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07: PHYSICAL ACTIVITY AND METABOLIC HEALTH

Metabolic Syndrome

Metabolic syndrome is a cluster of factors including abdominal obesity, insulin resistance, hyperlipidaemia and hypertension, which increase the risk of type 2 diabetes, cardiovascular disease, dementia and some forms of cancer. Regular physical activity has a beneficial effect on all these factors and so may reduce the risk of these serious medical problems.

To prevent and treat, it is recommended *to reduce sedentary time and use moderate intensity exercise daily for a minimum of 30 but preferably 60 minutes.*[1]

Physical activity is proven to reduce the associated health risks of metabolic syndrome **even if individuals who exercise remain obese.**[2, 3] This is a **key point** as both patients and health professionals are often over focused on weight and quickly become demoralized if weight loss is not achieved.

Type 1 Diabetes

Introduction

There is no evidence that regular physical activity can prevent type 1 diabetes. However, good clinical management for people with type 1 diabetes should incorporate regular physical activity. Unfortunately, many patients fail to reach minimum physical activity standards[4] due to fears of poor blood glucose control around exercise[5] and a failure to appreciate how different forms of exercise have different metabolic impacts. This results in poor patient confidence to manage blood glucose appropriately during and after exercise.

Learning how to adjust diet and insulin to endurance or strength activities can help form an individualised 'acute exercise management strategy' and help patients obtain the physical and psychological health benefits of being regularly active.[6] If patients have been appropriately assessed and have minimal complications, they should be encouraged to start a regular physical activity programme to develop for themselves a safe regimen.

General considerations for increasing physical activity

Performing unfamiliar exercise can cause glucose fluctuations that will differ when the same exercise is performed regularly. Different types of activity like aerobic or resistance exercise can alter glucose differently too. Intermittent exercise such as football and child's play are complex movements that can cause different glucose responses given the unpredictable nature of the activity.

Also, exercise in the morning compared with the afternoon or evening may have different glucose responses given the different amounts of on-board insulin and diurnal hormone variation. Thus, water and some carbohydrate should always be available during exercise. Never undertake exercise within 24 hours of severe hypoglycaemia. Wear comfortable clothing and footwear.

Insulin and Carbohydrate adjustments for Aerobic Exercise

- **Safe Blood Glucose ranges around exercise**
  A one-hour and immediate pre-exercise blood glucose sample will provide important information on the stability and direction of blood glucose. Immediate pre-exercise blood glucose values should be >6 mmol.l^{-1}, but if >14 mmol.l^{-1}, and in the presence of raised blood ketones, exercise should be delayed until values decline and ketones dissipate.[7] Blood glucose should be checked every 30 minutes in the initial familiarisation to regular exercise and serve as a learning strategy. After exercise check blood glucose at one hour and 6-8 hours post to track glucose concentrations.

- **Basal-Bolus Insulin reduction**
  Recent research demonstrates protection against nocturnal hypoglycaemia when basal insulin is reduced on the day of exercise.[8] Reductions to pre-exercise rapid-acting (bolus) insulin have ranged from 10-90%, [9] but a 50% reduction in the usual dose of rapid-acting insulin made 1-hour before physical activity is prudent.[10]

- **Carbohydrate ingestion**
  Decisions on carbohydrate consumption are usually made alongside a reduction in rapid-acting insulin. Low glycaemic index (GI) carbohydrates (or foods that are low GI) have been shown to reduce glycaemic fluctuations without detriment to exercise performance.[11,12] Current recommendations suggest ingesting an upper limit of 0.5-1.0 g carbohydrate per kg body mass per planned hour of exercise. As the patient progresses with training ongoing adjustments of ingested amounts will be needed as improved metabolic regulation and insulin sensitivity occurs.

  Following exercise there is a need to reduce insulin and increase carbohydrate to account for an increased organ sensitivity to insulin and greater rate of muscle and liver glucose replenishment. Therefore, consumption of a low glycaemic index carbohydrate-rich meal and a 50% reduction in usual rapid-acting insulin one hour after exercise can reduce glycaemic fluctuations and protect patients against hypoglycaemia for up to 8 hours.[13]

Insulin and Carbohydrate adjustments for Strengthening Exercises

Strengthening exercises cause counter-regulatory hormone (catecholamines, growth hormone) responses that may increase blood glucose concentrations. The amount of weight lifted in a session can determine the degree of hyperglycaemia and (for morning exercise at least), there is minimal need to consume carbohydrates for strength exercise lasting ~15 to 30 minutes. Beyond this duration the increase in muscle glucose uptake tempers the exercise-induced hyperglycaemia.[14] Moreover, if exercise-induced hyperglycaemia occurs, a small rapid-acting insulin dose immediately after exercise can help reduce blood glucose to euglycaemic levels[15] or alternatively, encourage individuals to perform aerobic exercise.[16]

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Complications

Given the known elevated cardiovascular disease risk in people with diabetes, it may be necessary to refer the individual for a graded exercise test to exclude underlying, significant heart disease.

- Avoid high intensity activities such as: team sports that encourage competition, relative exercise intensity and heavy resistance exercise.
- If the patient has significant diabetic retinopathy or nephropathy it is recommended the participant only engages in low impact cardio-vascular activities such as swimming, aqua-aerobics, yoga, Pilates, walking or cycling.
- If the patient has peripheral or autonomic neuropathy or has ulcers check feet before activity and recommend non-weight bearing aerobic activities such as swimming, aqua-aerobics, cycling, chair or arm exercises and avoid prolonged walking, step aerobics or jogging.

NICE guidelines NG17[17] Type 1 diabetes in adults: diagnosis and management recommend:
Advise adults with type 1 diabetes that physical activity can reduce their enhanced cardiovascular risk in the medium and long term. (2004)

Give adults with type 1 diabetes who choose to integrate increased physical activity into healthier lifestyle information about:

- Appropriate intensity and frequency of physical activity
- Role of self-monitoring of changed insulin and/or nutritional needs
- Effect of activity on blood glucose levels (likely fall) when insulin levels are adequate
- Effect of exercise on blood glucose levels when hyperglycaemic and hypoinsulinaemic (risk of worsening hyperglycaemia and ketonaemia)
- Appropriate adjustments of insulin dosage and/or nutritional intake for exercise and post-exercise periods, and the next 24 hours
- Interactions of exercise and alcohol
- Further contacts and sources of information (2004)

Conclusion

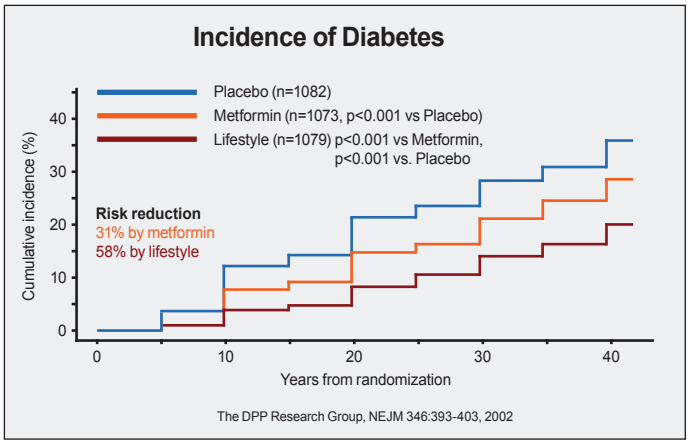
Regular exercise is a cornerstone of good clinical management in type 1 diabetes. Each patient's response to exercise may be different but prudent adjustments in exogenous insulin and carbohydrate intake in response to exercise will help patients develop their own individualised 'acute exercise management strategy' for their chosen activities.

Type 2 Diabetes

It is well known that physical inactivity is a major risk factor for developing type 2 diabetes.[18]

Primary prevention: Many studies have shown that type 2 diabetes can be prevented in high risk (obese) patients by taking regular exercise and following dietary guidelines.[19, 20] In all, there have been four major trials of diabetes prevention with intensive lifestyle counselling in China,[21] Finland,[19] India [22] and the US.[23] In the largest trial,[23] the US Diabetes Prevention Program, high risk individuals were assigned to a placebo control, a lifestyle intervention (which included aerobic activity of at least 150min/week) or a third group who were given metformin 850mg twice daily.

Lifestyle advice was nearly twice as effective in preventing diabetes compared to metformin drug therapy in high risk individuals (58% v 31% reductions in incidence) over 3 years of study.[23] (See figure below)



In three of these trials there was a 40-60% relative risk reduction in the incidence of diabetes in the lifestyles intervention group. This translates into one case of diabetes being averted by treating around seven people with glucose impairment for three years.[24 - 26] In the Indian study, the relative risk reduction of diabetes was a little lower at 28.5% but the Indian population was generally younger, with a relatively lower BMI and higher insulin resistance.[21] The long term follow up studies show that lifestyle interventions delayed on average the onset of diabetes by two to four years rather than preventing it totally.[25 - 27]

In the treatment of type 2 diabetes, regular physical activity remains a major part of treatment, alongside dietary and pharmacological interventions. Aerobic training remains the mainstay of treatment, but benefits also occur with strength training and are greatest when combined.[28] A meta-analysis comparing physical activity advice against structured exercise training consisting of aerobic exercise, resistance exercising or a combination, showed all were associated with a reduction of Haemoglobin A1c (HbA1c).[29] Longer programs than the recommended 150 minutes per week were associated with a greater reduction of HbA1c.[30] This study also confirmed physical activity is associated with lower HbA1c though only when combined with dietary advice.[29]

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Physical activity improves insulin sensitivity. It is increased sensitivity to insulin, once achieved, that is important in obtaining good metabolic control, but physical activity also impacts on lowering the risk of cardiovascular complications by improving the blood lipid profile, HbA1c, body weight and lowering blood pressure.[30]

Precautions: Hypoglycaemia rarely occurs in diet controlled, metformin or gliptin-treated diabetes unless any exercise is prolonged or strenuous, such as in marathon running.[31] In patients on sulphonylureas, glinides or insulin, moderate to vigorous exercise may cause a drop in blood glucose (sugar) with the effect lasting up to 12 hours post exercise.[32] Those wanting to take prolonged exercise may need to halve or further reduce oral medication, depending on their blood glucose levels and will need to monitor themselves more frequently. They should also be able to recognize the symptoms of hypoglycaemia. Suitable alteration of carbohydrate intake before, during and after exercise may then be required.

Foot care and exercise: Peripheral neuropathy is a feature of type2 diabetes and patients with this common complication may have a decreased ability to exercise but a greater need for exercise instruction and monitoring. Care should be taken to promote safe good foot care by encouraging patients to check their feet before and after exercise.[33]

NICE guidelines PH38 [34] Type2 diabetes: prevention in people at high risk recommend:

- Give information about increasing physical activity and reducing the amount of time spent being sedentary
- Consider referring those who want structured or supervised exercise to an exercise referral scheme or supervised exercise sessions, as part of an intensive lifestyle-change programme
- At least once a year, review the lifestyle changes people at high risk have made
- Raise awareness of importance of physical activity
- Help individuals to find other ways to identify and overcome any barriers to physical activity

Contraindications

- Uncontrolled blood glucose of >14 mmol or < 6.0 mmol/l, which should be corrected first [35]
- Patients with diabetic peripheral or autonomic neuropathy or foot ulcers should avoid weight bearing exercise

Key message:

Exercise is an important part of good clinical management for any patient with type 1 or type 2 diabetes. It can increase their quality of life and lead to better treatment outcomes.

Consider:

1. Auditing your diabetic patients to see if they have been offered any physical activity advice.
2. Finding out where you can seek further advice from your local diabetic service for your type 1 diabetic patients.

Benefits to health professionals:

Reduced drug costs, appointments and visits.

Signpost your patients to:
Diabetes UK are a leading charity group with a wealth of diabetes information and resources both for patients and healthcare professionals.

Extracted from the Wales HEIW CPD module on physical activity Motivate2Move. Now part of the RCGP Clinical Priority on physical activity and lifestyle. Review Dec 2020.

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