Weight Management Through Lifestyle Modification for the Prevention and Management of Type 2 Diabetes: Rationale and Strategies

A statement of the American Diabetes Association, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition

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The prevalence of diabetes in the U.S. continues to rise by epidemic proportions. This increase parallels the rising rates of obesity and overweight observed over the past decade (1,2). Indeed, as BMI increases, the risk of developing type 2 diabetes increases in a “dose-dependent” manner (3,4). The prevalence of type 2 diabetes is 3–7 times higher in obese than in normal-weight adults, and those with a BMI >35 kg/m² are 20 times more likely to develop diabetes than those with a BMI between 18.5 and 24.9 kg/m² (5,6). In addition, weight gain during adulthood is also directly correlated with an increased risk of type 2 diabetes (3,7–9).

Obesity also complicates the management of type 2 diabetes by increasing insulin resistance and blood glucose concentrations (10). It is an independent risk factor for dyslipidemia, hypertension, and cardiovascular disease (6,11–14) and, thus, increases the risk of cardiovascular complications and cardiovascular mortality in patients with type 2 diabetes (15).

The purpose of this statement is to review the important role of weight management in the prevention and management of type 2 diabetes and to describe strategies for achieving and maintaining a healthy body weight through lifestyle modification. The use of weight loss medications and bariatric surgery in the management of obesity will not be discussed in this document. Pharmacotherapy can be a useful adjunct to lifestyle modification in the long-term management of obesity in selected patients (16). Weight loss medications may be considered for those with a BMI ≥30 or those with a BMI ≥27 plus obesity-related comorbid conditions. Weight loss surgery may be a therapeutic alternative for patients with a BMI ≥40 or a BMI ≥35 plus comorbid conditions (16). Comprehensive review articles that discuss the use of weight loss medications and surgery in the management of obesity have recently been published (17–20).

Benefits of weight loss
Weight loss is an important goal for overweight or obese persons, particularly those with type 2 diabetes, because it improves glycemic control (21). Moderate weight loss (5% of body weight) can improve insulin action, decrease fasting blood glucose concentrations, and reduce the need for diabetes medications (22–28). Moreover, improvement in fasting blood glucose is directly related to the relative amount of weight lost (28). Moderate weight loss may not improve glycemic control in all obese patients who have diabetes (29), however, and it is possible that patients with longstanding disease or severe pancreatic β-cell dysfunction are not as responsive to weight loss as those with less extensive disease. Marked weight loss (30% of body weight) following gastric bypass surgery can normalize glycemic control in more than two-thirds of extremely obese patients with type 2 diabetes (30–33).

Weight loss has important additional health benefits in patients with diabetes because it improves other risk factors for cardiovascular disease (22–27) by de-
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Table 1 — Risk factors for type 2 diabetes

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
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<tr>
<td>Age ≥45 years</td>
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<tr>
<td>Overweight (BMI ≥25 kg/m²)</td>
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<tr>
<td>Family history of diabetes (i.e., parents or siblings with diabetes)</td>
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<tr>
<td>Habitual physical inactivity</td>
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<tr>
<td>Race/ethnicity (e.g., African Americans, Hispanic Americans, Native Americans, Asian Americans, and Pacific Islanders)</td>
<td></td>
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<tr>
<td>Previously identified pre-diabetes:</td>
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<tr>
<td>impaired fasting glucose (IFG)</td>
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<tr>
<td>impaired glucose tolerance (IGT)</td>
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<tr>
<td>History of gestational diabetes or delivery of a baby weighing ≥9 lb</td>
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<tr>
<td>Hypertension (≥140/90 mmHg in adults)</td>
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<tr>
<td>HDL cholesterol ≤35 mg/dl and/or a triglyceride level ≥250 mg/dl</td>
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<tr>
<td>Polycystic ovary syndrome</td>
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<tr>
<td>History of vascular disease</td>
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*May not be correct for all ethnic groups. Adapted from 105.

increasing blood pressure (34–38), improving serum lipid concentrations (decrease in serum triglycerides, total cholesterol, and LDL cholesterol and increase in serum HDL cholesterol concentrations) (39–42), and reducing serum markers of inflammation (43,44).

Moderate weight loss and increased physical activity can prevent or delay the development of type 2 diabetes in high-risk groups, such as those with impaired glucose tolerance (45–47). For example, data from the Diabetes Prevention Program (DPP) demonstrated that weight loss (7% of weight loss in the first year) and increased physical activity (150 min of brisk walking per week) reduced the 4-year incidence of type 2 diabetes by 58% in men and women with impaired glucose tolerance (45). Lifestyle changes were nearly twice as effective as metformin therapy (31% reduction in incidence of diabetes) in preventing type 2 diabetes (45).

Indications and goals for weight loss therapy

Weight loss is recommended for all overweight (BMI 25.0–29.9 kg/m²) or obese (BMI ≥30.0 kg/m²) adults who have type 2 diabetes or who are at risk for this disease (Table 1). It is important to set a weight loss goal that is both achievable and maintainable. Even moderate weight loss of 5% of body weight can produce significant health benefits (16,24,48–50) and may be a reasonable initial goal for most patients. Better outcomes for long-term weight reduction occur when a reduced calorie diet is combined with increased physical activity and behavior therapy that is aimed at developing skills required to successfully change problematic eating and activity patterns (16,51).

Diet

Weight loss occurs when energy expenditure exceeds energy intake. An energy deficit of 500–1,000 kcal/day will result in a loss of ~1–2 pounds/week and an average total weight loss of about 8% after 6 months (16). Although weight regain is common, approximately two-thirds of weight that is lost by dieting is maintained at 1 year (52). Severe calorie restriction that involves the use of a very-low-calorie diet (<800 kcal/day) causes rapid weight loss of about 15–20% within 4 months. However, very-low-calorie diets are not recommended for most patients, because they do not result in greater long-term weight loss and have a higher risk of developing medical complications, such as gallstones, than low-calorie diets (53–55). The National Heart, Lung, and Blood Institute (NHLBI) Obesity Education Initiative (OEI) Expert Panel recommends the use of a low-calorie diet that generates an initial deficit of 500–1,000 kcal/day and supplies at least 1,000–1,200 kcal/day for women and 1,200–1,600 kcal/day for men to treat obesity (51). An alternative approach for determining suggested energy intake goals for weight loss based on current body weight is shown in Table 2 (17).

A variety of diets have been proposed to treat obesity. Although many different dietary approaches may result in short-term weight loss, the limitation of most diets is poor long-term compliance and weight regain. The optimal dietary macronutrient composition that facilitates lasting and safe weight loss is not known (16).

A low-fat (e.g., 25–30% of calories from fat) diet is considered the conventional therapy for treating obesity. Data obtained from obese persons who were successful at maintaining long-term weight loss (56), diet intervention trials designed to decrease the risk of cardiovascular disease (57), and randomized controlled trials that evaluated diet therapy for obesity (58) indicate that decreasing dietary fat intake (to 25–30% of total calories) results in decreased total energy intake and weight loss. Data regarding the long-term effect of a very-low-fat diet (≤15% of total calories from fat) on weight loss are limited because few studies have successfully achieved this level of intake (59). Additionally, in some diabetic patients, the concomitant increase in carbohydrate intake can exacerbate the dyslipidemia (elevated triglyceride, low HDL cholesterol levels) frequently associated with insulin resistance/type 2 diabetes (60–63).

Recently, there has been increased interest in the use of low-carbohydrate diets as potential therapy for obesity. The results of five randomized controlled trials in adults (64–68) found that subjects randomized to a low-carbohydrate, high-protein/high-fat diet (~25–40% carbohydrate) achieved greater short-term (6 months) (64–66), but not long-term (12 months) (64,67), weight loss than those randomized to a low-fat diet (~25–30% fat, 55–60% carbohydrate). The data from these studies also found greater improvements in serum triglyceride and HDL cholesterol concentrations, but not in serum LDL-cholesterol concentration, in the low-carbohydrate than the low-fat group. In addition, glycemic control was better with low-carbohydrate than low-fat diet therapy in subjects who had type 2 diabetes (65,67). Data from a study conducted in overweight adolescents found that altering dietary glycemic load by reducing both total carbohydrate content (45–50% of energy intake) and consuming low-glycemic index foods resulted in more weight loss when compared with a conventional low-fat (25–30%) diet (69).
Additional research is needed to clarify the long-term efficacy and safety of low-carbohydrate diets, particularly in patients with diabetes.

It is unlikely that one diet is optimal for all overweight/obese persons. Dietary guidance should be individualized to allow for specific food preferences and individual approaches to reducing energy intake (21,51). A variety of strategies are available for decreasing energy intake. For example, lowering dietary energy density (e.g., by increasing fruit and vegetable intake and limiting foods that are high in fat) can reduce energy intake while maintaining a volume of food that might help control hunger (70). Increasing portion control by reducing portion sizes (70), using meal replacement products (41,71,72), and following structured meal plans (73,74) can also enhance compliance with energy-deficit diets.

The American Diabetes Association, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition recommend setting an energy intake goal to achieve a 500–1,000 kcal/day energy deficit with a food intake pattern consistent with current recommendations for reducing the risk of comorbidities associated with obesity. Therefore, we recommend that the macronutrient content of the diet be based upon current dietary guidelines from the American Diabetes Association (21), the American Heart Association (75), and the National Cholesterol Education Program (NCEP)-Adult Treatment Panel (ATP III) (76) (Tables 3 and 4). These recommendations are based on current evidence regarding the effects of dietary intervention to reduce several coronary heart disease risk factors, including hyper tension and elevated LDL cholesterol concentration (75,76), which is an important consideration in patients with type 2 diabetes because of their increased risk of cardiovascular disease (76). These recommendations may require modification, however, as new information is generated from additional diet intervention studies.

**Physical activity**

Physical activity is an important component of any weight management program. Although energy restriction by dieting is largely responsible for initial weight loss (16,77,78), regular physical activity helps to maintain weight loss and prevent weight regain (51,79). Regular exercise and aerobic fitness also improve insulin sensitivity and glycemic control (16,80,81), may decrease the risk of developing diabetes (82), and may reduce overall mortality in patients who have type 2 diabetes (83).

The NHLBI OEI Expert Panel recommends that individuals engage in 30–45 min of moderate-intensity aerobic physical activity (40–60% of maximal oxygen uptake or 50–70% of maximum heart rate), 3–5 days per week initially, gradually increasing the duration and frequency (16). This recommendation is in agreement with that of several other health organizations, including the Surgeon General’s office, the American College of Sports Medicine, the American Diabetes Association, the American Heart Association, and the National Institutes of Health (NIH) Consensus Development Panel on Physical Activity and Cardiovascular Health (80,84–87). A greater reduction in cardiovascular disease risk would be anticipated by increasing either the duration or intensity of physical activity (88). Data from most weight loss studies suggest that 60–75 min of moderate intensity activity (e.g., walking) or 35 min of vigorous activity (e.g., jogging) daily is needed to maintain long-term weight loss (56,79,89).

In previously inactive patients, an initial exercise program should be of a short duration (i.e., 10 min/day) of activity daily and gradually increase to 30 min/day of low-intensity activity (16,84). Intensity can be increased as the patient’s strength and fitness improves (16,90). In developing an activity program, the clinician should devise a plan that can be maintained without injury based on the patient’s current level of activity and readiness to increase activity. All individuals should be assessed regarding the need to undergo exercise stress testing before initiation of a moderate-intensity exercise program (86,91–93). Exercise testing should be performed at the discretion of the primary care physician before vigorous exercise, particularly in patients with diabetes (86,93,94).

Achieving adherence to a physical activity program is challenging. A structured exercise program that involves planned, repetitive exercise is not required for maintaining weight loss; increasing daily physical activity, such as walking and using stairs, is also effective (95–97). Exercise performed at home, rather than at a health club, reduces bar-
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riers of cost and travel time (98). Also, exercise does not need to occur in a single session to be beneficial, and dividing activity into multiple, short bouts produces similar benefits and can enhance compliance (99,100).

Facilitating lifestyle change in an office practice
Making long-term changes to eating and activity behaviors is extremely difficult for most patients (16). The role of the clinician is to encourage, monitor, and support the patient during this process. The office environment should be sensitive to the needs of obese persons. Appropriate chairs, examination tables, and restrooms and specialized equipment, such as large blood pressure cuffs, extra-large gowns, and scales that measure weight greater than 300 lb should be available. The physician and office staff should always be sensitive and encouraging, even when patients have been unable to lose weight. It is important that patients feel understood and supported, not guilty or embarrassed, at office visits (101).

Several techniques can be used in the office setting to promote behavior change (51,102–104). Initially, problem behavior(s) are identified, and specific, realistic goals are agreed upon. Setting small and achievable goals allows patients to experience success, which can be used as a foundation for additional lifestyle alterations. Strategies such as self-monitoring (daily records of food intake and physical activity), stimulus control (avoiding triggers that prompt eating), and problem solving (identifying barriers and ways to overcome them) can support the change process during follow-up visits. Frequent patient-provider contact (e.g., weekly or biweekly) is associated with better long-term weight loss maintenance (101).

Within a clinical practice, providing appropriate behavior modification treatment can be difficult due to limited time and expertise on the part of physicians. Utilizing the support of a health care professional (e.g., nurse, medical assistant, or dietitian) who could weigh patients, briefly review records, and praise their efforts may be beneficial. Additionally, physicians may choose to refer patients to a registered dietitian who has weight management experience or a legitimate commercial or self-help program available in the local community. At the present time, third-party reimbursement is available for medical nutrition therapy for diabetes but does not usually cover weight loss therapy.

Maintaining weight loss
Long-term maintenance of weight loss is more challenging than initial weight reduction (101). Some strategies that are associated with successful long-term weight loss include eating a diet low in calories (~1,400 kcal/day) and fat (24% of total energy intake), frequently monitoring body weight, and participating in regular physical activity (equivalent to 2,800 kcal/week or ~60 min of moderate activity/day) (56,79). Successful weight loss maintainers also reduced portion sizes and snacking, ate breakfast daily, ate meals away from home ~3 times/week, and watched television less than 3 h per week on average (52,79).

Summary
In summary, overweight and obesity are strongly linked to the development of type 2 diabetes and can complicate its management. Obesity is also an independent risk factor for hypertension and dyslipidemia as well as cardiovascular disease, which is the major cause of death in those with diabetes. Moderate weight loss improves glycemic control, reduces cardiovascular disease risk, and can prevent the development of type 2 diabetes in those with pre-diabetes. Therefore, weight loss is an important therapeutic strategy in all overweight or obese persons who have type 2 diabetes or are at risk for developing diabetes.

Specific recommendations
• Weight loss is recommended for all overweight (BMI 25.0–29.9 kg/m²) or obese (BMI ≥30.0 kg/m²) adults who have, or who are at risk for developing, type 2 diabetes.
• The primary approach for achieving weight loss is therapeutic lifestyle change, which includes a reduction in energy intake and an increase in physical activity.
• A moderate decrease in caloric intake (500–1,000 kcal/day) will result in a slow but progressive weight loss (1–2 lb per week). For most patients, weight loss diets should supply at least 1,000–1,200 kcal/day for women and 1,200–1,600 kcal/day for men.
• Overweight or obese patients with diabetes are encouraged to adopt the dietary recommendations known to reduce the risk of coronary heart disease (outlined in Tables 3 and 4). In conjunction with a moderate reduction in caloric intake (500–1,000 kcal/day), this diet is likely to result in moderate weight loss as well as improvement in cardiovascular risk factors. Dietary guidance should be tailored to each person, allowing for individual food preferences and approaches to reducing caloric intake.
• Physical activity is an important component of a comprehensive weight management program. Regular, moderate intensity physical activity enhances long-term weight maintenance. Regular activity also improves insulin sensitivity, glycemic control, and selected risk factors for cardiovascular disease (i.e., hypertension and dyslipidemia), and increased aerobic fitness decreases the risk of coronary heart disease.
• Initial physical activity recommendations should be modest, based on the patient’s willingness and ability, gradually increasing the duration and frequency to 30–45 min of moderate aerobic activity, 3–5 days per week, when possible. Greater activity levels of at least 1 h per day of moderate (walking) or 30 min per day of vigorous (jogging) activity may be needed to achieve successful long-term weight loss.

References
5. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales V, Marks JS: Prevalence of obesity, diabetes, and obe-


