



## Healthy lifestyle interventions in general practice Part 4: Lifestyle and diabetes mellitus

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# Healthy lifestyle interventions in general practice

## Part 4: Lifestyle and diabetes mellitus

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### Abstract

Diabetes mellitus, in particular Type 2 diabetes, can be classified as a chronic disease of lifestyle. A lifestyle intervention programme is therefore an essential component of the primary and secondary prevention (management) of diabetes mellitus. The main indication for referral to a lifestyle intervention programme is any patient with either pre-diabetes or established diabetes mellitus. Following a comprehensive initial assessment, patients are recommended to attend either a group-based programme (medically supervised or medically directed, depending on the severity of the disease and the presence of any co-morbidities) or a home-based intervention programme. The main elements of the intervention programme are nutritional intervention, exercise training (minimum of 150 minutes at moderate intensity per week), psychosocial support and education. Regular monitoring should be conducted during training sessions, and a follow-up assessment is indicated after 2–3 months to assess progress and to re-set goals. Longer-term (5–6 months) intervention programmes are associated with better long-term outcomes.

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### Introduction

Diabetes mellitus can be defined as a group of metabolic diseases that are characterised by hyperglycaemia which result from defects in insulin secretion, insulin action or both.<sup>1</sup> Diabetes mellitus, particularly Type 2 diabetes, is included in the list of chronic diseases of lifestyle because this group of diseases have important lifestyle associated risk factors that include obesity, physical inactivity, poor nutritional choices and psychosocial factors.<sup>2</sup> The general relationship between these risk factors and the primary and secondary prevention of the chronic diseases of lifestyle has been reviewed in the first of a series of articles in this journal that focus on lifestyle interventions for chronic disease.<sup>2-4</sup>

A detailed discussion of the epidemiology, pathogenesis, pathophysiology, diagnosis and medical care of diabetes mellitus has recently been reviewed, and is beyond the scope of this article.<sup>5</sup> In this article, the fourth in the series, the main focus is on the role of lifestyle changes in secondary prevention (treatment) of diabetes mellitus as one of these chronic diseases of lifestyle. The equally important role of lifestyle change in the primary prevention of diabetes mellitus will be discussed briefly.

### Classification and diagnostic criteria for diabetes mellitus and pre-diabetes

As mentioned, diabetes mellitus represents a group of diseases which has been classified into four broad clinical classes by the American Diabetes Association (ADA) as follows: 1) Type 1 diabetes (accounting for 5–10% of patients with diabetes and is characterised by pancreatic  $\beta$ -cell destruction usually leading to insulin deficiency), 2) Type 2 diabetes (accounting for 90–95% of patients with diabetes and is characterised

by insulin resistance and a relative insulin deficiency), 3) Other types of diabetes due to other causes (including genetic defects, disease of the exocrine pancreas, and drug- or chemical induced causes), and 4) gestational diabetes (diabetes diagnosed during pregnancy). A detailed review of this classification of diabetes has recently been published.<sup>1</sup> It must be recognised that, as with any classification system, not all patients can be clearly classified into one of these four classes, but this classification is a useful clinical tool. As indicated, the majority of patients with diabetes are classified as Type 2 diabetes, and this is also the type that is mostly associated with lifestyle factors – particularly obesity, physical inactivity, and poor nutritional habits. Therefore, the main focus of this review is on Type 2 diabetes, and where appropriate, reference will be made to the other classes.

It is also important to mention that in the testing to detect diabetes, individuals can be identified that have evidence of hyperglycaemia, but do not meet the full criteria for the diagnosis of diabetes. This group of individuals has been classified as pre-diabetes, and two sub-categories of pre-diabetes are recognised.<sup>1,5</sup> These are impaired fasting glucose (IFG), and impaired glucose tolerance (IGT). Individuals who fall into either of these two categories of pre-diabetes are at increased risk to develop diabetes and cardiovascular disease. The current laboratory criteria for the diagnosis of diabetes and pre-diabetes are summarised in Table 1.<sup>1</sup>

### Epidemiology of diabetes mellitus

The International Diabetes Federation estimated that, in 2007, there were 246 million people with diabetes in the adult population worldwide, and that this represented an increase from 194 million, reported in 2003.<sup>6</sup> The prevalence of diabetes in the population was estimated at 7.3% with

**Table I: Laboratory diagnostic criteria for diabetes and pre-diabetes (adapted<sup>1</sup>)**

	Pre-diabetes	Diabetes
Casual plasma glucose (mmol/L) <sup>a</sup>		≥ 11.1 <sup>b</sup>
Fasting plasma glucose (mmol/L) <sup>c</sup>	5.6–6.9 <sup>d</sup>	≥ 7
2 hour plasma glucose during OGTT (75g glucose load) (mmol/L)	7.8–11.0 <sup>e</sup>	≥ 11.1

a: Casual – defined as any time of day without regard to the timing since the last meal  
 b: With symptoms of hyperglycaemia (polyuria, polydipsia, unexplained weight loss)  
 c: Fasting – defined as no caloric intake for 8 hours  
 d: Pre-diabetes (Impaired Fasting Glucose)  
 e: Pre-diabetes (Impaired Glucose Tolerance)  
 OGTT: Oral Glucose Tolerance Test

a higher prevalence that was reported in certain geographical regions such as North America (9.2%) and Europe (8.4%).<sup>6</sup> In Sub-Saharan Africa, accurate data on the prevalence of diabetes is lacking, but in general, the prevalence appears to be lower than in North America and Europe.<sup>7</sup> In the South African population, data from studies in different cities and peri-urban areas estimate the prevalence of diabetes as 4–8%.<sup>7</sup>

Of particular concern in the last two decades, is the global trend of a steady increase in the prevalence of diabetes, in particular Type 2 diabetes mellitus, which has reached epidemic proportions.<sup>8</sup> This trend has also been observed in many developing countries,<sup>6</sup> including South Africa.<sup>7</sup> A number of lifestyle factors that may explain this observed increase in prevalence have been identified; a global increase in the prevalence of obesity, decreased physical activity and poor eating habits – lifestyle factors that are strongly linked to the development of particularly Type 2 diabetes mellitus.<sup>6-8</sup> Urbanisation, ageing populations and ethnicity are also other risk factors that have been associated with the increase in the observed prevalence of Type 2 diabetes mellitus.<sup>7</sup>

Therefore, the principle elements of a lifestyle programme in the primary and secondary prevention of Type 2 diabetes mellitus include nutritional intervention and regular physical exercise which both also contribute to weight management. Other elements are an educational (counselling) component and psychosocial intervention.

In this article, the scientific rationale for a lifestyle intervention programme for diabetes mellitus will first be discussed. The main focus will be on the rationale for a lifestyle intervention programme in the secondary prevention (treatment) of Type 2 diabetes mellitus. However, the importance of lifestyle intervention in the primary prevention of Type 2 diabetes mellitus will be briefly mentioned. This will be followed by an outline of the elements incorporated in a typical lifestyle intervention programme for the treatment of diabetes mellitus. Finally, the practical implementation of a lifestyle intervention programme as part of the management of diabetes mellitus will be reviewed.

### Rationale for a lifestyle intervention programme for diabetes mellitus

#### Lifestyle interventions and primary prevention of Type 2 diabetes mellitus

The rationale and scientific basis for lifestyle intervention programmes in the primary prevention of Type 2 diabetes mellitus have recently been reviewed,<sup>8,9</sup> and recommendations have been incorporated in the recently published Position Statement on “Standards of medical care in diabetes” by the American Diabetes Association.<sup>5</sup> Data from at least 12 well-controlled clinical trials<sup>10-21</sup> show that there is strong evidence that a

**Table II: Risk factors for diabetes mellitus for which screening is indicated<sup>5</sup> and for which lifestyle intervention is effective in the primary prevention of diabetes mellitus**

Population	Risk factors that are indications for screening for diabetes mellitus
Adults with BMI > 25	<ul style="list-style-type: none"> <li>Physical inactivity</li> <li>First-degree relatives with diabetes mellitus</li> <li>Members of a high-risk ethnic population (e.g. African American, Latino, Native American, Asian American, Pacific Islander)</li> <li>Women who delivered a baby &gt; 9lb</li> <li>Women with diagnosed gestational diabetes mellitus</li> <li>Hypertension (BP ≥ 140/90 mmHg or who are on treatment)</li> <li>HDL cholesterol ≤ 0.9 mmol/L</li> <li>Serum triglyceride ≥ 2.82 mmol/L</li> <li>Women with polycystic ovarian syndrome</li> <li>Previously documented pre-diabetes (IFG, IGT)</li> <li>History of cardiovascular disease</li> <li>Other clinical conditions associated with insulin resistance (e.g. acanthosis nigricans)</li> </ul>
Adults with BMI < 25	<ul style="list-style-type: none"> <li>Age &gt; 45 years</li> </ul>
Children that are overweight and have ≥ 2 risk factors (BMI > 85 <sup>th</sup> percentile for age/gender, Weight for height < 85 <sup>th</sup> percentile, > 120% of ideal weight for height)	<ul style="list-style-type: none"> <li>Family history of Type 2 diabetes (1st and 2nd degree relatives). Members of a high-risk ethnic population (e.g. African American, Latino, Native American, Asian American, Pacific Islander)</li> <li>Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidaemia, polycystic ovarian syndrome, small for gestational age birth weight)</li> <li>Maternal history of diabetes or gestational diabetes</li> </ul>

combination of dietary intervention and regular exercise training<sup>10,12,13,15,21</sup> reduces the incidence of Type 2 diabetes in patients that have risk factors for diabetes (Table II) and those who have pre-diabetes.

Thus, there is strong scientific support for recommending a lifestyle intervention programme for patients with risk factors for diabetes mellitus and those with established pre-diabetes. The main lifestyle intervention for the prevention of diabetes mellitus should incorporate a programme for weight loss (5–10% of body weight) and increasing physical activity to at least 150 min per week at moderate intensity.<sup>5,22</sup> The practical details of the elements of these lifestyle interventions are similar to those that are recommended for established diabetes mellitus, and this will be reviewed in detail later in this article.

#### Lifestyle interventions and the secondary prevention (treatment) of Type 2 diabetes mellitus

The principles that are involved in the evaluation, monitoring and treatment of Type 2 diabetes mellitus have recently been reviewed.<sup>23,24</sup> Comprehensive medical care of patients with diabetes mellitus incorporates many elements and these have recently been published as a Position Statement by the American Diabetes Association<sup>5</sup>(Table III). These recommendations include four lifestyle interventions (nutritional intervention, promoting physical activity, psychosocial assessment and care, and education) which are all considered to be very important components in the standard medical care of diabetics.

**Table III: Elements of a standard medical care programme for diabetics<sup>5</sup>**

Performing a comprehensive initial assessment
Using a team approach to management
Regular monitoring to achieve glycaemic control
Nutritional intervention – Medical Nutrition Therapy (MNT) *
Exercise intervention – promoting physical activity *
Psychosocial assessment and care *
Educational intervention – Diabetes Self Management Education (DSME) *
Bariatric surgery (considered for some patients with BMI > 35)
Prevention and management of intercurrent illness including immunization
Prevention and management of hypoglycaemia
Prevention, diagnosis and management diabetes complications

\*: Components of a lifestyle intervention programme for diabetes mellitus

**Elements of a lifestyle intervention programme for diabetes mellitus**

A comprehensive lifestyle intervention programme for diabetes mellitus can be defined as a programme that typically incorporates the following four main elements: medical nutritional therapy (MNT), promotion of physical activity, psychosocial care, and education. Other general healthy lifestyle interventions such as smoking cessation are also important. As with lifestyle interventions in other chronic diseases, this comprehensive intervention programme can only be effectively administered by a multi-disciplinary team of health professionals including general practitioners, physicians and endocrinologists, sports and exercise medicine specialists (sports physicians), nutritionists, biokineticists (applied exercise physiologists), physiotherapists and others.

Once a patient has risk factors for developing diabetes (Table II), has diagnosed pre-diabetes), or has established diabetes mellitus they should be referred to a lifestyle intervention programme.<sup>22</sup> The indications and contra-indications for referral of a patient to a lifestyle intervention programme for diabetes mellitus are listed in Table IV.

**Table IV: Indications and contra-indications for referral to a lifestyle intervention programme for diabetes mellitus**

Indications	<ul style="list-style-type: none"> <li>• All patients with risk factors for diabetes mellitus (Table II)</li> <li>• All patients diagnosed with pre-diabetes</li> <li>• All patients diagnosed with diabetes mellitus</li> <li>• Motivated patient</li> <li>• Adherent patient</li> </ul>
Absolute contra-indications	<ul style="list-style-type: none"> <li>• General contra-indications to exercise training and testing <sup>3</sup></li> <li>• Uncontrolled diabetes mellitus</li> </ul>
Relative contra-indications	<ul style="list-style-type: none"> <li>• General relative contra-indications to exercise training and testing <sup>3</sup></li> <li>• Relative contra-indications to exercise training in patients with diabetes mellitus (listed in Table VI – Specific considerations for patients with diabetes) <sup>5,25,26</sup></li> </ul>

A medical practitioner trained in sports and exercise medicine together with a physician specialising in the management of diabetes mellitus usually direct the programme. They work with a team of health professionals to successfully administer all the elements of the programme. Close cooperation between the referring doctors and the multi-disciplinary team is strongly encouraged.

**Practical implementation of a lifestyle intervention programme for diabetes mellitus**

The first step in the implementation of a lifestyle intervention programme for diabetes mellitus is a comprehensive initial medical assessment.<sup>5</sup> The details of this assessment are outline in the recently published position statement of the American Diabetes Association,<sup>5</sup> and should consist of a medical history, clinical examination and special investigations (as required) (Table V).

**Table V: Details of a medical assessment prior to a lifestyle intervention programme for diabetes mellitus**

<b>Medical history</b>	<ul style="list-style-type: none"> <li>• General demographics (age, gender, ethnicity)</li> <li>• History of the diabetes and management (onset, previous treatment, glycaemic control, past and current treatment, medication, monitoring, symptoms)</li> <li>• Current and past nutritional intervention</li> <li>• Current and past physical activity intervention</li> <li>• Complications of diabetes                         <ul style="list-style-type: none"> <li>- hypoglycaemic episodes</li> <li>- microvascular complications (retinopathy, neuropathy – sensory, autonomic, sexual dysfunction, gastroparesis)</li> <li>- macrovascular complications (coronary heart disease, cerebrovascular disease, peripheral vascular disease)</li> </ul> </li> <li>• Education history</li> <li>• Other past medical history</li> <li>• Psychosocial history</li> </ul>
<b>Physical examination</b>	<ul style="list-style-type: none"> <li>• Body weight, height, Body Mass Index (BMI), skinfolds for percent body fat</li> <li>• General medical examination</li> <li>• Cardiovascular assessment including blood pressure (including orthostatic response), heart rate, pulses</li> <li>• Respiratory assessment</li> <li>• Abdominal assessment</li> <li>• Neurological assessment</li> <li>• Musculoskeletal assessment to identify any limitations to exercise training</li> <li>• Specific assessment for diabetes complications:                         <ul style="list-style-type: none"> <li>- Fundoscopic assessment</li> <li>- Assessment for presence of autonomic neuropathy</li> <li>- Skin examination</li> <li>- Comprehensive foot examination (inspection, pulses, reflexes, proprioception, vibration sense, sensory assessment using monofilaments)</li> </ul> </li> </ul>
<b>Special investigations</b>	<ul style="list-style-type: none"> <li>• Blood tests (HBA1c – if not in last 2–3 months, fasting lipogram – if not in last 12 months, liver function tests, serum creatinine and calculated GFR, others as indicated)</li> <li>• Urinalysis</li> <li>• Full nutritional assessment</li> <li>• Diagnostic resting and graded exercise ECG *</li> <li>• Functional capacity tests (6 min walk test, flexibility, muscle strength, muscle endurance)</li> <li>• Psychosocial assessment</li> </ul>

\*: Recommendations for graded exercise ECG are as follows<sup>26</sup>:

- Age > 35 years
- Age > 25 years (Type 1 diabetes > 15 years or Type 2 diabetes < 10 years)
- Presence of any additional risk factors for coronary artery disease
- Presence of microvascular disease (proliferative retinopathy, nephropathy)
- Peripheral vascular disease
- Autonomic neuropathy

The aims of this assessment are:

- to confirm the indications for referral (Table IV)
- to exclude contra-indications to the lifestyle programme, in particular exercise training (Table IV)
- to identify any co-morbidities<sup>3</sup> and other systemic consequences of diabetes mellitus
- to determine functional capacity – this would typically include exercise electrocardiography (if indicated to exclude cardiac disease), 6-minute walk test, and tests to determine body composition, muscle strength, muscle endurance, and musculotendinous flexibility
- to determine nutritional status
- to determine psychological well-being and social well-being

Once a patient has been assessed, an individual lifestyle intervention programme for the patient with diabetes mellitus can be planned.

### Nutritional intervention for diabetes mellitus

It is well established that nutritional intervention (known as Medical Nutrition Therapy – MNT) is effective in the prevention and treatment of diabetes mellitus and the evidence for this has been reviewed extensively.<sup>5,22,27,28</sup> Data from randomised clinical trials show that nutritional intervention effectively reduces HbA1c by between 1–2%, depending on the type and duration of diabetes.<sup>28</sup> Detailed evidence based guidelines for nutritional interventions in diabetes have been published,<sup>27</sup> and the main components of a nutritional intervention programme can be summarised as follows:

- A nutritional intervention programme for diabetics should be provided by a registered dietician who is familiar with the components of MNT.
- The first important objective of nutritional intervention for diabetes mellitus is to achieve and maintain good glycaemic control by:
  - Encouraging small frequent meals
  - Monitoring of carbohydrate intake to achieve glycaemic control in diabetics
  - Using low glycaemic index foods (wholegrain breads, cereals, pasta and rice, oats porridge, and certain fruits and vegetables) and low glycaemic load meals
- The second important objective of nutritional intervention for diabetes mellitus is to achieve and maintain a healthy body weight by:
  - Encouraging weight loss for all individuals who are overweight or obese and who are at risk for diabetes, have established pre-diabetes, or have established diabetics (modest weight loss has been shown to reduce insulin resistance)
  - Setting a target BMI for diabetics at 19.5 to 25
  - Balancing calorie intake and physical activity to achieve or maintain a healthy body weight
- The third important objective of nutritional intervention for diabetes mellitus is to achieve and maintain a normal lipid profile by:
  - Increased dietary fibre intake is recommended (1.4g/1000 kcal)
  - Limit saturated fat intake to < 7% of total calorie intake
  - Limiting the intake of trans fats
  - Limiting dietary intake of cholesterol to < 200 mg per day
  - Encouraging the intake of fish, particularly oily fish (to provide n-3 polyunsaturated fatty acids) to at least twice a week.
  - Monitoring of their lipid profiles, renal function and protein intake (important for those with nephropathy), particularly in patients that are on a low-carbohydrate diet

- Other nutritional principles are:
  - Sugar alcohols (xylitol, mannitol and sorbitol) and non-nutritive sweeteners (saccharin, aspartame, acesulfame potassium and sucralose) are generally safe, provided they are consumed within acceptable daily limits (as recommended by the FDA)
  - Alcohol intake should be avoided in patients with poor glucose control. Adult diabetics where glucose control is good should limit their intake of alcohol (maximum of 1 drink per day for females, and 2 drinks per day for males).
  - Although a number of nutritional supplements for diabetes have been suggested (vitamins E and C, carotene, chromium and many others),<sup>29</sup> in general, the efficacy of these in the treatment of diabetes has not been established

Therefore, a comprehensive nutritional assessment (including determination of BMI, lean body mass, blood glucose levels, HbA1 levels, and lipid profile) and a carefully planned nutritional intervention programme are essential components of the lifestyle intervention programme for patients with diabetes mellitus. Furthermore, nutritional interventions, combined with exercise training are the cornerstone lifestyle components of a successful primary prevention programme for diabetes mellitus.<sup>10,12,13,15,21,27</sup>

### Exercise intervention – promoting physical activity

The health benefits of regular physical activity for diabetics are well established and have been extensively reviewed.<sup>25,26,30-32</sup> The main benefits of regular exercise training for diabetes relate to the following: improvements in muscle and liver insulin sensitivity, muscle glucose uptake, improved glycaemic control, reductions in HbA1c, improved lipid profile, reduced body weight, reduced blood pressure, positive effects on the thromboembolic state, and reductions in the overall cardiovascular risk.<sup>25,26,31,32</sup>

Exercise training combined with nutritional intervention are the cornerstones of a lifestyle intervention programme for diabetes mellitus<sup>10,12,13,15,21</sup> and should therefore be a mandatory component of such a lifestyle intervention programme.

The exercise training component of lifestyle intervention for diabetes mellitus can be administered in an out-patient setting or as a self administered home-based programme.<sup>25</sup> However, in most instances these programmes are initially administered in a group setting where sessions (usually 3/week) are supervised by members of the multidisciplinary lifestyle intervention team.

### Setting and level of supervision of the exercise intervention

At present there are no precise guidelines on the risk stratification prior to exercise training for patients with diabetes mellitus. Therefore, recommendations to determine the degree of medical supervision that is required during exercise rehabilitation sessions are not clear. However, there are criteria that can be used as guidelines to identify high risk individuals where direct medical supervision is required during exercise for patients with diabetes mellitus that undergo lifestyle intervention.<sup>25,26</sup>

Guidelines for a setting where exercise training sessions should be conducted under direct medical supervision (medical doctor present at the training sessions) are mainly related to the presence of co-morbidities where medical supervision would normally be indicated (e.g. cardiac disease),<sup>3</sup> the presence of complications of diabetes mellitus (poor

glycaemic control, presence of retinopathy, presence of nephropathy, and presence of peripheral or autonomic neuropathy). These patients with diabetes will benefit from an initial period of exercise training under medical supervision.

In patients with stable, well-controlled diabetes, or in those with co-morbidities where medically directed exercise is indicated, exercise intervention should take place in a group setting under medical direction (no doctor is necessarily required to be present at supervised training sessions).

In patients with stable, well-controlled diabetes and with minimal or no co-morbidities, the exercise intervention programme can be self administered in a home-based setting.

#### *Practical implementation of the exercise training component*

The practical implementation of any exercise training programme is usually discussed by describing the following practical aspects of a training programme: frequency of the training sessions, durations of individual training sessions, length of the intervention programme, intensity of training, modality (type) of exercise training, monitoring and progression of training and special considerations in the training programme. The practical recommendations for each aspect of an exercise training programme for diabetes mellitus are summarised in Table VI.

**Table VI: Recommendations for each component of the exercise training in patients with diabetes mellitus**

Component	Recommendation/s
Frequency of training sessions <sup>5,25,26,31</sup>	<ul style="list-style-type: none"> <li>Start the programme with training 2–3 times per week</li> <li>Can increase the training sessions to <math>\geq 3</math> times per week</li> <li>The heightened insulin sensitivity following exercise training lasts 24–72 hours, therefore exercise training is encouraged on most days of the week</li> </ul>
Duration of a training session <sup>5,31</sup>	<ul style="list-style-type: none"> <li>The endurance training component of the session should be at least 30 minutes</li> <li>Most exercise sessions are in total about 60 minutes</li> <li>The total accumulated weekly exercise duration should be at least 150 minutes</li> <li>Be aware that prolonged exercise may increase the risk of hypoglycaemia and carbohydrates may need to be ingested</li> </ul>
Length of the programme <sup>5,32</sup>	<ul style="list-style-type: none"> <li>Most programmes where benefits have been documented were <math>&gt; 8</math> weeks in length</li> <li>A long term commitment to maintain an exercise training programme is strongly recommended</li> </ul>
Intensity of training <sup>5,26,31</sup>	<ul style="list-style-type: none"> <li>The intensity of training is determined by the outcome of a symptom limited exercise test</li> <li>The usual recommended intensity is 50–70% of maximum heart rate (the use of the Borg scale of Rating of Perceived Exertion is recommended to determine exercise intensity in these cases)</li> <li>The heart rate response may be altered in patients with autonomic neuropathy</li> <li>Higher intensity exercise (<math>&gt; 60\%</math> maximum capacity) produces greater physiological benefits, and should be encouraged</li> <li>High intensity exercise may increase the risk of hypoglycaemia and carbohydrates may need to be ingested</li> </ul>
Type (modality) of training <sup>5,25,26,32</sup>	<ul style="list-style-type: none"> <li>Endurance type training (walking, jogging, cycling, rowing, stair climbing, Nordic ski trainer) has traditionally been the main type of exercise and should be included</li> <li>Recent evidence shows substantial benefits from regular resistance training in diabetic patients (recommended at 3 times per week)</li> <li>Flexibility training should also be included in the training programme</li> </ul>
Monitoring and progression of training	<ul style="list-style-type: none"> <li>Regular monitoring of each patients during training sessions is important</li> <li>Monitoring can include: <ul style="list-style-type: none"> <li>recording pre- and post exercise blood glucose concentration</li> <li>recording resting and exercise heart rate and blood pressure</li> <li>documenting Rating of Perceived Exertion (RPE) during exercise (important in patients with autonomic neuropathy)</li> </ul> </li> <li>Progression of the exercise training programme should take place at regular intervals (bi-weekly) and can include duration of sessions, intensity of exercise training, altered type of training and later increased the frequency of training sessions per week can be increased to most days of the week</li> </ul>
Special exercise considerations for patients with diabetes <sup>5,25,26</sup>	<ul style="list-style-type: none"> <li>Frequent blood glucose monitoring before, during and after exercise sessions is indicated (particularly at the start of an exercise training programme, or if the exercise training programme is altered)</li> <li>For diabetics on insulin or insulin secretagogues there is a risk of hypoglycaemia (blood glucose <math>&lt; 3.9</math> mmol/L) during exercise</li> <li>If the pre-exercise glucose is <math>&lt; 5.6</math> mmol/L, additional carbohydrate should be consumed prior to exercise</li> <li>If the pre-exercise blood glucose is <math>&gt; 13.5</math> mmol/L additional insulin may be need before exercise training – the additional presence of urinary or blood ketones is a contra-indication to exercise training</li> <li>Carbohydrate supplements are often necessary to reduce the risk of hypoglycaemia if the exercise session is spontaneous or unplanned, prolonged or performed at high intensity</li> <li>The patients and staff need to be familiar with the time course of insulin action and the delivery methods so that adjustments in pre-exercise insulin can be made</li> <li>A 30–50% reduction in the dosage of insulin during the time of exercise is generally accepted as a safe starting guideline</li> <li>Reductions in insulin may be required for an extended period after intense or prolonged exercise</li> <li>High intensity endurance training and resistance training are contra-indicated in patients with proliferative diabetic retinopathy (PDR) or severe non-proliferative diabetic retinopathy (NPDR) (due to the increased risk of triggering vitreous haemorrhage or retinal detachment)</li> <li>Non-weight bearing exercise is recommended for patients with peripheral neuropathy (increased risk of skin breakdown, infections and joint destruction – Charcot joint)</li> <li>Patients with autonomic neuropathy should a) undergo cardiac screening before exercise training (high incidence of cardiovascular disease), b) be monitored through parameters other than only heart rate and blood pressure during exercise, c) be monitored for abnormal thermoregulatory responses during exercise, and d) be monitored for hypoglycaemia during exercise training (gastroparesis may affect glucose delivery)</li> </ul>

### Educational intervention – Diabetes Self Management Education (DSME)

An educational strategy is a key component of any lifestyle intervention programme for patients with chronic disease in general, including diabetes mellitus.<sup>5</sup> Guidelines for the Diabetes Self Management Education (DSME) programme for diabetics have been provided.<sup>5,33</sup> It has been documented that DSME is associated with the following benefits: improved diabetes knowledge, improved self care, improved clinical outcomes, and quality of life, reduced self-reported weight. The general practitioner is uniquely positioned to address this first component of a lifestyle intervention programme for these patients.

The educational component can be delivered effectively in a variety of ways including group sessions (typically weekly and just before or after an exercise session), or through information booklets/pamphlets, and individual counselling.<sup>5</sup> The content of an educational programme should be based on the elements of a standard medical care programme for diabetics and would typically include the following topics<sup>33</sup>:

- The causes, disease process, treatment (including medications) and consequences of diabetes mellitus
- Nutritional management of diabetes mellitus
- Principles of physical activity and exercise training
- Monitoring blood glucose and other parameters (including interpreting and using the results)
- Preventing, detecting and managing acute complications of diabetes mellitus (hypoglycaemia, ketoacidosis)
- Preventing, detecting and managing chronic complications of diabetes mellitus
- Developing personal strategies to address psychosocial issue and concerns
- Developing personal strategies to promote health and behaviour changes

### Psychosocial intervention – including stress and diabetes

The role of exercise and nutrition in maintaining glycaemic control and preventing diabetic complications is a validated and well-established component of lifestyle modification in pre-diabetic and diabetic states. Perhaps less appreciated or recognised is the significant relationship between stress, insulin resistance and diabetes, thus highlighting another area of lifestyle that requires consideration in the integrative clinical management of these conditions. Furthermore the psychological and emotional sequelae at time of diagnosis and as a result of living with a chronic disease might undermine patient quality of life as well as compliance with both medication and lifestyle modification programmes, which might further contribute to the dynamics of chronic stress and its effects on disease progression.

Stress is a neurophysiological reaction to a variety of real or perceived stimuli which threaten to disrupt the dynamic equilibrium of the whole organism. The cascade of neuroendocrine responses enables the organism to cope with the challenges through activation of the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system (ANS), with the resultant release of glucocorticoids and catecholamines. This integrated, adaptive response mobilises glucose and lipids from hepatic and adipose stores, providing energy substrates for the fight or flight response that is necessary for survival, and allows for stability through change, called allostasis. Both physical and psychological factors generate this response, with the psychological dimensions closely related to the way in which an individual perceives a stressful situation.<sup>34</sup>

The prolongation and overactivation of the stress response, most commonly in a 21<sup>st</sup> century context in the face of psychosocial stress, results in dysregulation of both the HPA and the ANS which may be detrimental to the brain, cardiovascular system and the regulation of nutrient metabolism. Simply put the protective and adaptive effects of the stress response in the short term become damaging in the long term. The evidence is strong that, in the context of genetic predisposition, psychosocial stress is a significant risk factor for the metabolic syndrome (insulin resistance, visceral obesity, hypertension, and dyslipidaemia) and Type 2 diabetes.<sup>35</sup>

Insulin resistance – the attenuated effect of insulin on target tissue such as the liver, skeletal muscle and fat – is the common pathway that links the maladaptive stress response and Type 2 diabetes. Sustained elevations of cortisol which occur in chronic and sustained stress are antagonistic to insulin by impairing insulin signalling and glucose uptake and enhancing hepatic glucose output and adipose lipolysis. Furthermore, dysregulation of the ANS also seems to contribute to insulin resistance.

Clinical evidence in the Whitehall II study (in a cohort of over 10 000 civil servants) links everyday life stressors with the metabolic syndrome, showing that chronic work stress more than doubles the risk of developing the syndrome than those without work stress.<sup>36</sup>

Consequently, the assessment of psychological and social issues (psychosocial stressors) should be an integral part of the management of diabetes mellitus,<sup>5</sup> and should include assessment of the following: attitudes about illness, expectations of the medical management and the outcomes, affect/mood, quality of life, resources (coping capacities) and psychiatric history.<sup>5</sup> The main opportunities for screening are at the time of the initial assessment, or during follow-up visits, discovery of complications, or when problems arise (adherence, quality of life).

While many of these issues may be addressed at the primary health care level, indications for referral to a mental health professional are:

- Gross non-compliance to the lifestyle and medical management programmes
- Depression with the possibility of self-harm
- Debilitating anxiety (with or without depression)
- Indications of an eating disorder
- Cognitive functioning that significantly impairs judgment

It is preferable to incorporate psychological and stress-related assessment and interventions into routine care, in the context of an ongoing therapeutic relationship between the clinician and patient.<sup>37</sup> It is this collaborative and trusting environment that will optimise onward referral for more complex psychological (including stress reduction), psychiatric, exercise and nutritional interventions.

It is important to establish that emotional well-being is an important part of diabetes management.<sup>38</sup> The general practitioner and family physician are well positioned to support their patients emotionally through attentive and active listening which allows patients grappling with the effects of living with a chronic illness to feel seen and understood.

The recognition that ongoing motivation and modification of behavioural patterns must be undertaken by the patient themselves underscores the significance of the patient actively participating with their health professionals in ongoing disease management. Neither the patient nor the health care system can afford high levels of passivity in the diseases of lifestyle. Part of the role of clinicians, then, is to support patients in

the development of self-awareness, thereby internalising the sense of control, which together create the foundation for effective self-regulation at all levels of the self.

### Other lifestyle interventions

As with other chronic diseases of lifestyle, cessation of smoking is a very important component of lifestyle intervention for patients with diabetes mellitus.<sup>39</sup> Practical guidelines to assist patients with chronic disease to stop smoking have been reviewed in Part 3 (Chronic Respiratory disease) of this series.<sup>4</sup>

### Repeat assessment, follow-up and retention

All patients undergoing chronic disease rehabilitation should be assessed regularly during training sessions. Prior to each exercise training session, it is suggested that the following parameters be assessed and recorded: symptoms of diabetes mellitus (polyuria, polydipsia), other symptoms (cardiac, infectious disease), resting heart rate, resting blood pressure and blood glucose concentrations. During the exercise training the following should be recorded: rating of perceived exertion, peak heart rate, and peak blood pressure. A post-exercise blood glucose concentration may also be done.

All the parameters that were recorded during the initial assessment before entering the programme should be repeated after a defined period of intervention (usually 2–3 months). A feedback session should be arranged with the patient where these results are reviewed. At this session goal setting can be conducted and the intervention programme can be continued. Based on the repeat assessment this may require continued medically supervised or medically directed exercise training, or the patients can be discharged to continue with a self administered (home based) intervention programme. All the patients with diabetes mellitus should be re-assessed regularly (at least once per year).

### Summary and conclusions

There is strong scientific evidence that a lifestyle intervention programme is an essential component of the primary prevention as well as the treatment (secondary prevention) of diabetes mellitus. The main indication for referral to a lifestyle intervention programme is any patient with either pre-diabetes or any patient with established diabetes mellitus. The main elements of the intervention programme are nutritional intervention, exercise training (minimum of 3 times per week), psychosocial support and educational intervention. Regular monitoring should be conducted during training sessions, and a follow-up assessment is indicated after the first 2–3 months to assess progress and to re-set goals. Longer-term intervention programmes are associated with better long-term outcomes.

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