CLINICAL FOCUS SERIES

Diabetes Mellitus

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CHAPTER 1

Exercise and Diabetes: Personal Prescriptions

Sheri R Colberg

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INTRODUCTION

Implementing and maintaining a physical activity program is a cornerstone of diabetes self-management, especially for those with type 2 diabetes mellitus (T2DM) or gestational diabetes who need to enhance insulin action. In fact, physical activity may prevent or reverse "double diabetes" in anyone with type 1 diabetes mellitus (T1DM), which can result from insulin resistance related to a sedentary lifestyle and weight gain.[1]

It is recommended that healthcare providers use the broader term "physical activity" in place of the narrower term "exercise" because many types of movements have been proven to have a positive impact on both health and physical fitness. More than one type of physical activity may be required to gain optimal glycemic and health benefits.[2]

The purpose of this chapter, therefore, is to recommend the types and quantities of physical activities that can and should be undertaken by people with diabetes, as well as appropriate precautions related to medication use and diabetes-related health complications.

PRE-EXERCISE EVALUATION

Safe exercise participation can be complicated by the presence of diabetes-related health complications like cardiovascular disease, hypertension, neuropathy, or microvascular changes.[3] Nevertheless, no current evidence suggests that any screening protocol beyond usual diabetes care reduces risk of exercise-induced adverse events in asymptomatic individuals with diabetes.[4,5] Thus, pre-exercise medical clearance is not necessary for asymptomatic individuals receiving diabetes care consistent with guidelines who wish to begin low- or moderate-intensity physical activity not exceeding the demands of brisk walking or everyday living. However, some individuals desiring to exercise at a higher intensity (more vigorous than brisk walking) or with greater cardiovascular risk may benefit from referral to a healthcare provider for a checkup and possible exercise stress test before starting such activities.[6]

Assessments may include a graded exercise test depending on the age of the person, diabetes duration, and the presence of additional cardiovascular disease risk factors.[7,8] Although exercise stress testing may be done on anyone, most young individuals with a low cardiovascular disease risk may not benefit from doing it, and even the systematic detection of silent ischemia (using exercise testing or other methods) in high-risk asymptomatic patients with diabetes is unlikely to predict cardiovascular disease-related events or early mortality when risk is controlled with medical treatment. Exercise testing, therefore, should rarely be mandatory.[4]

DAILY MOVEMENT

For individuals with diabetes, many of whom are physically unfit and sedentary; it may be beneficial to start by encouraging them to find ways to incorporate more unstructured physical activity into daily living.[8] Both high levels of sedentary time and low levels of moderate to vigorous physical activity are strong and independent predictors of early death from any cause in adults ages 50 years or older.[9] Physical activity during weight loss also prevents weight regain in this population.[10]

EXERCISE PRESCRIPTION BY TYPE OF ACTIVITY

Prescribed exercise should meet the individual's unique preferences, lifestyle, and desired physical fitness and other health-related goals. For most with diabetes, exercise acutely reduces blood glucose levels and can be undertaken safely. Initial instructions and periodic supervision by a qualified exercise trainer is recommended for most beginning exercisers undertaking structured exercise programs, particularly resistance exercise training, to ensure optimal health benefits and to minimize injury risk.[11] Overall exercise recommendations by type are summarized in table 1.[12]

Aerobic Exercise

Cardiorespiratory or aerobic exercise is defined as continuous, dynamic exercise that uses large muscle groups and requires aerobic metabolic pathways to sustain the activity and includes activities like walking, jogging, biking, swimming, and cycling.[13] Aerobic exercise has been the mode traditionally prescribed for T2DM management and prevention, although it carries many health benefits for people with any type of diabetes.

Type of Aerobic Activity

Although walking is the most commonly prescribed exercise, undertaking a variety of modes of physical activity is recommended.[14] When people have comorbid health issues like peripheral neuropathy, obesity, and osteoarthritis, low-impact or nonweight-bearing types of activity (e.g., cycling, swimming, and aquatic or chair exercises) may be a better alternative.[6]

Intensity of Aerobic Activity

Moderate to vigorous intensity physical activity is generally recommended to achieve greater aerobic fitness and metabolic improvements.[6,13,14] For most people with T2DM, brisk walking is a moderate-intensity exercise. While more cardiovascular benefits may be gained by engaging in exercise, beginning exercisers should be encouraged to start

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TABLE 1: Physical activity and exercise training recommendations for people with diabetes[12]

	Aerobic	Resistance	Flexibility and balance
Type of exercise	• Prolonged, rhythmic activities using large muscle groups (e.g., walking, swimming, cycling, etc.) • May be done continuously or as high-intensity interval training	• Resistance machines, free weights, resistance bands, and/or body weight as resistance exercises	• Stretching: Static, dynamic, and other stretching, yoga • Balance (for adults ages 50+): Practice standing on one leg; exercises using balance equipment; lower-body and core resistance exercises; tai chi
Intensity	• Moderate to vigorous (subjectively experienced as "moderate" to "very hard")	• Moderate (e.g., 15 repetitions) to vigorous (e.g., 6–8 repetitions)	• Stretch to the point of tightness or slight discomfort • Balance exercises light to moderate intensity
Duration	• At least 150 min/week at moderate-to-vigorous intensity for most adults with diabetes. For adults able to job steadily at 6 miles per hour (9.7 km/h) for 25 minutes, 75 minutes/week of vigorous activity may provide similar benefits	• At least 8–10 exercises with completion of 1–3 sets of 10–15 repetitions to near fatigue per set on every exercise early in training	• Hold static or do dynamic stretch for 10–30 s; 2–4 repetitions of each exercise • Balance training can be any duration
Frequency	• 3–7 days/week, with no more than two consecutive days without exercise	• A minimum of 2 nonconsecutive days/week, but preferably 3	• Flexibility: ≥2–3 days/week • Balance: ≥2–3 days/week
Progression	• A greater emphasis should be placed on vigorous exercise if fitness is a primary goal and not contraindicated; both high-intensity interval and continuous exercise training may be appropriate activities for most individuals with diabetes	• Intensity should be moderate to start, involving 10–15 repetitions per set, with increases in weight or resistance undertaken with a lower number of repetitions (8–10) only after the target number of repetitions per set can be exceeded; increase in resistance can be followed by a greater number of sets and lastly by increased training frequency	• Continue to work on flexibility and balance training, increasing duration and/or frequency to progress over time

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at an easy-to-moderate pace, particularly since a low fitness level limits self-efficacy and is a perceived barrier to exercise participation.[15,16] When matched for energy cost, prolonged continuous low- to moderate-intensity aerobic exercise training is equally effective as moderate- to high-intensity training in improving overall glycemic control.[17]

For individuals already exercising moderately, undertaking some vigorous physical activity in place of moderate activity will likely result in additional health benefits.[18] For example, interspersing some faster intervals during an aerobic training session, particularly a lower intensity one, may increase fitness gains.[19] A recent training trend is low-volume high-intensity interval training (HIIT), which involves short bursts of very intense activity interspersed with longer periods of recovery at low to moderate intensity.[20,21] However, its safety and efficacy remain unclear for some adults with diabetes.[22,23] Before undertaking such training, people should be clinically stable and likely be supervised at least initially.[24] The risks with advanced disease are unclear,[24] and continuous, moderate-intensity exercise may be safer.[25]

Estimating exercise intensity using heart rate: Exercise intensity can be estimated by using heart rate measures. Recommended exercise intensity ranges from 40 to 89% of heart rate reserve (HRR, where HRR equals maximal minus resting heart). Intensity can be most accurately prescribed when a maximal heart rate is measured during an exercise stress test. The HRR formula is commonly used to calculate heart rate targets or ranges (see example in box 1). In general, moderate aerobic exercise corresponds to a HRR range of 40–59%, while vigorous exercise is 60–89% of HRR.

Target heart rate = (HRR × Desired intensity percentage) + Resting heart rate

If the actual maximal heart rate cannot be measured, target ranges can be formulated using an estimated maximal heart rate using one of the following:

Estimated maximal heart rate = 220 – Age (years)

Estimated maximal heart rate = 208 – (0.7 × Age)

The latter equation is usually more accurate in older adults; however, either equation may overestimate or underestimate maximal heart rate in some adults, particularly in

Box 1: Example using heart rate reserve to determine target heart rate range

- Patient: 50-year-old female
- Resting HR: 70 beats/min
- Maximum HR: 170 beats/min (estimated from formula, 220 – Age)
- Formula for sample calculation: Target HR = [(Max HR – Resting HR) × Desired intensity)] + Resting HR
- Lower end of HR range (40%) (Moderate) = [(170 – 70) × 0.40] + 70
  = [100 × 0.40] + 70
  = 40 + 70
  = 110 bpm
- Higher end of HR range (85%) (Vigorous) = [(170 – 70) × 0.85] + 70
  = [100 × 0.85] + 70
  = 85 + 70
  = 155 beats/min
- Target HR range (40–85% HRR) = 110–155 beats/min

HRR, heart rate reserve; HR, heart rate.

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anyone with autonomic neuropathy.[6] With autonomic neuropathy, intensity is better prescribed with maximal heart rate measured directly as it may be blunted.[26] Exercise intensity can also be monitored subjectively, with reasonable validity.[26,27]

Duration of Aerobic Activity

Exercise energy expenditure is a function of both duration and intensity. For caloric and glycemic benefits, a lower intensity exercise would need to be performed for longer periods of time compared to higher intensity sessions, although physical activity may be broken down into multiple sessions throughout the day and still lead to a cumulative effect.[2,13,14] Deconditioned individuals may need to start with more sessions of short duration (5–10 minutes), begin at low levels (i.e., 30–39% HRR) with brief rest intervals, and progress slowly to doing longer durations or higher intensity exercise.

It is recommended that most adults with diabetes engage in at least 150 minutes per week of aerobic activity done at a moderate to vigorous intensity, with a goal of approximately 30 minutes per day or more, most days of the week.[12] For adults able to jog steadily at 6 miles per hour (9.7 km/h) or faster for 25 minutes, 75 minutes per week of vigorous activity may provide similar cardioprotective and metabolic benefits. These include engaging in 60 minutes per day or more of moderate- or vigorous-intensity aerobic activity, with vigorous, muscle-strengthening, and bone-strengthening activities included at least 3 days per week.[14]

Frequency of Aerobic Activity

Since the duration of increased insulin action after an exercise session is usually greater than 24 hours but less than 72 hours, regular physical activity is needed for it to continue to lower blood glucose in people with insulin resistance.[28,29] Daily exercise, or at least not allowing more than 2 days to elapse between exercise sessions, is recommended to decrease insulin resistance, regardless of diabetes type.[20,21] For weight loss, the American College of Sports Medicine recommends 225–420 minutes of moderate-intensity aerobic exercise per week to lose 5–7.5 kg,[30] which can be divided into 5 or 6 sessions per week.

Progression of Aerobic Activity

Initially, adults should be advised to focus on increasing frequency and duration of exercise, rather than intensity, to reach target volumes of physical activity slowly over 4–6 months.[31,32] Doing so increases the likelihood of creating and sustaining an activity habit. Beginning exercise at an intensity that is too high and progressing too quickly can both lead to higher dropout and injury rates.[31,32]

Resistance Training Prescription

Given that diabetes is an independent risk factor for low muscular strength[33] and accelerated decline in muscle strength and functional status,[34] the primary goal of resistance or strength training in this population is increased muscular fitness, including both muscular strength and endurance.

Resistance exercise has also been shown to improve glycemic control, possibly even more so than aerobic training in adults with T2DM, particularly in the early stages.[35] In adults with T1DM, the effects on overall glycemic control levels are more variable,[20] although immediate declines in blood glucose are less during such training sessions.[36] Resistance training can also prevent falls and increase mobility in older adults, allowing

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them to remain more independent and self-sufficient for longer.[37] Moreover, coronary ischemia is less likely to occur during resistance compared to aerobic exercise eliciting the same heart rate, and resistance exercise may not induce ischemia.[38]

Type of Resistance Activity

Resistance exercises include weight lifting, use of resistance machines, and free weights (e.g., dumbbells and barbells) can result in fairly equivalent gains in strength and mass of targeted muscles.[39] However, heavier weights or resistance may be needed for optimization of insulin action and blood glucose control.[40]

Intensity of Resistance Activity

The prescribed resistance is determined by the individual's one-repetition maximum (1-RM), defined as the maximal amount of weight successfully lifted one time. Training should ideally be moderate (50% of 1-RM) or vigorous (75–80% of 1-RM) to optimize gains in strength and insulin action;[2,13] lighter weights are not as effective. Home-based resistance training is adequate for maintaining muscle mass and strength, but less effective than supervised, gym-based training for improving blood glucose control and optimizing insulin action.[39,40]

Duration of Resistance Activity

Resistance exercises should ideally be performed to fatigue during each set and consist of 10 to 15 repetitions to near fatigue per set early in training, progressing over time to heavier weights (or resistance) that can be lifted only eight to ten times.[2] A minimum of 1 set of repetitions to near fatigue, but as many as 3 to 4 sets, is recommended for optimal strength gains. Individuals should perform at least 8 to 10 exercises that cover all of the major muscle groups in the upper body, lower body, and core.[14]

Frequency of Resistance Activity

Resistance exercise should be undertaken at least twice weekly on nonconsecutive days,[13,14,41] but more ideally three times a week,[42,43] along with regular aerobic activities. Adequate rest periods between sets during a workout session should be included.

Progression of Resistance Activity

To avoid injury and burnout, the intensity, frequency, and duration of training sessions should progress slowly, particularly for people new to exercise or with a low fitness level or multiple perceived barriers to being active.[15] In most progressive training, increases in weight or resistance are undertaken only once the target number of repetitions per set can consistently be exceeded, followed by a greater number of sets and lastly by increased training frequency. Progression over 6 months to thrice weekly sessions of 3 sets of 8 to 10 repetitions done at 75–80% of 1-RM on 8 to 10 exercises may be an optimal goal for most adults.[42]

Combined Aerobic and Resistance Training

Prescribing both aerobic and resistance exercise training is recommended. Combined training thrice weekly in individuals with T2DM may be of greater benefit to glycemic control than either aerobic or resistance exercise alone.[44-47]

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Flexibility and Balance Training

Flexibility and balance exercises are likely equally important for health and well-being, particularly in older adults with diabetes. Limited joint mobility resulting in part from formation of advanced glycation end-products, which accumulate during normal aging, are accelerated by the presence of hyperglycemia.[48] Stretching increases range of motion around joints and flexibility,[49] but does not affect glycemic control. Such exercise should be undertaken regularly, although not necessarily as a substitute for other types of training.[6]

Traditional static and dynamic stretching, as well as yoga and tai chi, can provide fitness benefits, as can balance training. With basic stretching as part of the activity, yoga has the potential to improve glycemic control, lipid levels, and body composition in adults with T2DM,[50] whereas tai chi training may improve glycemic control, balance, neuropathic symptoms, and some dimensions of quality of life (QOL) in adults with diabetes and neuropathy.[51] Flexibility exercise combined with resistance training can increase joint range-of-motion in individuals with diabetes and allow them to more easily engage in activities that require flexibility.[49] Older adults with diabetes should also undertake exercises that maintain or improve balance.[14,41] Balance training can reduce falls risk by improving balance and gait, even with peripheral neuropathy present.[52]

ADOPTION AND MAINTENANCE OF AN ACTIVE LIFESTYLE

The promotion of regular exercise among individuals with any type of diabetes or at risk for developing T2DM is important. Fear of hypoglycemia is the strongest reported barrier to regular physical activity in individuals with T1DM, highlighting the importance of information and support regarding hypoglycemia management.[53] However, many of the other barriers to exercise are similar among people with and without diabetes, but those with diabetes need appropriate education about exercise effects on diabetes control and complications.[54] Greater levels of activity are frequently related to higher levels of self-efficacy, which reflect confidence in the ability to be more active.[16,55]

Developing realistic goals, selecting appropriate types of activity, progressing slowly (to avoid injury or burnout), and getting supportive feedback can increase confidence.[15,16,56] Counseling done by healthcare professionals may also be a meaningful and effective source of support.[57] Likewise, supervision of exercise sessions by qualified exercise trainers improves compliance and glycemic control,[11] and individuals engaging in supervised training likely gain benefits that exceed those of exercise counseling and increased activity undertaken alone.[58] Pedometers promote physical activity by providing motivation and visual feedback.[59]

EXERCISE GLYCEMIC MANAGEMENT

Hyperglycemia

Exercise-induced hyperglycemia is more common in T1DM since most people with T2DM still produce endogenous insulin. Purposeful insulin omission before exercise can promote a rise in glycemia, as can malfunctioning infusion sets,[60] overconsumption of carbohydrates prior to or during physical activities.[61]

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Anyone with diabetes may experience increases in blood glucose after aerobic or resistance exercise particularly with vigorous exercise,[62] particularly when the activity is more intense or if they are starting out with blood glucose levels that are elevated.[63] This effect may be mitigated by interspersing easier activities between more intense ones.[64,65] To correct postexercise hyperglycemia, a conservative (50% of usual) correction may work,[66] or an aerobic cool down may help lower blood glucose levels naturally.

Individuals with T1DM should, tested for blood ketones.[12] If blood glucose is over 300 mg/dL (16.7 mM) without ketones and people feel well, they can undertake exercise, but need to stay adequately hydrated.[6] Even with meal-induced hyperglycemia, undertaking mild- to moderate-intensity aerobic work will likely reduce glycemic levels given that circulating insulin levels will likely be higher.[67,68]

Hypoglycemia

In individuals managing diabetes with diet and exercise alone, the risk of developing hypoglycemia during or after any physical activity is minimal.[6] Undertaking longer duration and lower intensity physical activity generally reduces glycemic levels, but does not result in hypoglycemia.[69-71] While intense activity can cause transient blood glucose elevations,[72-74] intermittent high-intensity exercise done immediately after breakfast in individuals treated with diet only reduces blood glucose levels and insulin secretion.[75] Glucose monitoring should be performed before and after physical activity.

Factors Affecting Glycemic Responses in Type 1 Diabetes Mellitus

For anyone using insulin or oral insulin secretagogues, physical activity may complicate diabetes management.[76-78] For people with T1DM in particular, a number of factors can increase the risk for exercise-associated hypoglycemia, including the timing, duration, and intensity of the activity.[79] Engaging in a new or unfamiliar activity may also increase the risk, while endurance training may lower it.[80] However, resistance exercise may minimize the risk of exercise-induced hypoglycemia due to its intensity.[81] When both aerobic and resistance exercise are undertaken in one exercise session, performing resistance exercise first results in less hypoglycemia than when aerobic exercise is performed first.[82]

Many individuals with T1DM may have an impaired counter-regulatory hormone response reduced by prior hypoglycemia and/or exercise, placing them at high risk for severe hypoglycemia.[83] In older individuals with T2DM, unawareness of hypoglycemia increases probability of severe hypoglycemia in these individuals.[84]

Strategies to Prevent Activity-related Hypoglycemia

Carbohydrate intake will vary with insulin regimens, timing of exercise, type of activity, and more,[79] but also be impacted by blood glucose levels at the start of the activity. For low- to moderate-intensity aerobic activities lasting 30–60 minutes undertaken under fasting or basal conditions, approximately 10–15 g of carbohydrate may suffice to prevent hypoglycemia.[85] However, while exercising when insulin levels are higher (such as after a bolus of rapid-acting insulin), 30–60 g of carbohydrate per hour of exercise may be needed.[86]

Insulin adjustment: Decreasing circulating insulin levels enough during any activity may reduce or eliminate the need for carbohydrate intake. For example, a 20% or greater

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Box 2: Medications with a higher risk of activity-related hypoglycemia	
• Glimepiride	• Glyburide and metformin
• Glipizide and extended release	• Nateglinide
• Glipizide and metformin	• Repaglinide
• Glyburide and combinations	• Insulin: All types and delivery methods

reduction in basal insulin for individuals on multiple daily injections can be made for doses both before and after exercise.[61] People using an insulin pump can choose to reduce[87] or suspend[88] insulin delivery at the start of exercise, or reduce it starting 30–60 minutes beforehand.[89] For exercise performed within 2–3 hours after any bolus of rapid-acting insulin, making dose reductions of 25–75% may assist in lowering the risk of hypoglycemia.

Prevention of delayed hypoglycemia: Repeated interval or intense resistance training in particular can cause substantial depletion of muscle glycogen and increase risk of postexercise hypoglycemia in insulin or insulin secretagogues users.[90] Consuming 5–30 g of carbohydrate during and within 30 minutes following exhaustive, glycogen-depleting exercise will lower the risk and allow for more efficient restoration of muscle glycogen.[91]

Medication Effects

Some individuals may need to reduce their oral medications or insulin dosing before (and possibly after) exercise.[92] Meglitinides are the main class of oral medications that can be readily adjusted due to their short durations of action (Box 2); they can be reduced or omitted if physical activity is planned within a few hours after eating. Doses of sulfonylureas may also need to be lowered in response to regular physical activity if the frequency of hypoglycemia increases.[78,90] Users of rapid-acting insulin analogs will need to monitor glucose levels before and after exercise and make appropriate dietary and/or medication changes. If only longer-acting basal insulins are used, exercise-induced hypoglycemia is less likely.[93]

Medications prescribed for comorbid conditions, including antihypertensive agents, aspirin, and lipid-lowering agents, generally do not affect exercise responses, with some notable exceptions. Beta-blockers blunt heart rate responses to exercise and lower maximal exercise capacity by approximately 13%,[94] and they frequently mask the symptoms of hypoglycemia. However, β-blockers may increase exercise capacity in those with heart disease by reducing coronary ischemia during activity.[95] Diuretics lower overall blood and fluid volumes and may result in dehydration and electrolyte imbalances, particularly during exercise in the heat. Lipid-lowering drugs (e.g., statins) carry an elevated relative risk of myalgia and myositis, particularly when combined with use of fibrates and niacin.[96]

EXERCISE WITH COMPLICATIONS

Vascular Disease

Diabetic individuals with known coronary disease and exercise-induced ischemia should exercise in a supervised cardiac rehabilitation program, at least initially.[97] For

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anyone with peripheral artery disease, with and without intermittent claudication and pain in the extremities during exercise, low to moderate walking, arm-crank, and cycling exercise can enhance mobility, functional capacity, exercise pain tolerance, and QOL.[98,99] Lower extremity resistance training also improves functional performance.[100]

Peripheral Neuropathy

Peripheral neuropathy, with an associated decrease in sensation, carries with it an increased risk of injury, along with greater discomfort from painful neuropathy during physical activity. Sensations connected to balance and strength can be diminished and gait altered, contributing to development of orthopedic issues and a greater risk of falling.[101] However, participation in mild to moderate exercise may help prevent the onset of peripheral neuropathy.[102] Moderate walking does not appear to increase risk of foot ulcers or reulceration in those with peripheral neuropathy.[103,104]

Autonomic Neuropathy

Cardiac autonomic neuropathy (CAN) results in more frequent silent myocardial ischemia,[105] orthostatic hypotension, and resting tachycardia,[106] but also impaired exercise tolerance and lower maximal heart rate.[105] Cardiac autonomic neuropathy also greatly increases mortality risk.[26,105] Given the likelihood of heart rate abnormalities in CAN, these individuals should be medically cleared and possibly undergo stress testing before starting an exercise training program.[105] Moderate-intensity aerobic training can improve autonomic function in individuals with and without CAN.[107-109] Exercise intensity may be accurately prescribed using the HRR method with maximal heart rate directly measured, or subjective ratings of perceived exertion can be used.[26,105]

Diabetic Eye Disease

Exercise should never be undertaken during an ongoing retinal hemorrhage. Macular edema and glaucoma should be evaluated by an ophthalmologist or optometrist and activity guidelines determined by the results of the examination.

Diabetic Kidney Disease

Microalbuminuria, or minute amounts of albumin in the urine, is a common risk factor for more severe kidney dysfunction[110] and cardiovascular mortality.[111] Although urinary albumin excretion rates can rise proportionally with increasing exercise intensity during the period following the activity, such changes should not be interpreted to mean that exercise is causing additional damage.[112]

Most people with overt nephropathy have diminished capacity for physical activity, but can benefit from staying physically active. Physical activity during dialysis sessions is possible and often recommended to increase functional capacity.[113] Both aerobic and resistance training improve physical function and QOL in those with kidney disease.[114] Resistance exercise training is especially effective in improving muscle function and activities of daily living, which are normally severely impacted by later stage kidney disease.[114] Individuals with overt nephropathy should be screened, have physician approval, and possibly undergo stress testing to detect cardiovascular disease and abnormal responses.[115]

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CONCLUSION

This chapter discusses exercise prescription for individuals with diabetes, based on the current physical activity and exercise guidelines. The basic elements of the exercise prescription serve as a guide to creating safe and effective physical activity programs, even when complicated by the use of certain medications and presence of diabetes-related health issues. Most adults will benefit from engaging in both aerobic exercise (for at least 150 minutes per week spread over at least 3 days of the week, or a lesser amount of more intense activity) and resistance exercise training, along with flexibility and balance training if older. Healthcare professionals can prescribe appropriate physical activities and promote individual adoption of lasting behavior changes that benefit diabetes management and prevent health complications.

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