Nutrition in Metabolic Syndrome

Topic 24

Module 24.3

Lifestyle Interventions in Metabolic Syndrome

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Learning Objectives

• Diet modification in overweight and obese individuals;
• Beneficial effects of exercise;
• Prescription of exercise;
• Strategies to improve lifestyle counselling;
• Evidence of lifestyle intervention efficacy.

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2. Diet
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   3.4 Prescription of exercise
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4. Lifestyle-counseling
5. Evidence of lifestyle intervention efficacy
6. Self-assessment test
7. Clinical case

Key Messages

• Lifestyle modification improves diabetes and cardiovascular risk;
• Modest weight loss and light physical activity significantly reduce insulin resistance;
• Behavioral strategies are necessary to achieve long-term success in maintaining adequate food intake and exercise.
1. Lifestyle Interventions in Metabolic Syndrome

Abdominal obesity is the main etiologic factor in the development of metabolic syndrome. As the syndrome advances many persons suffer a cascade of adverse events, such as the development of type 2 diabetes and cardiovascular disease, as well as complications associated to them (Fig. 1).

![Figure 1](image)

The primary intervention for correcting metabolic syndrome is lifestyle therapy. It has the potential to reduce the severity, slow the progression of all metabolic risk and delay the need of drug therapy in persons with metabolic syndrome. These therapies consist of weight reduction, increased physical activity, following an anti-atherogenic diet and smoking cessation (1). Once a person is found to have the syndrome, lifestyle therapies should be introduced, reinforced, and monitored. Modest weight loss (5-10% of body weight) and modest physical activity (30 min daily) are the recommended goals (2).

2. Diet

The ideal diet for individuals with Metabolic Syndrome has to improve insulin sensitivity and prevent or correct the associated metabolic and cardiovascular abnormalities. Most individuals with Metabolic Syndrome are overweight and obesity is the main cause of insulin resistance.

Effective weight reduction improves all risk factors associated with the metabolic syndrome and it will further reduce the risk for type 2 diabetes. Weight loss improves insulin sensitivity in a proportion greater than that obtained with insulin-sensitizing drugs. The treatment of obesity consists of diet change, exercise, behavioral modification, and in some patients, drugs or surgery. Dietary intervention to reduce energy intake and physical activity to enhance energy expenditure are basic forms of treatment in any overweight or obese patient. In contrast to drug therapy or surgery, diet and physical activity can be changed by lifestyle modifications.

Many different diets have been proposed for the treatment of obesity (3). These dietary approaches vary in their total energy prescription, macronutrient (fat, carbohydrate, and protein) content, glycemic index, energy density, and portion control.
2.1 Energy Intake

The energy content of a diet is the primary determinant of weight loss. Diets can be classified as

Low Calorie Diets (LCD): 12-20 kcal/kg ideal body weight/d (50-80 kj/kg), usually between 800 to 1500 kcal/day;

Very Low Calorie Diets (VLCD): < 12 kcal/kg ideal body weight/d (< 50 kj/kg), usually less than 800 kcal/day.

An LCD typically causes a ≈ 8% loss of body weight at ≈ 6 months of treatment. In contrast, the use of a VLCD usually produces a weight loss of ≈ 15% to 20% within 4 months. However, VLCDs are associated with poorer weight loss maintenance and a greater weight regain than are LCDs, so weight loss at 1 year after treatment with a VLCD does not differ from treatment with an LCD.

Most authorities and clinical guidelines recommend a 500- to 1000-kcal/d deficit diet for obese persons, which will initially result in a weekly weight loss of 0.45 to 0.9 kg. Patient’s daily energy requirements can be estimated from the equation proposed for obese individuals by the Institute of Medicine’s Dietary Reference Intakes for Energy (4):

For men:

\[ TEE = 1086 - (10,1 \times \text{age [years]}) + \text{AF} \times (13,7 \times \text{weight [kg]} + 416 \times \text{height [m]}) \]

AF (activity factor) depends on the physical activity level (PAL):

\[
\begin{align*}
\text{AF} &= 1 & \text{if activity is sedentary:} & \text{PAL is} \geq 1 < 1,4 \\
\text{AF} &= 1,12 & \text{if activity is light:} & \text{PAL is} \geq 1,4 < 1,6 \\
\text{AF} &= 1,29 & \text{if activity is active:} & \text{PAL is} \geq 1,6 < 1,9 \\
\text{AF} &= 1,59 & \text{if activity is very active:} & \text{PAL is} \geq 1,9 < 2,5
\end{align*}
\]

For women:

\[ TEE = 448 - (7,95 \times \text{age [years]}) + \text{AF} \times (11,4 \times \text{weight [kg]} + 619 \times \text{height [m]}) \]

AF (activity factor) depends on the physical activity level (PAL):

\[
\begin{align*}
\text{AF} &= 1 & \text{if activity is sedentary:} & \text{PAL is} \geq 1 < 1,4 \\
\text{AF} &= 1,16 & \text{if activity is light:} & \text{PAL is} \geq 1,4 < 1,6 \\
\text{AF} &= 1,27 & \text{if activity is active:} & \text{PAL is} \geq 1,6 < 1,9 \\
\text{AF} &= 1,44 & \text{if activity is very active:} & \text{PAL is} \geq 1,9 < 2,5
\end{align*}
\]

If it is difficult to determine a patient’s daily energy requirements, calorie-intake guidelines for a weight-loss diet have been suggested based on a patient’s initial body weight (Table 1) (3).

Table 1

<table>
<thead>
<tr>
<th>Body Weight, kg</th>
<th>Suggested Energy Intake, kcal/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-90</td>
<td>1000</td>
</tr>
<tr>
<td>90-115</td>
<td>1200</td>
</tr>
<tr>
<td>115-135</td>
<td>1500</td>
</tr>
<tr>
<td>135-160</td>
<td>1800</td>
</tr>
<tr>
<td>&gt; 160</td>
<td>2000</td>
</tr>
</tbody>
</table>
2.2 Macronutrient Distribution

It is generally accepted that the macronutrient composition of a diet does not affect the rate of weight loss. However, several concepts have been proposed as the ideal macronutrient distribution in diets for obese patients (5):

**Low fat diet**: a low-fat diet is considered the standard approach for the treatment of obesity. The “classical” distribution of macronutrients in a diet for obesity is shown in Figure 2, left column. Despite the traditional support that well-informed physicians have given to these diets, a Cochrane review conducted to evaluate dietary therapy for obesity found that weight loss induced by low-fat diets and other weight-reducing diets were similar, especially after 12 months’ follow-up (6). On the other hand, some data suggest that obese persons, who are successful at maintaining long-term weight loss, consume a lower percentage of calories from fats.

**Low carbohydrate diet**: in recent years, the use of low-carbohydrate diets has become the focus of much research. In all studies, weight loss at 3 and 6 months in subjects randomized to the low-carbohydrate diet was = 2 times as great (= 4- to 5-kg greater weight loss) as those randomized to the low-fat group. However, when patients were followed-up for 1 year, weight loss was not significantly different between groups. It appears that the positive benefits come from a reduction of energy intake, and not from the carbohydrate restriction itself. The low-carbohydrate diet was more beneficial in serum triglyceride and HDL-C concentrations as compared with the low-fat diet, but the low-fat diet was more beneficial in serum LDL-C concentration. It is not known whether these alterations are associated with long-term beneficial effects on CHD. The low content of antioxidant vitamins, dietary fiber and high content in total fat are a cause of concern because their long-term effects, on either global health or cardiovascular health in particular, have not been evaluated (7).

**High protein diet**: Replacing protein for carbohydrates has also been proposed as a method for weight loss. Several advantages have been pointed out: better conservation of lean body mass, lower postprandial insulin response, higher satiating effect, decrease in triglyceride levels (8). However, comparison of iso-energetic high protein diets with standard high carbohydrate diets has failed to show differences of weight loss. There is also a concern that these diets could increase urinary calcium excretion and bone turnover. Therefore, they can not be advocated for long-term treatment of individuals with Metabolic Syndrome.

2.3 Diet Recommendations for the Metabolic Syndrome

Specific recommendations for subjects with Metabolic Syndrome have recently been proposed (Table 2)

### Table 2

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>↓ Energy intake to ↓ 5-10 % body weight or maintain desirable weight</td>
</tr>
</tbody>
</table>
| Carbohydrate | ↑ Low Glycemic Index foods  
|             | ↑ Fibre intake  
|             | Avoid potatoes, bread, pasta, rice, sweetened cereals, soft drinks, sweetened juices |
| Proteins   | ↑ Fish, low dairy and vegetable protein |
| Fat        | ↓ Saturated fat (< 7 % energy) and trans fatty acids (< 2 % energy)  
|           | ↑ Monounsaturated fatty acids  
|           | Use virgin olive oil as a basic cooking fat |
| Others     | ↓ Salt intake to < 6 g/day  
|           | ↓ Alcohol intake to < 2-3 drinks/day |
The main features of these recommendations are (9):

**Energy:** Energy intake should allow patients to maintain weight, if it is acceptable, or to reduce it in 5 to 10%. It is important that patients learn to make good food choices, such as low-energy-density foods, and to decrease the size of the portion served to decrease the amount of food consumed.

**Carbohydrates:** Foods with low Glycemic Index (GI) may have favorable effects on insulin sensitivity and lipid levels. However, systematic reviews have failed to substantiate these benefits. The glycemic response to a specific food that is ingested as part of a meal can be altered by many factors, such as the method of preparation and the effect of concomitantly ingested foods on intestinal motility. Nevertheless, fruits, vegetables, legumes, and whole-grain cereals are considered important components of the diet. In contrast, bread, potatoes, pasta, and refined rice, all of them with higher GI, should be sparingly consumed. Very recently, a classification of drinks has been formulated. Soft drinks and sweetened juices are considered main culprits of the obesity epidemic and should be avoided or eliminated.

**Proteins:** Fish, low-fat diary, vegetable protein and lean meats are recommended. Some authors entertain the hypothesis that these protein sources reduce insulin resistance in comparison with red meat, but more evidence is necessary.

**Fat:** Quality of fat is more important than quantity. Following a Mediterranean-diet style, monounsaturated fatty acids (MUFA) intake should be 20-25%. A 60-70% proportion of the energy intake as low glycemic index carbohydrates together with MUFA should be the best choice in individuals with metabolic syndrome. This approach facilitates the compliance with the diet recommendations, since it allows a less drastic reduction of the total amount of fat. On the other hand, saturated fat and trans fatty acids should be limited to < 7% and < 2% of energy intake, respectively. The ω-3 fatty acids have anti-thrombotic effects and can decrease cardiovascular risk (10). Patients should remember that a food’s energy density is directly correlated with its fat content and inversely correlated with its water content. The use of low-energy-density foods may be an effective approach for treating obesity.

**Macronutrient distribution:** When energy restriction is prescribed, the percentage of protein is frequently higher than 20% of total energy. Fat can be increased up to 35-40%, if MUFA plus low GI carbohydrates add up to 60-70%. In that case, carbohydrates are reduced to 40-45% of total energy (Fig. 2).

![Figure 2](image)

Some authors have advocated a 30-40-40 diet for patients with metabolic syndrome and type 2 diabetes. Foods included and excluded in this diet are similar to those recommended above.
Other nutrients: According to the Dietary Approaches to Stop Hypertension (DASH) study, salt intake should be not higher than 6 g of sodium chloride/day. Alcohol intake should be less than 2-3 drinks/day (< 30 g/day) in men and 1-2 (< 20 g) in women. Although modest consumption of alcohol is associated to a decrease in the relative risk of coronary heart disease, alcohol ingestion may worsen other factors linked to Metabolic Syndrome, such as steatohepatitis or triglyceride levels.

2.4 Benefits of Weight Loss
Intentional weight loss, even a modest deficit of \(\approx 5\%\) of initial weight, can improve or prevent many of the obesity-related risk factors: insulin resistance, metabolic syndrome and type 2 diabetes mellitus, dyslipidemia, hypertension, pulmonary disease and inflammation. There are not reports of randomized clinical trials that had studied whether intentional weight loss affects CVD mortality (3). As weight loss modifies many cardiovascular disease risk factors, it could be assumed that weight reduction would decrease cardiovascular events or mortality.

3. Exercise

3.1 Benefits of physical activity
Modern lifestyles are characterized by a reduced physical activity on the job and during leisure time. Many individuals with metabolic syndrome have a sedentary life. The decrease in physical activity augments the risk of obesity, diabetes, fatal and nonfatal coronary artery disease (CAD), as well as all-cause mortality. In contrast, the most physically active subjects have reduced incidence of CAD, with a constant inverse correlation: The higher the level of activity the lower the CAD rate.

Numerous studies have identified multiple mechanisms that could explain the beneficial consequences of physical activity on the development of these diseases. Among them are anti-atherogenic, anti-thrombotic, anti-ischemic, and anti-arrhythmic effects (11). Physical activity both prevents and helps treat many established atherosclerotic risk factors. In general, the effect of exercise on these risk factors is substantially less than that achieved by pharmacological therapies. However, combined with weight loss and improvements in dietary composition, the effect of exercise may be more relevant (12).

Obesity
Increasing physical activity favors weight loss. Although it is difficult to achieve a significant weight loss based only on increased exercise, when it is combined with diet, individuals loose more weight than with diet alone. Furthermore, this loss is maintained for longer periods of time.

Exercise also produces beneficial changes in body composition. Weight loss induced by combining physical activity with diet decreases the loss of Fat Free Mass that occurs when weight loss is produced by diet alone. Physically active men and women have a more favorable waist-to-hip ratio than do sedentary individuals, reflecting a decrease of central obesity (11).

Physical activity is very important for preventing weight regain. Numerous studies confirm that patients that keep their increased physical activity for longer periods after lifestyle interventions regain less weight, although exercise alone does not completely prevent some weight recuperation. The amount of weekly-spent calories in physical activities is higher in patients that maintain the lost weight (3).

Lipids
Epidemiological studies of physical activity have shown an average reduction in triglyceride and LDL- C of 4-5% and a similar increase in HDL-C. A meta-analysis of 95 studies, most of which were not randomized controlled trials, reported better results with a reduction of 6.3% in total cholesterol, 10.1% in LDL cholesterol, and 13.4% in total/HDL cholesterol ratio and a 5% increase in HDL (13). Table 3 shows the reductions observed in the HERITAGE study that included 675 normolipidemic subjects who participated in 5 months of exercise training (14).
Blood pressure
Physical activity has also beneficial effects on resting blood pressure. The reported average reduction in systolic and diastolic blood pressure is of 3.4 and 2.4 mm Hg, respectively. The decrease of blood pressure is more significant in hypertensive subjects. Average systolic and diastolic blood pressures decreases 2.6 and 1.8 mm Hg in normotensive subjects and 7.4 and 5.8 mm Hg in hypertensive subjects, respectively (15). Regular exercise reduces the incidence of hypertension. Moderate-intensity dynamic exercise is preferable to vigorous exercise, as moderate-intensity exercise appears to be more effective in reducing blood pressure (16).

Diabetes Mellitus
Physical activity reduces insulin resistance and glucose intolerance, postprandial hyperglycemia, and possibly hepatic glucose output. Several prevention trials (Table 4) have proven that physical activity and weight loss can decrease the onset of type II diabetes in individuals at high risk for this disease. In a study of 6000 men followed for 14 years, each 500 kcal/week increase in physical activity reduced the age-adjusted risk of diabetes by 6 % (17).

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDL-c, mg/dl</td>
<td>+ 1.1 (3 %)</td>
<td>+ 1.4 (3 %)</td>
</tr>
<tr>
<td>LDL-c, mg/dl</td>
<td>- 0.9 (0.8 %)</td>
<td>- 4.4 (4 %)</td>
</tr>
<tr>
<td>Triglycerides,</td>
<td>- 5.9 (2.7 %)</td>
<td>- 0.6 (0.6 %)</td>
</tr>
<tr>
<td>mg/dl</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Metabolism 2000; 49:513-520

Table 4

<table>
<thead>
<tr>
<th>Study</th>
<th>Age (y)</th>
<th>BMI</th>
<th>FPG mg/dl</th>
<th>Intervention</th>
<th>RRR %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Da Qing</td>
<td>44</td>
<td>&gt; 25</td>
<td>NA</td>
<td>Diet ± Exercise</td>
<td>31-46</td>
</tr>
<tr>
<td>FDPS</td>
<td>55</td>
<td>31</td>
<td>110</td>
<td>Diet + Exercise</td>
<td>58</td>
</tr>
<tr>
<td>DPP</td>
<td>51</td>
<td>34</td>
<td>110</td>
<td>Diet + Exercise</td>
<td>58</td>
</tr>
<tr>
<td>XENDOS</td>
<td>43</td>
<td>37</td>
<td>83</td>
<td>Metformine</td>
<td>31</td>
</tr>
<tr>
<td>STOP-NIDDM</td>
<td>55</td>
<td>&gt; 31</td>
<td>101-139</td>
<td>Orlistat</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Acarbose</td>
<td>25</td>
</tr>
</tbody>
</table>

Modified from: Endocrinol Metab Clin N Am 2005; 34:199-219

3.2 Characterization of exercise
From a clinical point of view, any physical activity should be assessed according to five features: intensity, frequency, duration, mode, and progression. In relation to the first concept, it is useful to distinguish between absolute and relative intensity:
**Absolute intensity:** rate of energy expenditure during exercise. It is usually expressed in METs, where 1 MET equals the resting metabolic rate of $3.5 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. One MET is the energy consumed during resting conditions, such as television viewing, and is equal to $\approx 1 \text{ kcal/kg of body weight per hour}$. On the other hand, brisk walking at 4.8 km/hour (3 miles/hour) has an absolute intensity of 4 METs. Table 5 and Table 6 list the energy requirements of various activities of daily life and of leisure time. METs can be transformed in kilocalories with the following formula: kilocalories per minute $= \frac{(\text{METs} \times 3.5 \times \text{body weight in kilograms})}{200}$.

### Table 5

<table>
<thead>
<tr>
<th>Activity</th>
<th>METs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardening (no lifting)</td>
<td>4.4</td>
</tr>
<tr>
<td>Household tasks, moderate effort</td>
<td>3.5</td>
</tr>
<tr>
<td>Lifting items continuously</td>
<td>4.0</td>
</tr>
<tr>
<td>Loading/unloading car</td>
<td>3.0</td>
</tr>
<tr>
<td>Lying quietly</td>
<td>1.0</td>
</tr>
<tr>
<td>Mopping</td>
<td>3.5</td>
</tr>
<tr>
<td>Mowing lawn (power mower)</td>
<td>4.5</td>
</tr>
<tr>
<td>Raking lawn</td>
<td>4.0</td>
</tr>
<tr>
<td>Riding in a vehicle</td>
<td>1.0</td>
</tr>
<tr>
<td>Sitting; light activity</td>
<td>1.5</td>
</tr>
<tr>
<td>Taking out trash</td>
<td>3.0</td>
</tr>
<tr>
<td>Vacuuming</td>
<td>3.5</td>
</tr>
<tr>
<td>Walking the dog</td>
<td>3.0</td>
</tr>
<tr>
<td>Walking from house to car or bus</td>
<td>2.5</td>
</tr>
<tr>
<td>Watering plants</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*Circulation 2001; 104:1694–1740*

### Table 6

<table>
<thead>
<tr>
<th>Activity</th>
<th>METs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billiards</td>
<td>2.4</td>
</tr>
<tr>
<td>Dancing (ballroom)</td>
<td>2.9</td>
</tr>
<tr>
<td>Golf (with cart)</td>
<td>2.5</td>
</tr>
<tr>
<td>Golf (without cart)</td>
<td>4.4</td>
</tr>
<tr>
<td>Horseback riding (walking)</td>
<td>2.3</td>
</tr>
<tr>
<td>Walking (2 mph)</td>
<td>2.5</td>
</tr>
<tr>
<td>Walking (3 mph)</td>
<td>3.3</td>
</tr>
<tr>
<td>Walking (4 mph)</td>
<td>4.5</td>
</tr>
<tr>
<td>Climbing hills (no load)</td>
<td>6.9</td>
</tr>
<tr>
<td>Climbing hills (5 kg load)</td>
<td>7.4</td>
</tr>
<tr>
<td>Jogging (10 min mile)</td>
<td>10.2</td>
</tr>
<tr>
<td>Cycling (leisurely)</td>
<td>3.5</td>
</tr>
<tr>
<td>Cycling (moderately)</td>
<td>5.7</td>
</tr>
<tr>
<td>Skiing (water or downhill)</td>
<td>6.8</td>
</tr>
<tr>
<td>Swimming (slow)</td>
<td>4.5</td>
</tr>
<tr>
<td>Swimming 7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Tennis (doubles)</td>
<td>5.0</td>
</tr>
<tr>
<td>Squash</td>
<td>12.1</td>
</tr>
</tbody>
</table>

*Circulation 2001; 104:1694–1740*

**Relative intensity:** relative percentage of maximal aerobic power that is maintained during exercise. It is expressed as a percentage of maximal heart rate (maximum heart rate equals 220 minus age) or a percentage of VO$_2$max.
Table 7 shows a classification of activities and their corresponding percentages of both $\text{VO}_{2 \text{max}}$ and maximum heart rate, as well as METs. As it can be seen, METs attributed to the different classes of activities (light, moderate, etc) are lower in older than in young persons. Therefore, in relative terms, the intensity depends on the age of the person. Brisk walking could be considered as a vigorous exercise for an 80 year-old person, but a light activity for a 20-year-old individual (11).

Table 7

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Relative Intensity</th>
<th>Absolute Intensity (Age) METs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\text{VO}_{2 \text{max}}$ %</td>
<td>Max Heart Rate %</td>
</tr>
<tr>
<td>Very light</td>
<td>&lt; 20</td>
<td>&lt; 35</td>
</tr>
<tr>
<td>Light</td>
<td>20-39</td>
<td>35-54</td>
</tr>
<tr>
<td>Moderate</td>
<td>40-59</td>
<td>55-69</td>
</tr>
<tr>
<td>Hard</td>
<td>60-84</td>
<td>70-89</td>
</tr>
<tr>
<td>Very hard</td>
<td>&gt; 85</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>Maximum</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

3.3 Prescription of exercise

Exercise does not need to be of high intensity to achieve the benefits associated with it. The total amount of activity is more important than the performance of high-intensity exercise. On the other hand, vigorous exercise performed by untrained individuals predisposes them to orthopedic injuries and higher dropout rates.

In current living conditions, individuals have few opportunities to do exercise in their jobs. Therefore, they should turn to physical activities during their leisure time, with a minimum goal of 700 to 1000 kcal/week.

A consensus has been reached that a minimum of 30 minutes of moderate intensity physical activity, such as a brisk walking, is required on most, and preferably all, days of the week to obtain the clinical benefits described before. This is equivalent to ≈1.5 miles per day of brisk walking at an energy cost of 150 kcal per day for an average-sized person (3).

In the Diabetes Prevention Program (see below) the goal for physical exercise was selected to approximate at least 700 kcal/week expenditure from physical activities. This goal was described as at least 150 min/weekly of moderate physical activities similar in intensity to brisk walking. Other activities that are usually equivalent are aerobic dance, bicycle riding, and swimming (18).

Alternatively, it has been reported that the intensity of activity needed to improve physical conditioning may be as low as 40% of $\text{VO}_{2 \text{max}}$ for 20 minutes 3 times per week. However, there is still debate about a possible beneficial activity threshold and the general recommendation is to do exercise daily. A summary of the main components of the exercise prescription, according to the FITT principle, is provided in Table 8 (19).
Table 8

<table>
<thead>
<tr>
<th>Component</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>3-5 days/week. More frequent exercise is desirable, but make sure that a regular exercise habit is acquired</td>
</tr>
<tr>
<td>Intensity</td>
<td>Start at a low to moderate intensity and gradually progress over the course of several weeks or months. Emphasis should be on increasing duration rather than intensity,</td>
</tr>
<tr>
<td>Time</td>
<td>30 to 60 minutes, using a gradual progression. Multiple short bouts produce similar benefits as a single long bout of the same total duration</td>
</tr>
<tr>
<td>Type</td>
<td>Low-impact activities (e.g., walking, cycling, low-impact aerobics, water exercise) that are convenient, accessible, and perceived as enjoyable by the participant</td>
</tr>
</tbody>
</table>

Individuals should follow some general guidelines when programming physical activity (Table 9).

Table 9

- Exercise only when feeling physically well.
- Do not exercise vigorously soon after eating.
- Drink fluids.
- Adjust exercise to the weather.
- Wear proper clothing and shoes.
- Understand personal limitations.
- Select appropriate exercises.
- Slow down for hills.
- Be alert for symptoms.
- Watch for signs of over-exercising.
- Start slowly and progress gradually. Allow time to adapt.

Circulation 2001; 104:1694–1740

A more active lifestyle may also be developed changing daily activities (e.g., walking instead of riding, using stairs instead of escalators/elevators, using public transportation instead of private car in the cities). These routines help to reliably increase overall physical activity, without considering them as an added time investment or occupation. Good exercise adherence and long-term weight loss has been observed in users of home exercise equipment such as treadmill.
Along with hobbies and sports, more formal exercise training may be useful to reduce the risk of injury or cardiovascular events associated with sudden onset of activity, increase functional capacity and muscular strength, improve the ability to sustain activities of daily living, and promote personal independence and positive self image. These activities consist of periods of warm-up and cool down, endurance exercise, flexibility exercise, and resistance training (11).

### 3.4 Risks of exercise

The main risks of exercise are musculoskeletal injuries, sudden cardiac death and myocardial infarction. These complications are more frequent in subjects who are not physically active, perform unaccustomed vigorous physical activities, or have previous cardiovascular disease. Musculoskeletal lesions are common in inactive people and individuals who suffer them may stop exercising. In general, it is advised a gradual increase of exercise over time to reduce injury risk. Sedentary subjects should avoid vigorous physical activity (12). The American Heart Association has established a classification of risk associated to exercise, according to the cardiovascular status (Table 10), as well as recommendations for the type of exercise and medical supervision that is prudent for patients with cardiovascular disease (11).

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Apparently Healthy Individuals</td>
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<tr>
<td>B</td>
<td>Presence of Known, Stable Cardiovascular Disease With Low Risk for Complications With Vigorous Exercise, but Slightly Greater Than for Apparently Healthy Individuals</td>
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<tr>
<td>C</td>
<td>Those at Moderate-to-High Risk for Cardiac Complications During Exercise and/or Unable to Self-Regulate Activity or to Understand Recommended Activity Level</td>
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<tr>
<td>D</td>
<td>Unstable Disease With Activity Restriction</td>
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A recent systematic review for the U.S. Preventive Services Task Force came to the conclusion that stress tests should usually not be recommended to detect ischemia in asymptomatic individuals at low CAD risk (<10% risk of a cardiac event over 10 years) because the risks of subsequent invasive testing triggered by false-positive tests outweighed the expected benefits from detection of previously unsuspected ischemia (20).

### 4. Lifestyle-counseling

Health professionals need to convince patients that effective lifestyle interventions will help prevent the development of the metabolic syndrome. Manson and colleagues have suggested that the stages for the intended behaviors of weight loss and increased physical activity are: pre-contemplation, in which desired behaviors are not occurring and the patient does not intend to initiate them; contemplation, in which desired behaviors are not occurring and the patient intends to initiate them;
preparation, in which the patient is exploring options;
action, in which the patient has begun lifestyle modification and engaged in it for > 6 months;
maintenance, in which the patient has engaged in lifestyle modification for > 6 months (21).

Several external barriers to lifestyle modification for patients have been identified in the ATP III report (22):
Increased consumption of foods prepared away from home;
Lack of time to both eat right and exercise;
Lack of third-party reimbursement for nutritional counseling;
Lack of adequate strategies for referral to registered dietitians and exercise trainers;
Perception that drug therapy is easier and, in all cases, more effective.

These and other obstacles have to be overcome by patients and health providers. Foreyt has proposed the concept of “toolbox” of strategies that can be to aid patients to introduce lifestyle changes (23). These strategies include:

**Setting goals**: The average weight loss is 8 % to 10 % of baseline weight. Patients and health professional should avoid unrealistic goals, such as trying to achieve a 20 % of their current weight in two months. Easy short-term goals can effectively motivate patients to comply with recommendations. They can be formulated as contracts that patients commit themselves to carry out. Goals should be reevaluated regularly, adapting them depending on patient’s achievements.

**Raising awareness**: If patients have to change their lifestyle, they have to recognize what they are eating and how much they are exercising. Food and exercise diaries are essential to collect this information, along with daily or weekly body weight recording. Patients should be instructed how to keep these diaries. It may also be useful to teach them how to transform food and physical activity into calories consumed and spent. Health professionals should encourage patients to keep these diaries convincing them that they are important means to long-tem success. Under-reporters of energy intake have a higher prevalence of Metabolic Syndrome than those who did not under-report (24).

**Confronting barriers**: Health professionals should help patients to devise strategies to solve problems that they will confront, such as coping with psychological stress, eating away of home, traveling and vacation, changing schedules, attending celebrations, etc.

**Changing eating behaviors and routines**: Patients should have a plan with a fixed number of meals. They should struggle to acquire new habits, such as eating slowly, using small dishes and portions, avoiding watching TV as they eat or repeating a dish without feeling hungry, adopting new forms of cooking that are more healthful, reading food labels, understanding portion size and energy intake during meals and snacks, etc.

**Organizing support**: family members, friends, colleagues can be very helpful to encourage patients to persevere with their efforts to modify their lifestyle. They should avoid suggestions to make transgressions, -just this time-, shopping food and beverages wisely, arranging for attractive and healthful leisure activities, etc.

5. Evidence of lifestyle intervention efficacy

Several randomized controlled trials have explored the efficacy of lifestyle modification or glucose-lowering drugs in preventing diabetes (Table 4). A common observation in all these trials was that substantial efforts were necessary to achieve only modest changes in weight and exercise, but those changes were sufficient to attain an important reduction in the incidence of diabetes (25).

The first large, randomized trial to show the impact of diet and exercise on the development of diabetes in high-risk individuals was the Da Qing Study. 577 men and women from 33 health care clinics in the city of Da Qing, China, were screened with oral glucose tolerance test (OGTT), and those with impaired glucose tolerance (IGT) were randomized by clinic to a control group or to one of three active treatment groups: diet only, exercise only, or diet plus exercise. For the intervention group, a diet of 25 to 30 kcal/kg (55-65 % carbohydrates, 25-30 % fat and 10-15 % protein) was designed. Participants were encouraged to increase their daily
intake of vegetables, to reduce the consumption of simple sugars. They were asked to increase their leisure activity by one or two units. The equivalence of one “unit” is defined in Table 11.

Table 11

<table>
<thead>
<tr>
<th>Activity Unit</th>
<th>Example</th>
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<tbody>
<tr>
<td>Mild</td>
<td>30 minutes slow walking</td>
</tr>
<tr>
<td>Moderate</td>
<td>20 minutes faster walking</td>
</tr>
<tr>
<td>Strenuous</td>
<td>10 minutes slow running</td>
</tr>
<tr>
<td>Very strenuous</td>
<td>5 minutes swimming, jumping rope</td>
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Subjects were seen by local physicians every 3 months and were reexamined biannually by the research staff. After an average of 6 years' follow-up, the diet, exercise, and diet plus exercise interventions were associated with 31, 46, and 42% relative reductions in risk of developing type 2 diabetes, respectively (26).

In the Finnish Diabetes Prevention Study, 522 middle-aged obese subjects with IGT were randomized to receive either brief diet and exercise counseling (control group) or intensive individualized instruction on weight reduction (target, at least < 5 % of body weight), food intake (fat and saturated fat < 30 % and < 10 % total calories, respectively, fiber > 15 g/1000 kcal), and guidance on increasing physical activity with. Moderate exercise, such as brisk walking, for 30 min/day was suggested. Supervised resistance-training sessions were also offered. Dietary advice was tailored by trained dietitians for each subject based on 3-day food diaries that were completed quarterly. An oral glucose-tolerance test was performed annually; the diagnosis of diabetes was confirmed by a second test. The mean duration of follow-up was 3.2 years. Weight loss averaged 4.2 kg at 1 year, and 3.5 kg after 2 years in the intervention group, versus 0.8 kg in the control group. There was a direct relationship between adherence with the lifestyle intervention and the reduced incidence of diabetes. After an average follow-up of 3.2 years, there was a 58% relative reduction in the incidence of diabetes in the intervention group compared with the control subjects (27).

The largest and best described diabetes prevention trial has been the Diabetes Prevention Program (DPP). In this 3-year study, carried out in U.S, 3234 subjects were randomized to one of three intervention groups, which included the intensive nutrition and exercise counseling (“lifestyle”) group or either of two masked medication treatment groups: the metformin group, 850 mg twice a day, or the placebo group. The latter interventions were combined with standard diet and exercise recommendations. There was a fourth arm that used troglitazone, 400 mg/d, but it was stopped when liver toxicity was observed with this drug. A low-fat (<25% fat) intake was recommended; if reducing fat did not achieve the weight loss goal, calorie restriction was also recommended. Participants weighing 54-78 kg at baseline were instructed to follow a 1,200-kcal/day diet (33 g fat), those 79-99 kg a 1,500-kcal/day...
diet (42 g fat), those 100-113 kg an 1,800-kcal/day diet (50 g fat), and those > 114 kg were instructed to follow a 2,000-kcal/day diet (55 g fat).

Participants in the lifestyle modification group received an individualized 16-lesson curriculum that covered diet, exercise and behavior modification, during the first 24 weeks. Subsequently, individual sessions occurred monthly and group sessions were used to reinforce behavioral changes.

On average, 50% of the lifestyle group achieved the goal of ≥7% weight reduction and 74% maintained at least 150 min/week of moderately intense activity. The lifestyle group lost -5.5 kg at 2 years and 4.1 kg at 3 years (mean weight loss for the study duration was -5.5 kg or 6% of initial body weight).

After an average follow-up of 2.8 years, a 58% relative reduction in the progression to diabetes was observed in the lifestyle group and a 31% relative reduction in the metformin group compared with control subjects. The benefit of lifestyle change over metformin was more apparent in older individuals and those who had lower BMI. Additional data show that part of the effect of metformin actually was treating some cases of already established diabetes more than preventing it (28).

In the STOP-IDDM trial, participants with IGT were randomized in a double-blind fashion to receive either the α-glucosidase inhibitor acarbose or a placebo. Lifestyle intervention has little intensity. Mean bodyweight decreased from 87.6 kg to 87.1 kg during the study in patients given acarbose and increased from 87.0 kg to 87.3 kg in those on placebo. Participants were instructed on a weight-reduction or weight-maintenance diet, and encouraged to exercise regularly. All participants met with a dietician before randomisation and yearly thereafter. Patients also completed a 3-day nutritional diary at time of eating and recorded their physical activities during the 3 days (2 weekdays, 1 weekend day) in the last month before each yearly visit. After a mean follow-up of 3.3 years, a 25% relative risk reduction in progression to diabetes, based on one OGTT, was observed in the acarbose-treated group compared with the placebo group. If this diagnosis was confirmed by a second OGTT, a 36% relative risk reduction was observed in the acarbose group compared with the placebo group. Acarbose therapy was associated with a relative reduced risk of 49% in the development of cardiovascular events (2.5% absolute risk reduction). However, 25% of individuals discontinued their participation early as a result of gastrointestinal adverse events (29).

In the XENDOS study (XENical in the prevention of Diabetes in Obese Subjects), orlistat was examined for its ability to delay type 2 diabetes when added to lifestyle change in a group with BMI ≥30 kg/m² with or without IGT. 3,305 study participants were randomized to treatment with orlistat plus lifestyle changes (n = 1,650) or placebo plus lifestyle changes (n = 1,655). All patients were prescribed a reduced-calorie diet (~800 kcal/day deficit) containing 30% of calories from fat and not more than 300 mg of cholesterol per day. The prescribed energy intake was readjusted every 6 months to account for any weight lost during the preceding months. Participants received dietary counseling every 2 weeks for the first 6 months and monthly thereafter. Participants were also encouraged to walk at least 1 extra kilometer a day in addition to their usual physical activity. All patients kept physical activity diaries.

Mean weight loss was significantly greater with orlistat than placebo at 1 year (10.6 vs. 6.2 kg) and remained significantly greater at the end of the 4-year study (5.8 vs. 3.0 kg). For those patients who completed 4 years of treatment (52% of the orlistat patients and 34% of the placebo patients initially randomized), weight loss was significantly greater with orlistat than placebo at year 1 (11.4 vs. 7.5 kg) and year 4 (6.9 vs. 4.1 kg). During 4 years of treatment, orlistat plus lifestyle changes significantly decreased the progression to type 2 diabetes compared with placebo plus lifestyle changes. Cumulative incidence rates after 4 years were 6.2 vs. 9.0%. The hazard ratio corresponds to a 37.3% decrease in the risk of developing diabetes with orlistat compared with placebo. The effect of orlistat addition corresponded to a 45% risk reduction in the IGT group, with no effect observed in those without IGT (30).

Finally, Wadden et al have recently described that the combination of sibutramine and group lifestyle modification resulted in more weight loss at one year (12.1 ± 9.8 kg) than either medication (5.0 ± 7.4 kg) or lifestyle modification alone (6.7 ± 7.9 kg) (Fig. 3). However, this
study did not provide data about prevention of diabetes. It could only be hypothesized that such weight loss would also have reduced the development of diabetes in the participants (31).

Health providers and patients can discuss about the preference between lifestyle changes and drugs. In the DPP study a comparison of lifestyle intervention and medication was made, the former being more effective in preventing diabetes (58 vs. 31% relative reductions, respectively). In the XENDOS trial addition of orlistat to lifestyle changes significantly reduced the incidence of type 2 diabetes in obese subjects with IGT. However, the lifestyle intervention was less intense in the XENDOS study that in the DPP trial. The ADA standards of care 2006 state that there is insufficient evidence to support the use of drug therapy as a substitute for, or routinely used in addition to, lifestyle modification to prevent diabetes. At present, the greater benefit of weight loss and physical activity strongly suggests that lifestyle modification should be the first choice to prevent or delay diabetes. In future we could have more data to identify the most efficient strategies for the primary prevention of type 2 diabetes (32).

There have been some reservations about the feasibility of applying the results of lifestyle intervention trials to real world clinical practice. The reasons cited are that: 1) patients who were recruited to these clinical trials may not be representative of the general prediabetic population; 2) adherence to lifestyle changes would be lower in routine practice with patients less committed and with less access to nutritional counseling and exercise programs; 3) educational efforts to allow patients accomplish the predefined goals were significantly higher than the standard of care.

However, lifestyle intervention is the first and basic approach to treat the Metabolic Syndrome, independently from the potential benefits of added drug treatment that can be known in the future. Clinical practice should adapt to the results of lifestyle modification trials. Health authorities should review financial and human resources to allow the development of preventive programs for sedentary overweight adults.

Summary

The primary intervention for correcting metabolic syndrome is lifestyle therapy. It has the potential to reduce the severity, slow the progression of all metabolic risks and delay the need of drug therapy in persons with metabolic syndrome. Most individuals with this syndrome are overweight and obesity is the main cause of insulin resistance. Dietary intervention to reduce energy intake and physical activity to enhance energy expenditure are basic forms of treatment in any overweight or obese patient.

Many different diets have been proposed for the treatment of obesity. These dietary approaches vary in their total energy prescription, macronutrient (fat, carbohydrate, and protein) content, glycemic index, energy density, and portion control. Most authorities and clinical guidelines recommend a 500- to 1000-kcal/d deficit in the diet for obese persons, which will initially result in a weekly weight loss of 0.45 to 0.9 kg. It is generally accepted that the macronutrient composition of a diet does not affect the rate of weight loss. Specific recommendations for subjects with Metabolic Syndrome have recently been proposed and are discussed in this review.

Many individuals with metabolic syndrome have a sedentary life. Physical activity both prevents and helps treat many established atherosclerotic risk factors. From a clinical point of view, any physical activity should be assessed according to five features: intensity, frequency, duration, mode, and progression. A consensus has been reached that a minimum of 30 minutes of moderate intensity physical activity, such a brisk walking, is required on most, and preferably all, days of the week to obtain the clinical benefits described before. This is equivalent to ≈1.5 miles per day of brisk walking at an energy cost of 150 kcal per day for an average-sized person.

Some strategies have been proposed to aid patients to introduce lifestyle changes: Setting goals, raising awareness, confronting barriers, changing eating behaviors and routines and organizing support.
Several randomized controlled trials have explored the efficacy of lifestyle modification. Lifestyle intervention is the first and basic approach to treat the Metabolic Syndrome.

References