Journal of Enam Medical College
Vol 3 No 2 July 2013

Review Article

Exercise for the Management of Diabetes Mellitus: A Review of the Evidence

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Abstract

Diabetes mellitus is a public health problem in both developed and developing countries and has increased alarmingly, giving the disease the dimension of an epidemic. The aetiology of diabetes is multifactorial involving genetic, environmental, and behavioural origins. Exercise is an important part for the management of diabetes mellitus. Regularly planned exercise reduces insulin resistance, improves glucose tolerance, improves lipid profile and increases cardiovascular and cardiopulmonary function. This article critically reviews the more relevant evidence on the interrelationships between exercise and diabetes mellitus. This study included bibliography research from both the review and the research literatures on exercise in diabetes mellitus. From this review it appears that the effects of aerobic exercise are well established, and interventions with more vigorous aerobic exercise programmes resulted in greater reductions in HbA1c, greater increase in oxygen consumption and greater increase in insulin sensitivity. Considering the available evidence, it appears that resistance training could be an effective intervention to help glycaemic control, especially considering that the effects of this form of intervention are comparable with what is reported with aerobic exercise. It is well established that physical activity produces general and specific health benefits for diabetic patients. The basic principles of an effective exercise programme are the intensity, duration and frequency of exercise in an appropriate environment. Usually, moderate-intensity and long-duration exercise programmes are considered most suitable for diabetic patients. As it is supported by published evidence, encouragement to adopt increased physical activity and reduction of sedentary behaviour is a successful public health approach for diabetes mellitus prevention and management.

Keywords: *Physical activity, Diabetes mellitus, Management*

J Enam Med Col 2013; 3(2): 99–108

1. Introduction

Although exercise and adequate physical activity are considered to be very useful in the treatment of diabetes mellitus (DM)[1], actual translation of this knowledge into practice in daily life has been neglected by both the patients and treating physicians. Before the discovery of insulin, patients with diabetes, particularly those with type 1 diabetes were very limited in their ability to exercise, because it was almost impossible for them to avoid ketosis and dehydration. After insulin therapy was established as a mainstay treatment, exercise was no longer an elusive activity. Properly planned exercise is equivalent to one antidiabetic pill, but patients always attempt to replace exercise by another pill. Exercise also plays a critical role in patients with type 2 DM. The benefit offered by exercise exists from the very initial stages of diabetes till the terminal stage. It can help improve insulin sensitivity and assist with reduction and maintenance of body weight in obese patients. Exercise together with diet and pharmacological therapies, is important as part of the overall approach to improve glycaemic control

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and reducing cardiovascular risk factors. Prevention of type 2 DM is also possible by exercise, if practised in the stage of prediabetes and effects are stronger than drugs as shown in different large clinical trials.[2-5]

2. Effects of exercise on metabolism

A. Fuel metabolism during exercise

During the first 5–10 minutes of exercise, muscle glycogen is the main source of energy. With advancing exercises, muscle glycogen is depleted and glucose comes from hepatic glycogen initially and hepatic neoglucogenesis subsequently. If exercise continues for several hours, the contribution of glucose diminishes and nonesterified fatty acid (FA) becomes the major fuel. Most important factors influencing this fuel utilization are work intensity and duration. Other factors include nutrition, age, type of exercise and physical condition.[6]

B. Metabolic effects of exercise in healthy individual

Exercise induces muscle glucose uptake in several ways.[7]

Exercise-induced increased blood flow enhances insulin delivery to muscle and opens up previously nonperfused capillaries, thus increasing both surface area and effect of insulin for glucose transport.

Muscle contraction can stimulate glucose transport from extracellular space to the cell. Even then, blood glucose is virtually maintained in a static state by hepatic glucose production which may even exceed the rate of glucose utilization. But hepatic glucose production may no longer keep pace with glucose utilization in case of prolonged exercise and glycaemia may begin to decline.

C. Metabolic effects of exercise in diabetic people

Type 1 DM: Higher amounts of habitual physical activity are associated with decreased incidence of diabetes related complications and reduced mortality in individuals with type 1 DM.[8] The intensity and duration of exercise, the patient' s level of blood glucose control, the type, dose and site of preexercise insulin injections and the timing of the previous insulin injection and meals relative to the exercise can affect the response of an individual with diabetes to physical activity. Accordingly, blood glucose concentrations can decline (the most common response in moderate aerobic exercise), increase (particularly in very intense exercise) or remain unchanged.

Type 2 DM: Hepatic and peripheral insulin resistance and hyperinsulinaemia in the fasting state are the characteristic feature of type 2 DM. During moderate intensity exercise, peripheral glucose uptake usually raises more than hepatic glucose production and the blood glucose concentration tends to decline.[9] At the same time, plasma insulin level falls, and the risk of exercise induced hypoglycaemia in individuals with type 2 DM not taking exogenous insulin is relatively small, even during prolonged exercise.[10] Chronic exercise improves insulin sensitivity in type 2 DM patients. The effects of moderate exercise on glucose tolerance and insulin sensitivity are similar whether the activity is performed in single or multiple bouts of the same total duration.

3. Aims of exercise

To achieve good metabolic control of DM

To reduce weight

To increase physical capacity

To improve sense of wellbeing and quality of life

To improve cardiovascular function and dyslipidaemia

4. Types of exercise[11]

A. Aerobic exercise

This includes activities that use rhythmic, repetitive and continuous movements of the same large muscle groups for at least 10 minutes at a time. Typical examples include walking, jogging, swimming, bicycling, stair climbing and water aerobics.

B. Resistance exercise

This form refers to exercise that uses muscle strength to move a weight or work against a resistive load. Weight lifting and exercise with weight machine are the examples. Resistance exercises should be selected for each of the muscle groups including hips and legs, chest, shoulders, back of the arms and abdominal muscles.

C. Flexibility exercise

Flexibility or stretching exercise is aimed at increasing or maintaining range of motion at joints and hopefully reducing risk of injury.

5. Benefits of exercise

A. Aerobic exercise[12]

- Improves glucose tolerance
- Reduces insulin resistance
- Increases maximal oxygen consumption
- Improves cardiovascular and cardiopulmonary function
- Improves blood supply to muscles
- Lowers heart rate and blood pressure at any level of exercise
- Lowers resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) in people with high BP
- Decreases triacylglycerol (TG) level
- Increases high density lipoprotein cholesterol (HDLC) level
- Reduces body fat and improves weight control
- Prevents type 2 diabetes in high risk individuals[13,14]

B. Resistance exercise[15]

- Improves glucose tolerance and insulin sensitivity
- Increases muscle strength
- Increases strength of tendons and ligaments
- Reduces body fat and increases lean body mass
- Improves strength, balance and functional ability in older individuals

C. Flexibility exercise

- Potentially improves flexibility in terms of joint movements
- Helps to reduce risk of injury

Structured exercise interventions of at least 8-week duration have been shown to lower HbA1c by an average of 0.66% in people with type 2 diabetes, even with no significant change in body mass index (BMI).[12] Higher levels of exercise intensity are associated with greater improvements in A1c and in fitness.[16] A joint position statement of the American Diabetic Association (ADA) and the American College of Sports Medicine (ACSM) summarises the evidence for the benefits of exercise in people with type 2 diabetes.[17]

6. Potential risks of exercise in DM patients

- Cardiovascular events
- Musculoskeletal injury
- Vitreous haemorrhage or retinal detachment
- Foot ulcer
- Hypoglycaemia
- Hyperglycaemia
- Ketosis etc.

7. Preexercise evaluation

Exercise programmes need to be taken with expectation that potential benefits of exercise outweigh potential risks. So before advocating exercise to a diabetic person, particularly for moderate and strong exercises, a preexercise evaluation should be performed. This preexercise evaluation includes complete medical history, physical examination and laboratory evaluation to determine whether the patient has any long term diabetic complications, particularly coronary artery disease (CAD), neuropathy, nephropathy, retinopathy etc. Till date, debate remains how far and how invasive this screening is logical and acceptable to the patients.

The unavoidable area of controversy is that when a graded exercise ECG stress test should be done as for medical indication to avoid cardiac complications out of initiation of exercise. At present, no randomized large trials or cohort studies are available to dictate the indications and advantage of stress ECG in diabetics. Current ADA guidelines dictate that before initiating any moderate or intense exercise beyond brisk walking, stress ECG should be done in all diabetic individuals aged >35 and >25 years in the presence of even one additional CVD risk factor (Diabetes duration >10 years for type 2 DM and >15 years for type 1 DM, hypertension, dyslipidaemia, smoking, proliferative retinopathy, nephropathy, microalbuminuria, peripheral vascular disease, or autonomic neuropathy). But if this recommendation is strictly followed, great number of diabetics including large number of young diabetics with low risk of CAD should be screened before going above brisk walking. This involves a huge cost and a negative panic reaction among the patients. Moreover, exercise tests are highly false positive for low CAD risk than severe degree CAD, where positive stress test ECG will force the patient to go for costly invasive and noninvasive tests for CAD, which are nonrewarding in majority of cases. On the basis of this fact, US Preventive Service Task Force[18] recommends that stress test should usually not be done to detect ischaemia in

asymptomatic individuals at low CAD risk. It should also be remembered that if stress ECG is possible, it also gives an idea about maximal heart rate and blood pressure responses to different exercise levels, initial performance status, and prognosis. These data finally help to plan a suitable exercise regimen for a diabetic.

In the absence of any specific definitive recommendation based on large trials, Gibbons et al has proposed a modified recommendation in ACC/AHA guideline.[19] This suggests that all the diabetics with sedentarism, before practising aerobic physical activity with an intensity more than brisk walking and whose 10-year risk of coronary event is >10%, should be investigated. This risk can be directly estimated from United Kingdom Prospective Diabetes Study (UKPDS) Risk Engine and correspond to meeting any of the following criteria.

1. Age >40 years with or without CVD risk factors other than diabetes

2. Age >30 years and
   - T1 DM or T2 DM >10 years
   - Hypertension
   - Smoking
   - Dyslipidaemia
   - Proliferative or preproliferative retinopathy
   - Nephropathy including microalbuminuria

3. Regardless of age
   - Known or suspected CAD, CVD and/or PVD
   - Autonomic neuropathy
   - Advanced nephropathy with renal failure

8. Exercise recommendations in DM

The effect of exercise on insulin sensitivity lasts not more than 72 hours. As such there should not be a gap of more than 2 days for aerobic exercise, though the effect of resistance exercise is longer due to increased muscle mass. Moderate intensity exercise for 30 minutes/day is ideal. But those who cannot afford daily exercise must have a total of 150 minutes/week.[20] Isolated effect of exercise on weight loss is poorer (2 kg) than if combined with diet restriction and behaviour therapy (9–13 kg) after 20 weeks.[21]

A. Aerobic exercise: The combination of intensity, frequency and duration is used to describe recommended volume of exercise.

Intensity – this is the most difficult part to determine. Various methods can be used to describe and monitor exercise intensity. These include heart rate (HR), oxygen uptake, and rating of perceived exertion (RPE).

The HR method is the one most commonly used where maximum heart rate (HRmax) can be estimated by deducing patient's age from 220. Ideally HRmax should be determined during graded exercise testing.

Light intensity exercise : <50% of HRmax

Moderate intensity exercise : 50- -70% of HRmax

Hard intensity exercise : >70% of HRmax

The American College of Sports Medicine (ACSM) recommends that higher intensity exercise is associated with greater cardiovascular (CV) risk and greater chance of musculoskeletal (MSK) injury than lower intensity exercise. Thereby a low to moderate intensity exercise is mostly preferable for people with DM.

Frequency and duration: ADA technical review recommends 150 minutes per week of moderate intensity aerobic exercise or 75 minutes per week of vigorous (>70% HRmax) exercise or an equivalent combination of the two.[22] This 150 minutes per week could be achieved with 3 days exercise with 50 minutes/day in a week or 5 days exercise with 30 minutes/day in a week. For multiple bouts of exercise, ACSM recommends a minimum of 10 minutes per bout. Low intensity exercise needs to be conducted for a longer period of time than high intensity exercises.

B. Resistance exercise: Aerobic exercises, though safe, cannot be practised in the presence of severe peripheral neuropathy and gross obesity. Resistance exercises are not only acceptable in these cases but also cause more rapid changes in functional status and body composition, and it is also not monotonous like aerobic exercise as it involves different exercises at a time. It also involves muscle mass, muscle strength, and balance, which is particularly beneficial in older persons where sarcopenia is a problem. Resistance exercise improves insulin sensitivity to about the same extent as aerobic exercise.[23] Clinical trials have provided strong evidence for the A1c lowering value of resistance training in older adults with type 2 diabetes[24,25]and for an additive benefit of combined aerobic and resistance exercise in adults with type 2 diabetes.[26,27]

ACSM now recommends[28]resistance training in adults with type 2 DM also. Resistance exercise also improves bone density, functional capacity, resting BMR, adiposity and insulin resistance appreciably. In last 20 years, several trials have established the efficacy and safety of resistance exercise. ACSM recommends a minimum of 8–10 exercises involving major muscles with a minimum of 10–15 repetitions, at least three times a week including all major muscle groups initially under supervision and periodically reassessed by qualified exercise trainer.

C. Stretching exercise: There is no sufficient evidence to recommend for or against stretching exercise as part of routine exercise programme.

9. Exercise protocol

The standard recommendation regarding exercise in DM patients includes 4 stages.

Stage 1 : Warm up period of 5–10 minutes of aerobic activity at a low intensity level

Stage 2 : Muscle stretching for 5–10 minutes will follow the warm up period

Stage 3 : Exercise proper

Stage 4 : Cool down period for another 5–10 minutes which helps to bring the HR gradually to pre exercise level

10. Timing of exercise

Ideally, physical activity should be done at the most convenient time of the day for the participant. In a diabetic patient, exercise however needs to be coordinated with meals, medication and glucose testing regimens. Exercise should be timed so that it does not coincide with periods of peak action of antidiabetic agent. It is initially preferable to exercise at the same time each day.

11. Exercise recommendation in special situation

A. Uncontrolled glycaemia: When people with type 1 diabetes are deprived of insulin for 12–48 hours and are ketotic, exercise can worsen hyperglycaemia and ketosis;[29] therefore vigorous exercise should be avoided if FPG >250 mg/dL in the presence of ketosis and to be done with caution if FPG is >300 mg/dL in the absence of ketosis, particularly in type 1 DM. In type 2 DM, as there is no severe insulin deficiency, moderate exercise would rather decrease plasma glucose.

B. Hypoglycaemia: Prolonged exercise can cause hypoglycaemia during or after exercise in patients treated with peak doses of insulin or secretagogues, but rarely with glycosidase inhibitors, metformin, glitazones, and gliptines, and only diet treated group. According to ADA guidelines, if patients have preexercise blood glucose <100 mg/dL, they should take some carbohydrate diet before and/or during exercises, and should reduce insulin or secretagogues or adopt both to avoid hypoglycaemia.[30]

C. Concomitant medications: Diabetic patients are frequently advised various drugs such as beta blockers, lipid lowering drugs, aspirin, ACE inhibitors, diuretics etc. which usually do not interfere with the exercise performance. But precautions should be taken for any adverse reactions as shown in Table I.

Table I: Adverse effects of drugs on exercise[6]

Drugs	Mechanism	Effect
Diuretics	Higher doses alter fluid and electrolyte balance	Hypotension, syncope, fatigue, muscle cramps
Beta blockers	Blunt adrenergic pathway Negative iono- and chronotropic effect	Hypoglycaemia, unawareness, reduced maximal exercise capacity
ACE inhibitors	Modest increase in insulin sensitivity	Increased chances of hypoglycaemia
Aspirin	Unclear mechanism	Increased chances of hypoglycaemia
Statins/fibrates	Myositis	Muscle pain, fatigue, weakness

D. Exercise in pregnancy: Moderate intensity exercise, such as walking for 20–30 minutes twice daily (taking obstetric problems/contraindications in account), is recommended. Pregnant women should avoid high intensity activity, stress at lower trunk and jerky/bouncy movements.

12. Exercise in the presence of chronic complications

No definite trial is available, opinion is based on expert's experience.

A. Retinopathy: Exercise including both vigorous aerobic or resistant exercise is totally safe in the presence of background and nonproliferative retinopathy. But these can cause vitreous haemorrhage or retinal detachment in proliferative or advanced nonproliferative retinopathy.[31] After laser photocoagulation, one should wait for 6 months for vigorous exercises.

B. Peripheral neuropathy: Diminished pain sensation predisposes to damage to the skin and Charcot joint. Therefore, prior recommendations have advised only non-weight bearing exercises like swimming, cycling, and arm exercises for patients in the presence of severe peripheral neuropathy.[32] However, studies have shown that moderate intensity walking may not lead to increased risk of foot ulcers or reulcerations in those with peripheral neuropathy. Anyone with a foot injury or open sore should be restricted to non-weight bearing activities.

C. Autonomic neuropathy: Very often, several problems, mentioned below, are seen with autonomic neuropathy which can be a bar to moderate to heavy exercises.

- Silent or overt CVD[33,34]
- Gastroparesis with unpredictable food delivery leading to hypoglycaemia[35]
- Postural hypotension
- Decreased cardiac responses to exercise
- Impaired night vision due to pupillary abnormality
- Impaired thermoregulation

Prior cardiac investigations, particularly thallium scintigraphy may be required in selected cases to avoid complications with initiation of unaccustomed exercise.

D. Nephropathy: Although exercise by increasing blood pressure >20 mmHg can increase proteinuria acutely, in long term no worsening in renal function is seen, probably due to improvement in glycaemic control, blood pressure and insulin sensitivity. Thus no specific restriction in exercise is now recommended in the presence of nephropathy except end stage renal disease (ESRD).[36] But prior to initiating exercise, stress ECG test should be done in all cases of nephropathy including microalbuminuria due to frequent association with CVD before beginning moderate or intense exercise.

13. Exercise and type 2 DM prevention

The role of exercise in type 2 DM prevention has been well established in multiple large number of trials such as Finish Diabetes Prevention Study, US Diabetes Prevention Program (USDPP)[37], Malmo Study[38], Da-Quing Study[5,39], Indian Diabetes Prevention Program etc. There is strong and significant evidence that increasing physical activity and weight loss programme reduce the incidence of T2DM in individuals with impaired glucose tolerance (IGT). But relative contribution of diet and exercise is not yet substantiated even in larger studies like Finish Diabetes Prevention Study and USDPP. Till now, the effect of exercise in prevention of diabetes in persons with IFG is not well substantiated. In people with IGT standard recommendation for exercise is at least 150 min/week of moderate to vigorous physical activity with energy restriction.

14. Insulin and oral hypoglycaemic agent adjustments for exercise

In individuals with T1DM or T2DM treated with multiple insulin injections, the dosage of short acting insulin taken before exercise can be reduced instead of using dietary adjustment. The amount of such reduction, if required, should be tailored to each individual, based on blood glucose results before, during and after exercise, at least until the pattern of glucose response to exercise for that individual is known. Depending on the intensity and duration of exercise, the reduction required can be as much as 75% of the usual dose[40], although dose reductions by 20–50% are more typical. The insulin formulation (short or intermediate acting) to be reduced is that which has its maximal action at the time of exercise.

In very intense exercise such as competitive hockey, weightlifting or sprinting, there may be no need to reduce insulin dose. If the blood glucose concentration increases during exercise, the insulin dosage may need to be slightly increased or the injection schedule is changed in order to achieve higher plasma insulin concentrations during exercise. Use of an insulin pump may be advantageous for many physically active individuals, as circulating insulin levels can be more easily adjusted to accommodate meals, snacks and exercise.[41] The variability of glucose absorption is also generally decreased, lowering the risk of hypoglycaemia.[41] Decreases in insulin for pump users may or may not need to be accompanied by carbohydrate supplementation.[41]

In individuals with T2DM, exercise does not usually cause hypoglycaemia, and in obese individuals it can be a valuable tool to improve glycaemic control and assist with weight maintenance. For these reasons, carbohydrate supplementation is usually unnecessary with exercise. If blood glucose declines rapidly during exercise, as may occur in individuals taking oral hypoglycaemic agents or insulin, the dosage of the drug should be reduced or the drug should be withheld on exercise days.

15. Carbohydrate supplementation

There are few controlled studies regarding the appropriate type and amount of carbohydrates to be taken with exercise in people with T1DM. A reasonable starting point is to take approximately 15 gm carbohydrate before and 15–40 gm at 30–60 minute intervals during longer exercise sessions. Supplementation should be advised if preexercise blood glucose levels are <5.6 mmol/L. The amount of carbohydrate consumed should be adjusted according to blood glucose monitoring results; some individuals will not require any carbohydrate supplementation whereas some will require large amounts. During strenuous exercise, at least part of this can be taken as sucrose containing beverage. If exercise is performed postprandially, there is less need for carbohydrate supplementation, whereas larger snacks should be taken if some hours have elapsed since the last meal. Also, the risk of hypoglycaemia and subsequent need for exogenous carbohydrate supplementation decreases as the amount of time since the last insulin injection increases.[42,43] A recent review by Perkins & Riddell[41] describes several methods of carbohydrate supplementation. The goal is for the patient to consume a quantity of oral carbohydrate that matches the amount of glucose being used by the working muscles during activity. This can involve either a basic approach (where 15–30 gm of carbohydrate is consumed for every 30–60 minutes of exercise), a semiquantitative approach (consuming approximately 1 gm glucose/kg body weight/hour of activity) or a quantitative method, based on standardized tables of energy requirements for specific activities, intensities and individual body weights.[41] The latter is referred to as "excarbs" (extra carbohydrates for exercise), developed originally by Walsh & Roberts.[44] However, it should be noted that only a finite amount of carbohydrate (40–60 g/hour) can be absorbed while the body is moderately or vigorously active[45], requiring that a certain amount of the carbohydrate be consumed prior to exercise or during recovery. Regular glucose monitoring is still recommended, especially where the participant is experimenting with new types, intensities or durations of exercise training.

16. Guidelines for exercise in diabetes mellitus

- Exercise used to reduce weight should be combined with dietary measures.
- Moderate intensity aerobic exercise should be part of the daily schedule if possible, accumulating 150 minutes each week. More vigorous exercise (>70% of VO_2max) undertaken 3–5 times per week will provide additional health benefit. Previously sedentary patients may have to build up exercise volume gradually, starting with as little as 5–10 min/day.
- Multiple shorter exercise sessions lasting at least 10 minutes each in the course of a day are probably as useful as a single longer session of equivalent length and intensity.
- Include low intensity warm up and cool down periods, especially if vigorous exercise is undertaken.
- Exercise should be appropriate to the person's general physical condition and lifestyle.

- Resistance exercise performed 2–3 times per week will provide benefits over those of aerobic training. The studies reporting greatest impact of resistance exercise on HbA1c have had subjects who progressed to 3 sets of approximately 8 resistance type exercises at relatively high intensity (8 repetitions performed at the maximum weight that can be lifted 8 times).
- Use proper footwear and, if appropriate, other protective equipments.
- Avoid exercise in extreme heat or cold.
- Inspect feet before and after exercise.

17. Specific considerations for exercise in type 1 diabetes

Hypoglycaemia during exercise is to be avoided by

- Avoiding heavy exercise during peak insulin action.
- Using nonexercising sites for insulin injection.
- Reducing preexercise insulin doses by 20–50% or more if necessary when multiple daily injections are used. If using an insulin pump, decrease basal rate and/or amount of last bolus before exercise. These reductions should be individualised and based on blood glucose monitoring; not all individuals will require an insulin dose reduction.
- Monitoring glycaemia before, during and after exercise as necessary.
- Taking extra carbohydrate before and hourly during exercise. This amount should be individualised and based on blood glucose monitoring.
- Monitoring glycaemia and taking extra carbohydrate after prolonged exercise to avoid delayed hypoglycaemia. The quantity required can be estimated using the semiquantitative technique (1 g carbohydrate/kg body weight/hour of activity) or by consulting tables of energy requirements for particular activities.
- Using extra caution in monitoring glycaemia if exercise is being performed within 24 hours of a hypoglycaemic episode.

18. Specific considerations for exercise in type 2 diabetes

- Hypoglycaemia is less common during exercise than in type 1 diabetes, and extra carbohydrate is therefore usually unnecessary.
- Patients taking insulin or sulfonylureas may need to reduce the doses of these medications during days when they exercise. Such adjustments should be guided by glucose monitoring.

19. Conclusion

It has long been known that exercise has beneficial effects for people with diabetes. In the past, it was often difficult to avoid the hazards of exercise, particularly in patients with type 1 diabetes. Now-a-days a greater understanding of energy metabolism and fuel homeostasis has made it possible to include exercise as a realistic goal for almost all patients with diabetes. Improvements in glucose monitoring technology have further contributed to the feasibility of active physical exercise programmes for people with diabetes. It is important to address strategies for avoiding hypoglycaemia (both during and after exercise), as well as hyperglycaemia and ketosis, with all patients before they embark on routine exercise.

Patients with type 2 diabetes clearly benefit from frequent exercise. Physical activity plays an important part in the treatment strategy in these patients, as it decreases obesity, lowers blood pressure while improving insulin sensitivity, long term glycaemic control, and blood lipid profiles. Because of the risk of exercise unmasking ischaemia as well as causing soft tissue and joint injury or retinal haemorrhage, it is critical that all patients have a complete history and physical examination before they engage in moderate or vigorous activity.

For all patients with diabetes, physician-patient interaction is key to establishing a successful exercise programme. A team approach that involves coordination among exercise physiologists, nutritionists, diabetes educators, the physician, and the patient is usually the most effective way to create an individualised exercise regimen that provides benefits to the patient while avoiding potential harm.

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