraindications. It seems likely that the risk of

an adverse event during PA in patients with type 1 diabetes is elevated acutely when PA programs are first initiated, particularly if the activity is vigorous; however, as exposure to PA becomes habitual, the risk of adverse events is expected to decrease, much as it does in both patients with type 2 diabetes and healthy patients.

Conclusion

Because of an imperfect blood glucose regulatory capacity, patients with type 1 diabetes mellitus are at increased risk of adverse responses to exercise when compared with healthy individuals; however, the risks of PA can be largely controlled with careful screening, pre-exercise preparation, and appropriate exercise prescription. Because patients with type 1 diabetes who are physically more active have a lower overall risk of cardiovascular events than their sedentary counterparts, we conclude that this long-term benefit more than compensates for the minor increase in acute risk when PA programs are initiated. Moreover, current evidence suggests that the acute risks of PA-related adverse events are low. Carefully prescreening patients using the new decision tools presented in this article will further ensure the safety and effectiveness of prescribed exercise.

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Competing interests

None declared

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Table 1. Physical activity and exercise recommendations for prescreening of patients with type 1 diabetes mellitus

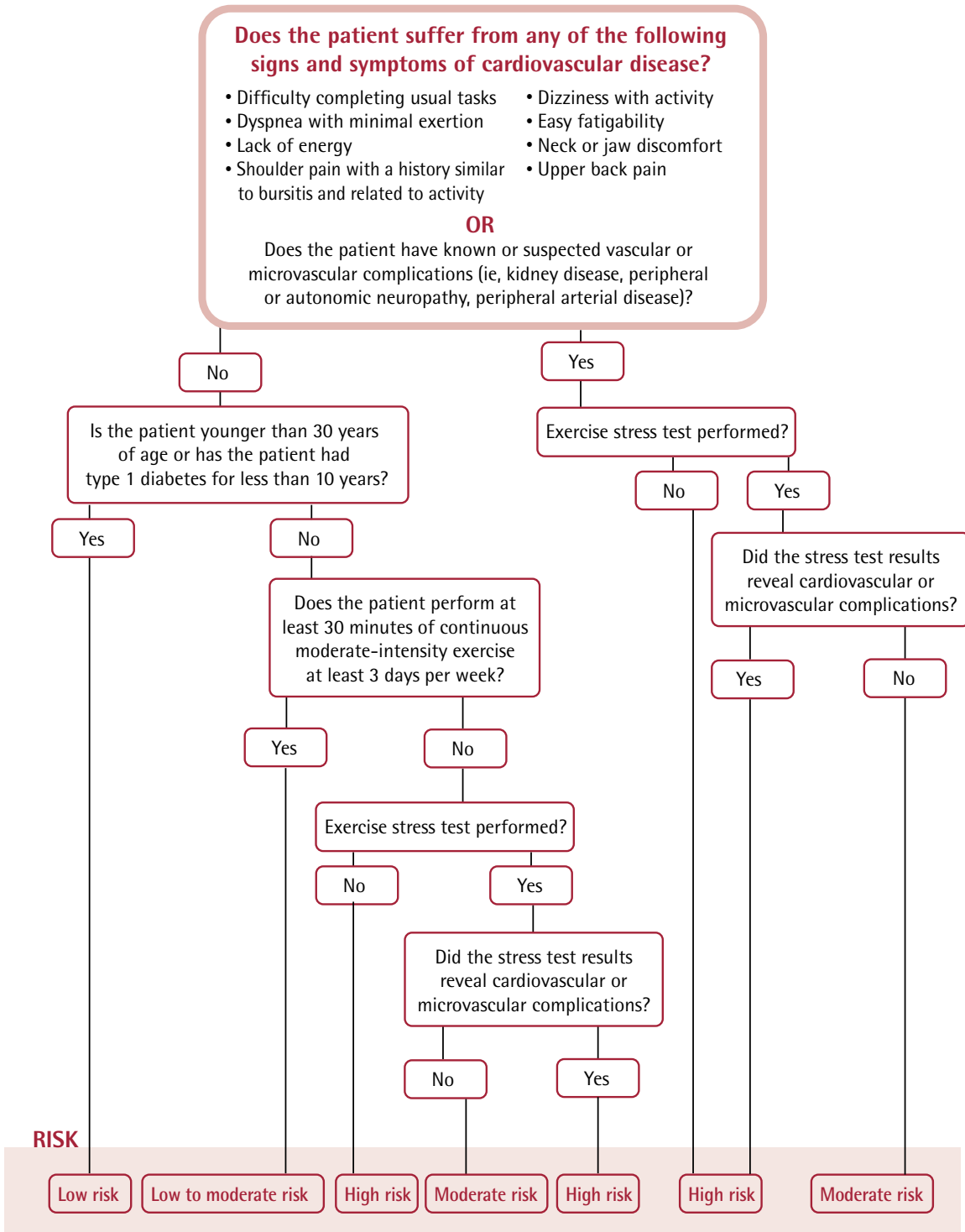
RECOMMENDATION	LEVEL*	GRADE†
For all individuals with type 1 diabetes, vigilance is required to limit PA-associated hypoglycemia, as the risk for this adverse event can be high	2	A
Individuals with signs and symptoms of CVD should be sent for CVD screening before the initiation of a new exercise program more vigorous than brisk walking	3	C
No exercise restrictions should be placed on previously sedentary persons with type 1 diabetes younger than 30 years of age (or those older than 30 years of age who have had diabetes for less than 10 years) and who are free from symptoms of CVD and diabetes-related complications, as the risk for clinically significant adverse events (except for hypoglycemia) is low	3	C
For previously sedentary patients with type 1 diabetes older than 30 years of age (and those who have had diabetes for 10 years or longer) or with any diabetes-related complications (microvascular or macrovascular), exercise programming of activities more vigorous than walking should be suspended until medical assessment is complete, which might include exercise stress testing for the evaluation of CVD	4	C
Individuals with excessive hyperglycemia (fasting blood glucose >15 mmol/L) and elevated ketone levels in their urine (ketonuria) should refrain from initiating vigorous exercise until glycemic control is reestablished	4	C

CVD—cardiovascular disease, PA—physical activity.

*Level I evidence includes randomized controlled trials; level II evidence includes randomized controlled trials with important limitations or observational trials with overwhelming evidence; level III evidence includes observational trials; and level IV evidence includes anecdotal evidence or expert opinion.

†Grade A recommendations are strong; grade B recommendations are intermediate; and grade C recommendations are weak.

Figure 1. Clinical decision tree for assessing the risk of adverse events during PA in patients with type 1 diabetes mellitus. *This decision tree can be used to categorize a patient as high, moderate, or low risk, informing the requirements of PA prescription and the monitoring of exercise programs.*



PA—physical activity.