

Healthy lifestyle interventions in general practice

Part 6: Lifestyle and metabolic syndrome

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Abstract

Although there is no clarity on the precise definition of the metabolic syndrome, there is consensus that it is a cluster of inter-related risk factors (elevated blood pressure, elevated plasma glucose, atherogenic dyslipidaemia) that are due to mainly abdominal obesity and insulin resistance, and which appear to directly promote the development of atherosclerotic cardiovascular disease (ASCVD), and increase the risk for developing type 2 diabetes mellitus. The prevalence of the metabolic syndrome is increasing globally, including in the adolescent population. In developed countries the prevalence of the metabolic syndrome is about 30% of the adult population. The cornerstone of management of this syndrome is lifestyle intervention. Following a comprehensive initial assessment to risk-stratify patients, they 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 a lifestyle intervention programme for metabolic syndrome are nutritional intervention (mainly for weight loss and to improve the atherogenic dyslipidaemia), exercise training (minimum of 30–60 minutes at moderate intensity on most days of the week), and psychosocial interventions. Regular monitoring should be conducted and a follow-up assessment is indicated after three months to assess progress and to re-set goals. Longer-term (5–6 months) and supervised intervention programmes are associated with better long-term outcomes.

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Introduction and definition of the metabolic syndrome

The historical origin of the metabolic syndrome appears to date back to the 1920's with a report linking metabolic abnormalities (gout and hyperglycaemia) and hypertension.¹ In 1988, during a landmark Banting lecture, Reaven first defined a "syndrome X" as a syndrome linking the metabolic complications of insulin resistance in obese and non-obese patients.² Since then, a definition of the metabolic syndrome has been proposed by a number of organisations and expert panels³ including the World Health Organization (WHO)(1998),⁴ the European Group for the Study of Insulin Resistance (EGIR)(1999),⁵ the National Cholesterol Education Program-Adult Treatment Panel III (ATPIII)(2001),⁶ the American Association of Clinical Endocrinologists (AAACE)(2003),⁷ the International Diabetes Federation (IDF)(2005),⁸ and the American Heart Association together with the National Heart, Lung and Blood Institute (AHA/NHLBI) (2005).⁹ It is clear that there is no single correct definition of the metabolic syndrome and that it is also not possible to determine which of these definitions is the best.^{3,10} There is also still a debate as to whether the metabolic syndrome is simply a clustering of risk factors or a true syndrome.¹¹

The most recent definition of the metabolic syndrome (AHA/NHLBI) (2005)⁹ describes it as a constellation of inter-related risk factors (elevated blood pressure, elevated plasma glucose, atherogenic dyslipidaemia) that are due to mainly abdominal obesity and insulin resistance,¹¹ but also physical inactivity, aging, and hormonal imbalance.⁹ These inter-related risk factors appear to directly promote the development of atherosclerotic cardiovascular disease (ASCVD), and to increase the risk for developing type 2 diabetes mellitus.⁹ For the purposes of this article, this definition

will be used, recognising however, that there is no clear consensus on the definition of the metabolic syndrome. It is important to note that two other metabolic risk factors have been included in this cluster. These are the pro-inflammatory state, and the pro-thrombotic state.¹¹

A detailed discussion of the epidemiology, pathogenesis, pathophysiology, diagnosis and management of the metabolic syndrome has recently been reviewed, and is beyond the scope of this article.^{9,11,12} In this article, the sixth in the series, the main focus is on the role of lifestyle intervention programmes in management of the metabolic syndrome.

Diagnostic criteria for the metabolic syndrome

As mentioned, a variety of definitions for metabolic syndrome have been proposed over the past 2–3 decades.^{4–9} Similarly, there is no consensus on the diagnostic criteria for the metabolic syndrome. For the purposes of this article, the clinical diagnostic criteria of the most recent consensus group, the American Heart Association together with the National Heart, Lung and Blood Institute (AHA/NHLBI) (2005) will be adopted⁹ (Table I).

Epidemiology of the metabolic syndrome

There are a number of studies that have reported on the prevalence of metabolic syndrome in various populations. The results of these studies are difficult to interpret, because different definitions and criteria for the diagnosis have been used.³ Despite these limitations, it is clear that the prevalence of the metabolic syndrome is high and is increasing in most populations that have been studied. In the United States, the age-adjusted prevalence of the metabolic syndrome was reported as 34% in 2002, which was an increase from 23.7% reported in 1994. Of

Table I: Clinical diagnostic criteria for the metabolic syndrome - AHA/NHLBI guidelines⁹

Diagnostic criteria ^a	Cut-off values
Elevated blood pressure	Systolic blood pressure \geq 130 mmHg or Diastolic blood pressure \geq 85 mmHg or On anti-hypertensive drug treatment in a patient with a history of hypertension
Elevated fasting blood glucose	\geq 5.5 mmol/L
Elevated waist circumference	Males \geq 102 cm Females \geq 88 cm
Elevated serum triglycerides	\geq 1.7 mmol/L or On drug treatment for elevated serum triglycerides
Reduced HDL cholesterol	Males \leq 1.03 / Females $<$ 1.3 mmol/L or On drug treatment for reduced HDL cholesterol

^a The diagnosis of metabolic syndrome is made if 3–5 of the criteria are present

particular concern is also the increase in the prevalence of the metabolic syndrome in the adolescent population.¹⁰ The prevalence of the metabolic syndrome in adult populations has also been reported in Brazil (19%), Greece (23.6%), India (41.4%), Iran (33.7%), Ireland (20.7%), Turkish males (32.2%) and Venezuela (31.2%).¹⁰

The prevalence of the metabolic syndrome in the South African population is not accurately known as national prevalence surveys have not been conducted. However, the prevalence of cardiovascular risk factors that constitute the metabolic syndrome is increasing. This is particularly so amongst black people because of urbanisation and the associated adoption of western lifestyle¹³ and the increase in the prevalence of obesity. It is estimated that 29% of men and 56% of women in SA are overweight or obese.¹⁴ The first SA Demographic Health Survey conducted in 1998 estimated the overall prevalence of hypertension to be 23.9%.¹⁵ Dyslipidaemia is less common amongst black people¹⁶ but this appears to change with the demographic transition.

A recent cardiovascular risk factor profile study¹⁷ of 1691 volunteers in Soweto (mean 46 years), found that 78% of subjects had more than one major risk factor for heart disease. By far the most prevalent risk factor overall was obesity (43%) with significantly more obese women than men (23% versus 55%). Furthermore, 33% of subjects had high blood pressures and 13% an elevated (non-fasting) total blood cholesterol level: There was a positive correlation between increasing BMI and other risk factors with overweight subjects three times more likely to have concurrent hypercholesterolaemia. This study strongly suggests a high prevalence of related risk factors for heart disease in urban black populations in epidemiologic transition.

A concern that there is an increase in the prevalence of the metabolic syndrome in adolescents is not only present in the United States. A recent report on the prevalence of metabolic syndrome amongst 10 to 16 year olds in South Africa (Western Cape) reported an overall prevalence of 6.5%, similar to rates reported in the US.¹⁸

In summary, the prevalence of the metabolic syndrome is increasing globally and in South Africa. In this article, the scientific rationale for a lifestyle intervention programme for the metabolic syndrome will first be discussed. The main focus will be on the rationale for a lifestyle intervention programme in the management of the metabolic syndrome. This will be followed by an outline of the elements incorporated in a typical lifestyle intervention programme for the management of the

metabolic syndrome. Finally, the practical implementation of a lifestyle intervention programme as part of the management of metabolic syndrome will be reviewed.

Rationale for a lifestyle intervention programme for the metabolic syndrome

The principles that are involved in the diagnosis and management of the metabolic syndrome have recently been reviewed.^{9,11,12} Comprehensive medical care of patients with the metabolic syndrome incorporates a number of treatment modalities including lifestyle intervention, drug treatment and laparoscopic weight-reduction surgery in selected patients.¹⁹ Of these, lifestyle intervention is consistently regarded as the first-line treatment and the cornerstone of management of the metabolic syndrome.^{9,11,19} The scientific support for all three these interventions has recently been reviewed.¹⁹ Data from a number of clinical trials show that lifestyle intervention results in resolution after treatment in 25% of subjects with the metabolic syndrome (varying from 20–48% across trials).^{20–22} A detailed discussion of the evidence for drug treatment and surgical treatment is beyond the scope of this article and has recently been reviewed.¹⁹ However, it is worth noting that drug treatment (rimonabant – 3 clinical trials, metformin – 1 clinical trial), and rosiglitazone – 1 clinical trial) as well as laparoscopic weight-reduction surgery in selected patients resulted in a mean % resolution of the metabolic syndrome after treatment in 19% and 93% subjects respectively.¹⁹

Elements of a lifestyle intervention programme for the metabolic syndrome

The main lifestyle interventions for the treatment of the metabolic syndrome are similar to those for other chronic diseases of lifestyle^{23–27} and include nutritional intervention, promotion of physical activity, psychosocial care and education. The main focus of a lifestyle intervention programme for metabolic syndrome is to reduce the risk factors which are overweight and obesity, physical inactivity and atherogenic dyslipidaemia.²⁸ In addition, psychosocial care and education should be included as a part of a comprehensive lifestyle intervention programme for metabolic syndrome in order to reduce the risk factors and improve adherence.

As with lifestyle interventions in other chronic diseases, the 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 been diagnosed with the metabolic syndrome (Table I), as part of first-line treatment, they should be referred to a lifestyle intervention programme. The indications and contra-indications for referral of a patient to a lifestyle intervention programme for the management of metabolic syndrome are listed in Table II.

A medical practitioner trained in sports and exercise medicine together with a general physician or one specialising in the management of the metabolic syndrome usually directs 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.

Table II: Indications and contra-indications for referral to a lifestyle intervention programme for the metabolic syndrome

Indications	<ul style="list-style-type: none"> All patients with a clinical diagnosis of the metabolic syndrome (Table I) Motivated patient Adherent patient
Absolute contra-indications	<ul style="list-style-type: none"> General contra-indications to exercise training and testing²⁴
Relative contra-indications	<ul style="list-style-type: none"> General relative contra-indications to exercise training and testing²⁴

Practical implementation of a lifestyle intervention programme for the metabolic syndrome

The first step in the implementation of a lifestyle intervention programme for metabolic syndrome is a comprehensive initial medical and risk assessment.^{9,11} The main reason for this is that the metabolic syndrome is associated with an increased risk of i) cardiovascular events (Relative Risk – RR = 2.18), ii) coronary heart disease event (RR = 1.65), iii) cardiovascular deaths (RR = 1.91), coronary heart disease deaths (RR = 1.60) and iv) overall death (RR = 1.60).²⁹ In addition, the risk of diabetes mellitus is also increased by about five fold in patients with the metabolic syndrome.¹² Therefore, the initial assessment should consist of a medical history, clinical examination and special investigations (as required) (Table III).

Table III: Details of a medical assessment prior to a lifestyle intervention programme for metabolic syndrome

Medical history	<ul style="list-style-type: none"> General demographics (age, gender, ethnicity) History of past or current metabolic, cardiovascular or endocrine disease Comprehensive nutritional history Comprehensive physical activity history Other general past medical and injury history Psychosocial history
Physical examination	<ul style="list-style-type: none"> Body weight, height, Body Mass Index (BMI), skinfolds for percent body fat General medical examination Cardiovascular assessment including blood pressure (including orthostatic response), heart rate, pulses Respiratory assessment Abdominal assessment Neurological assessment Musculoskeletal assessment to identify any limitations to exercise training
Special investigations	<ul style="list-style-type: none"> Blood tests (fasting blood glucose, HBA1c – if not in last 2–3 months, fasting lipogram for atherogenic dyslipidaemia – if not in last 12 months) Full nutritional assessment Diagnostic resting and graded exercise electrocardiogram (ECG) Functional capacity tests (6 min walk test, flexibility, muscle strength, muscle endurance) Psychosocial assessment

The aims of this assessment are:

- to confirm the indications for referral (Table II)
- to exclude absolute and identify relative contra-indications to the lifestyle programme, in particular exercise training (Table II)
- to identify any co-morbidities and other systemic consequences of metabolic syndrome
- to determine functional capacity – this would typically include exercise

electrocardiography (ECG) (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 metabolic syndrome can be planned.

Nutritional intervention for metabolic syndrome

Nutritional intervention of the metabolic syndrome should be aimed at the clinical consequences related thereto, which could include insulin resistance as well as cardiovascular and/or metabolic complications.^{7,30} Clinical management goals should also address those factors which could pose underlying risk in susceptible individuals.⁹

The principle nutritional intervention strategies in the metabolic syndrome are listed in Table IV.

Table IV: Principle nutritional intervention strategies for metabolic syndrome

Nutritional intervention	Rationale
Weight reduction	<ul style="list-style-type: none"> A significant proportion of individuals who have metabolic syndrome are overweight One of the main treatment areas should be weight reduction, with the main objective of reduced insulin resistance^{9,30}
Reduced dietary fat intake	<ul style="list-style-type: none"> A reduced saturated fat intake is advised because of the likelihood of dyslipidaemia and subsequent risk for developing cardiovascular disease^{7,9,30} This should be combined with the intake of monounsaturated fatty acids (MUFA) in moderate quantities, as well as omega 3 polyunsaturated fatty acids (PUFA), which could potentially have a positive effect on the lipid profile A total fat intake of 30–35% TE (total energy) is recommended, with 5–10% being omega 3 PUFA^{30,31}
Carbohydrate intake	<ul style="list-style-type: none"> Intake of wholegrain carbohydrates (CHO) is advised Fruit, vegetables, legumes and starchy foods with a low glycaemic index (GI) are encouraged³⁰ CHO intake should comprise 45–55% of total energy intake
Protein intake	<ul style="list-style-type: none"> It is recommended that protein intake be limited to 15–20% of total energy intake The emphasis in protein intake should be on the reduction of saturated and trans fats Reduced fat protein choices are recommended such as skinless chicken, turkey and fish; reduced fat and fat-trimmed beef, veal, lean pork, ham; low fat or fat free dairy, dairy alternatives and cottage cheese, and ricotta cheese³¹
Alcohol intake	<ul style="list-style-type: none"> Alcohol intake should be restricted to less than 30 grams per day³⁰
Salt intake	<ul style="list-style-type: none"> Salt intake should be restricted to less than 4 grams per day³⁰

Other interventions such as drug therapy and surgery are only recommended once these nutritional intervention strategies have not been successful.⁹

Exercise intervention for metabolic syndrome

The health benefits of regular physical activity for metabolic syndrome are well established and have been extensively reviewed. The main

benefits of regular exercise training for patients with the metabolic syndrome relate to the following: improvements in muscle and liver insulin sensitivity, increased muscle glucose uptake, improved glycaemic control, improved lipid profile, reduced body weight, reduced blood pressure, positive effects on the thromboembolic state, and reductions in the overall cardiovascular risk.

Exercise training combined with nutritional intervention are the cornerstones of a lifestyle intervention programme for metabolic syndrome^{9,11,12,28} and should therefore be a mandatory component of such a lifestyle intervention programme.

The exercise training component of lifestyle intervention for metabolic syndrome can be administered in an out-patient setting, as a self administered home-based programme, or 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 metabolic syndrome. 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 metabolic syndrome that undergo lifestyle intervention.^{9,11} High risk individuals are those with 1) established diabetes mellitus, 2) established cardiovascular disease or 3) those where the 10-year risk for coronary heart disease (CHD) is > 25% (using the Framingham risk scoring system).⁹

As with many other chronic diseases, the 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 such as in co-existing cardiovascular disease²⁴ or diabetes mellitus and its complications (poor glycaemic control, presence of retinopathy, presence of nephropathy, and presence of peripheral or autonomic neuropathy).²⁶ These higher risk patients will benefit from an initial period of exercise training under medical supervision.

In patients with metabolic syndrome and a moderately high risk of CHD (10–20% Framingham risk score), or in those with co-existing disease where medically directed exercise is indicated,^{24,26} 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 metabolic syndrome and a low risk of CHD (< 10% Framingham risk score), and with minimal or no co-morbidities, the exercise intervention programme can be self administered in a home-based setting. However, it should be noted that supervised exercise is associated with greater adherence to the lifestyle intervention.³²

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 metabolic syndrome are summarised in Table V.

Table V: Recommendations for each component of the exercise training in patients with the metabolic syndrome

Component	Recommendation/s
Frequency of training sessions⁹	<ul style="list-style-type: none"> Start the programme with training 2–3 times per week Can increase the training sessions to ≥ 3 times per week As for diabetes mellitus, the heightened insulin sensitivity following exercise training lasts 24–72 hours, therefore exercise training is encouraged on most days of the week
Duration of a training session^{9,11}	<ul style="list-style-type: none"> The endurance training component of the session should be at least 30 minutes (preferably longer up to 60 minutes) Physical activity during the day (stair climbing, walking) is strongly encouraged The regular use of pedometers can motivate patients to increase their daily physical activity
Length of the programme	<ul style="list-style-type: none"> A long term commitment to maintain an exercise training programme is strongly recommended
Intensity of training⁹	<ul style="list-style-type: none"> The intensity of training is determined by the outcome of a symptom limited exercise test The usual recommended intensity is moderate (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)
Type (modality) of training^{9,11}	<ul style="list-style-type: none"> Endurance type training (brisk walking, jogging, cycling, rowing, stair climbing, Nordic ski trainer) has traditionally been the main type of exercise and should be included Recent evidence shows substantial benefits from regular resistance training in patients with the metabolic syndrome (recommended at 2 times per week) Flexibility training should also be included in the training programme
Monitoring and progression of training	<ul style="list-style-type: none"> Monitoring of each patients during training session is important Monitoring can include recording resting and exercise heart rate and blood pressure 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

Psychosocial intervention

The primary pathophysiological link between metabolic syndrome and psychosocial phenomena centers on stress. There is a growing body of evidence suggesting that the syndrome is a maladaptive consequence of an initially successful adaptation to high environmental demands. In other words, dysregulation of the glucocorticoid and autonomic stress axes mediate the pathogenic role of metabolic syndrome.³³⁻³⁵

The therapeutic corollary, that is reducing chronic psychosocial stress, is thus (theoretically at least) a significant component of managing this disorder. The literature in this regard almost exclusively focuses on exercise and nutrition, with a relative paucity of data investigating behavioural, psychological and mind-body therapies to modify the metabolic sequelae.

Initial evidence suggests that traditional mind-body therapies offer potential benefit in both the prevention and attenuation of the development of insulin resistance, dyslipidaemia and obesity. As is often the case in

this area, the available data is inconsistent with respect to study design, setting and population groups. However, meta-analyses of the possible protective effects of different forms of yoga, breathing techniques and meditation suggest that these modalities may reduce risk factors and improve clinical outcomes. The hypothesised mechanism through which these modalities exert therapeutic effect include modification of cardiac vagal tone/heart rate variability (increased parasympathetic activation), reduction in perceived stress and reactivity to stressful stimuli, decrease in fatigue and tension, enhancement of sleep, and reduced symptoms of anxiety and depression.^{36,37}

Finally, the enhancement in capacity to cope with stress, through any means, will further support compliance and motivation with well-established behavioural modification (exercise and nutrition) which is central to the effective management of the metabolic syndrome.

Other lifestyle interventions

As with other chronic diseases of lifestyle, educational strategies as well as cessation of smoking are two very important components of lifestyle intervention for patients with metabolic syndrome. Practical guidelines to assist patients with chronic disease to stop smoking have been reviewed in Part 3 (Chronic Respiratory disease) of this series.²⁵

Repeat assessment, follow-up and retention

All the parameters that were recorded during the initial assessment, before entering the lifestyle intervention programme, should be repeated after a defined period of intervention (usually three 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 metabolic syndrome should be re-assessed regularly (at least once per year).

Summary and conclusions

There is strong scientific evidence that a lifestyle intervention programme is the first-line and the cornerstone management strategy for patients with the metabolic syndrome. The main indication for referral to a lifestyle intervention programme is any patient who fulfills the clinical diagnostic criteria for the metabolic syndrome. The main elements of the intervention programme are nutritional intervention, exercise training (minimum of three times per week) and psychosocial intervention. A follow-up assessment is indicated after the first three months to assess progress and to re-set goals. Longer-term and supervised intervention programmes are associated with better long-term outcomes.

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