

# Diet Modification for Treatment and Prevention of Obesity

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**The obesity epidemic is best explained by global life-style alterations favoring weight gain in a susceptible population. The consumption of calorically dense foods, increased portion sizes, and a decrease in workplace and leisure physical activity most likely accounts for the increase in overweight and obesity worldwide. The cornerstone of overweight and obesity therapy is dietary intervention, but unfortunately most patients eventually regain the weight lost through diet alone. The search for a macronutrient composition that may enhance and help maintain weight loss has brought an abundance of fad diets into the lay literature. According to the available data, weight loss and maintenance of weight loss are dictated by total caloric intake, and not by macronutrient composition. There is epidemiologic data linking sugar-sweetened beverages to adult and childhood obesity, and an inverse relationship between dairy intake and overweight and obesity has also been observed. More research is needed to elucidate mechanisms explaining these relationships. Further research should focus on permanent lifestyle changes that may reverse this growing epidemic. This review will focus on current practices for the dietary management of obesity and to promote weight maintenance.**

**Key Words:** Diet; obesity; macronutrients; weight loss; weight maintenance.

## Introduction

Obesity is a common nutritional disorder worldwide. The prevalence of overweight and obesity has risen sharply during the last three decades reaching epidemic proportions (1,2). Obesity is associated with increased morbidity and mortality because it causes or exacerbates co-morbid conditions such as diabetes, coronary heart disease, hypertension, dyslipidemia, stroke, sleep apnea, and certain cancers (3–5). Modest weight losses of 5–10% of initial body weight are shown to significantly improve co-morbid con-

ditions and reduce the risk of diabetes (6,7). Unfortunately, there is a high rate of recidivism, with 90–95% of persons who lose weight subsequently regaining part of the weight lost (8,9). If successful weight maintenance is defined as intentionally losing more than 10% of weight and keeping it off for at least 1 yr, the results seem more optimistic with more than 20% of patients maintaining weight loss (10).

The causes of obesity are multifactorial and involve genetic, environmental, and psychosocial factors. The obesity epidemic is best explained by an energy imbalance caused by a high caloric consumption coupled with decreased physical activity. Numerous epidemiologic studies have linked a sedentary lifestyle (at the workplace and during leisure time), and the availability of calorically dense, low-fiber foods to weight gain in adults and children (11,12).

It is not surprising that there is great public interest in halting and treating obesity. In the US most adults are trying to lose or maintain their weight (13) and the profitable weight loss industry has brought to the market an abundance of diet books selling the dream of an easy, attainable and durable weight loss (14). Unfortunately, obesity in America seems to be here to stay, at least for a while.

In this review we will discuss the current practice in medical nutrition therapy (MNT) for weight loss and weight maintenance.

## Clinical Assessment of the Overweight and Obese Patient

The body mass index (BMI) is a useful measure of fatness that can be easily implemented in clinical practice. BMI is calculated by dividing the weight in kilograms by the height in meters squared (an adaptation to inches and pounds is shown in Table 1). BMI along with waist circumference can be used to determine health risk (Table 2) (15). It should be mentioned that different ethnic groups, particularly Asian populations, may be at increased risk for diabetes and hypertension at lower BMIs (16).

The basis of treatment of overweight and obesity includes MNT, increased physical activity, and behavioral therapy (17). Pharmacotherapy may be added for those with BMI  $\geq 30$  kg/m<sup>2</sup> or  $\geq 27$  with a co-morbidity, and along with diet and physical activity can enhance weight loss. Surgery may be indicated in patients with BMI  $\geq 40$  kg/m<sup>2</sup> or  $\geq 35$  kg/m<sup>2</sup> in the presence of an obesity-related co-morbidity. An ini-

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**Table 1**  
Calculation of Body Mass Index (BMI)

BMI = weight (kg)/height <sup>2</sup> (meter)
BMI = weight (pounds) × 703/ height <sup>2</sup> (inches)

**Table 2**  
Classification of Overweight and Obesity by BMI,  
Waist Circumference, and Associated Disease Risks

	BMI (kg/m <sup>2</sup> )	Obesity class	Disease risk* relative to normal weight and waist circumference <sup>†</sup>	
			Men > 102 cm (40 in.) or less Women > 88 cm (35 in.) or less	Men > 102 cm (40 in.) Women > 88 cm (35 in.)
Underweight	<18.5		—	—
Normal	18.5–24.9		—	—
Overweight	25.0–29.9		Increased	High
Obesity	30.0–34.9	I	High	Very high
	35.0–39.9	II	Very high	Very high
Extreme Obesity	40.0 +	III	Extremely high	Extremely high

\*Disease risk for type 2 diabetes, hypertension, and CVD.

<sup>†</sup>Increased waist circumference can also be a marker for increased risk even in persons of normal weight.

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tial weight loss goal of 10% of actual body weight in 6 mo is an attainable goal for most overweight and obese patients. Unrealistic expectations for weight loss should be discussed with the patients in order to prevent disappointment and non-compliance with dietary modifications.

### Medical Nutrition Therapy

MNT is the cornerstone of weight loss and weight maintenance therapy. A negative caloric balance is essential to promote weight loss. Weight loss is generally achieved by a low-calorie diet (LCD) that provides 800–1500 kcal/d. A caloric deficit of 500–1000 kcal/d will promote a desired weight loss of 1–2 lb/wk (18).

Very-low-calorie diets (VLCDs) generally provide 800 kcal/d or less. They promote a higher short term weight loss of 3–5.5 lb/wk but at 1 yr of treatment with a VLCD weight loss is not significantly lower than that of a LCD (19,20). VLCDs necessitate intensive medical supervision, monitoring of electrolytes, and supplementation of minerals and vitamins. Therefore, their role in weight loss prescription is limited to cases in which there is a need for rapid weight loss and they should not be widely implemented.

### Macronutrient Composition

The macronutrient composition of the diet is currently the most widely debated topic in the weight loss prescrip-

tion. The public interest and the potential economic market involved in weight loss has led to an abundance of diet books and fad diets promising easy and sustained weight loss. Clinical trials have produced some data to sort out fact from fiction, but more data are needed.

Most diets can be divided into high-fat (55%–65%), high-protein, low-carbohydrate diets (<100 g/d) (e.g., Dr. Atkins' new diet revolution, Protein Power); moderate fat 20–30%, moderate protein (15–20%), and high carbohydrates diets (e.g., ATP III Therapeutic Lifestyle Changes [TLC] diet (21), USDA Food Guide Pyramid, Dietary Approaches to Stop Hypertension [DASH] diet (22)); low fat (11–19% kcal/d) and very low fat diets (<10% kcal/d), moderate-protein, high carbohydrate diets (Ornish Program, New Pritikin program) (14,18). Table 3 summarizes the macronutrient components of the different diets.

Moderate fat diets have been widely used for weight loss and weight maintenance (23). A diet providing 30% of calories from fat, 10–20% from protein, and 40–55% as carbohydrates, as recommended by the National Cholesterol Education Program III, is also appropriate for weight loss. Saturated fat should comprise less than 7% of total calories, polyunsaturated fats (PUFA) less than 10%, and monounsaturated fats (MUFA) less than 20% of total calories. Complex carbohydrates from vegetables, fruits, and whole grains should be the main source of carbohydrates, enabling a daily intake of 20–30 g of fiber (24). Moderate- and low-

**Table 3**  
Characterization of Diets as Percentage of Calories

Type of diet	Fat (% kcal)	Carbohydrates (CHO) (% kcal)	Protein (% kcal)
High-fat, low-CHO	55–65	<20% (<100 g)	25–30
Moderate-fat, balanced nutrient reduction	20–30	55–60	15–20
Low- and very-low-fat	<10–19	>65	10–20

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fat diets decrease energy intake and therefore promote weight loss. Low- and very-low-fat diets (<20% of daily caloric intake from fat) are less palatable diets and therefore have less long-term adherence (25).

The high-fat, high-protein, low-carbohydrate diets gained wide public acceptance due to rapid weight loss and decreased hunger. The rationale of the diet is that decreased insulin levels will induce lipolysis and fat mobilization, and a high protein diet and ketosis will promote satiety. Practically, the rapid weight loss is caused by diuresis due to depletion of glycogen stores in the liver and muscle coupled with a lower caloric intake due to limited food choices (26–28). A major concern for recommending a low-carbohydrate diet is nutritional inadequacy and the potential atherogenic and adverse metabolic effects. These diets are low in fiber, micronutrients, and minerals, and high in saturated fat and protein (29). Until recently there were no long-term randomized trials comparing the safety and efficacy of such diets, but during the last 3 yr, several randomized trials were published comparing the high-fat, high protein, low-carbohydrate diets to low-fat, high-carbohydrates diets. In these trials, weight loss at 6 mo was 4–5 kg greater in patients following a low-carbohydrate diet compared to a low-fat diet, but when patients were followed for 1 yr, there was no difference in weight loss between groups (30–33). Patients following the low-carbohydrate diet had a greater decrease in triglycerides compared to low-fat diets. This difference may be explained by the greater weight loss and the reduced carbohydrate intake in patients following the low-carbohydrate diet. An increase in HDL cholesterol was also observed in most studies in patients treated with a low-carbohydrate diet (30,32,33). Whether the increase in the HDL cholesterol represents an improvement in cardiovascular risk profile needs to be further evaluated (34).

The long-term effect of low-carbohydrate diets on cardiovascular outcome, renal function, and bone mineralization has not yet been investigated. Furthermore, there are no data concerning the safety of low-carbohydrate diets in individuals with ischemic heart disease, diabetes, or kidney disease. According to the present data, low-carbohydrate diets may be prescribed for short term in “healthy”

obese individuals with appropriate supplementation of fiber, vitamins, and minerals.

## Sugar Sweetened Foods and Beverages

Increased consumption of sucrose and high-fructose corn syrup has been linked to obesity particularly in children and adolescents (35–37). Overconsumption of liquid carbohydrates are not fully compensated for by increasing satiety compared to solid food ingestion (38). It is not clear if the net caloric imbalance or the consumption of fructose itself is the culprit for the decreased compensatory mechanisms. According to NHANES 1999–2000, soft drinks contribute 7.1% of total energy intake. Sweets and desserts, soft drinks and alcoholic beverages contribute approx 25% of the total energy consumed in the American diet (39). For example, a 12-oz can of sugar-sweetened soda containing 30–40 g of sugar, contributes 150 kcal to total daily calories. If this small caloric intake is not deducted from other dietary sources, it may promote a 7.8 kg weight gain in 1 yr. Therefore, a reduction in sugar-sweetened beverage intake may be the best single prescription to reduce caloric intake without compromising essential nutrient adequacy (40). If successfully implemented, it may halt the obesity epidemic and promote weight loss.

## Calcium and Dairy Products

Dietary calcium plays an important role in energy regulation. In the first National Health and Nutrition Examination Survey (NHANES I) an inverse relationship between dietary calcium intake and body weight was noted (41). Subsequent studies supported this finding (42,43). The effect on weight loss is more pronounced when the calcium intake is derived from dairy products than from calcium supplementation. Data concerning interventions focusing primarily on dairy and calcium intake to promote weight loss are scarce. Most of the available data are derived from observational studies or a retrospective evaluation of trials designed to evaluate other outcomes (44). Nevertheless, there is a clear inverse relationship between calcium intake and body weight, particularly body fat accumulation. According to Heaney et al, a 300 mg increment in calcium intake will decrease body fat by 1 kg in children and decrease body weight in adults by 2.5–3 kg (45). The authors suggest that increasing calcium intake by two dairy servings per day may reduce the risk of overweight by as much as 70%.

## Glycemic Index

The glycemic index is a ranking of foods according to their effect on glycemia compared to the same amount of glucose or white bread. The type and amount of carbohydrates are important determinants of the postprandial glucose and is referred as the glycemic load (glycemic index  $\times$  grams of carbohydrates) (46). It is important to empha-

size that there may be a significant variation in individuals, between individuals, and also according to the meal components that may affect postprandial glycemia. Epidemiological studies have shown a higher cardiovascular risk in nondiabetic patients with postprandial hyperglycemia (47). There is also evidence linking the glycemic index, but not carbohydrate amount to BMI and a higher glycemic load was associated with a higher risk of type 2 diabetes in the Nurses' Health Study (48,49). The role of low glycemic foods in the treatment and prevention of obesity is controversial (50,51). A recent study comparing weight loss in two groups of patients given high or low glycemic foods and followed for 10 wk, found no difference in weight loss between groups, but there was a greater decrease in LDL cholesterol in the low glycemic group (52). Patients that lost weight on a low-glycemic-index diet had a smaller decrease in energy expenditure compared to patients following a low-fat diet, a finding that may be important for further weight loss and maintenance (53). In normal weight and overweight children, a low-glycemic-index breakfast was associated with reduced food intake during lunch (54).

## Weight Maintenance

Despite successful weight loss, most individuals subsequently regain the weight lost (55). Patients that lost weight through lifestyle modification for 20–30 wk regain almost 35% of the lost weight in 1 yr after treatment, and by 5 yr more than 50% of patients will return to their baseline weight (56). If defining weight loss success as more than 10% weight loss kept for more than 1 yr, the picture is more optimistic, with more than 20% of patients successfully maintaining weight loss (57). There has been an expansion of knowledge regarding the compensatory mechanisms and hormones involved in the maintenance of body weight. Mechanisms involved in weight gain after weight loss include decreased energy expenditure, increased hunger, and dietary nonadherence (58). Nevertheless, patients should be reassured that even if they regain part of the lost weight, there are still beneficial health implications (59).

Patients and health care providers treating obesity need to deal with weight maintenance. After a successful weight loss, most patients experience a plateau phase. At this point, it is necessary to adjust caloric intake to promote further weight loss, or at least to prevent weight gain. It is also possible to consider pharmacotherapy at this stage to increase weight loss (60). The plateau phase is generally distressing and disappointing for the patient, because there is no reward for weight loss effort. Retention of the patient in a weight loss program is critical for weight loss maintenance (61).

Although in the short term, low-carbohydrate diets promoted a greater weight loss, at 1 yr the net weight loss was not different from that of a moderate-low-fat diet (29,32). It is not clear if a low-fat *ad libitum* carbohydrate diet is superior to a low-calorie weight maintenance diet. A few

studies have shown less long-term weight gain with a low-fat diet (62), but this was not a consistent outcome in all studies (63).

Portion-controlled servings and meal replacements were shown to improve weight loss and weight maintenance (56, 64). Obese individuals underestimate their caloric intake (65), therefore providing a portion-controlled meal may improve adherence to a low-calorie diet and improve weight loss and maintenance (66).

The consumption of low-calorie dense foods, particularly by increasing the consumption of fiber and replacing fat by carbohydrates and proteins, has shown a short term decrease in caloric intake (56). A diet enriched with low-energy dense food, such as fruits, vegetables, and soups, was shown to reduce caloric intake while promoting satiety, and has been shown to be superior to fat- and portion-restriction diet for weight loss (67). The long-term effect of such a strategy needs to be further evaluated.

The National Weight Control Registry has identified persons who lost at least 13.6 kg and have succeeded in maintaining the weight loss for at least 1 yr. Members of the registry have lost an average of 33 kg and maintained the loss for more than 5 yr (10). Common behavioral strategies of this group included consuming a moderate-low-fat diet (<25% of total daily caloric intake), frequently monitoring caloric intake and weight, eating breakfast, and high levels of physical activity (23). Registry members report expending 1 h/d of physical activity amounting to approx 2778 kcal per week physical activity. Interestingly, only 4.3% of the registry members report using weight-loss medication and only 1.3% had bariatric surgery. It seems that weight maintenance becomes easier with time, with patients that succeed in keeping weight loss over 2–5 yr are more successful in maintaining weight loss thereafter (10).

## Summary

The obesity epidemic is a worldwide threat to the public health. The increasing prevalence of obesity in all ethnic groups and through all ages in spite of intensive health care and public interest is alarming.

There is no doubt that lifestyle changes, particularly a dietary shift toward a less calorically dense, healthier diet is essential. Presently there are no data to support any particular macronutrient composition as superior to promote weight loss and maintenance of the weight loss. A balanced diet that provides adequate nutritional requirements and may be adopted as a permanent lifestyle should be recommended for weight loss and maintenance.

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