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# Obesity and the Metabolic Syndrome

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Obesity, a chronic imbalance between energy intake and energy expenditure, has become a major public health issue in the United States. Nearly one third of the American population is considered obese, with approximately 5% considered morbidly obese.[1,2] A century ago, obesity was considered a rare medical problem, but the prevalence of obesity has increased dramatically in the past 20 years, reaching epidemic proportions among Americans.[3] Both men and women among Native Americans, African Americans, and Mexican Americans have an increased prevalence of obesity and metabolic syndrome compared with white Americans. The prevalence of obesity and metabolic syndrome is rapidly increasing among children and adolescents, especially in groups with the lowest level of education. In the United States, the prevalence of overweight children reached approximately 14%, which is 3 times higher than the prevalence observed 40 years ago. A vicious circle of higher birth weight, childhood obesity, metabolic syndrome, and type 2 diabetes mellitus has evolved. Without evidence to support biological evolutions in society, such as genetic or metabolic changes, these trends in increasing obesity are largely due to behavioral and environmental influences. Increases in energy consumption coupled with an increasingly sedentary society have led to marked weight increases in all age-groups.

Obesity is well documented as a contributing factor in diabetes, cardiovascular disease (CVD), hypertension, stroke, cancer, osteoarthritis, asthma, and sleep apnea.[4] Obesity is estimated to cost the United States $117 billion each year in direct costs from diagnosis, treatment, and use of health services as well as in indirect costs from lost productivity due to illness or premature death.[5] Given the serious health consequences of obesity and its economic impact, greater attention must be directed to the prevention, identification, and treatment of overweight and obese conditions.

The third part in a series on the metabolic syndrome, this article describes the relationship between obesity and the metabolic syndrome, reviews the clinical implications of obesity, identifies contemporary approaches to prevention and treatment, and presents a case study to illustrate key points.

### TAKE HOME POINTS

- Obesity is 1 of the 5 components of the metabolic syndrome.
- Visceral obesity leads to a state of insulin resistance, increased inflammatory response, atherogenic dyslipidemia, and significantly enhanced lipid oxidation.
- First-line therapy of obesity consists of weight loss caused by inducing a negative energy balance through dietary restriction and increased physical activity.
- Pharmacologic treatment should be started when the body mass index is ≥ 30 kg/m$^2$ or when it is between 27 and 29.9 kg/m$^2$ and obesity-associated comorbidities are present.

## DEFINING AND MEASURING OBESITY

Measurement of body mass index (BMI) is the most frequently used method to define degree of obesity and quantify health risk. BMI can be calculated based on the height and weight of a person according to the formula:

BMI = Body weight (kg)/Height (m2)

BMI calculators are available on numerous web sites and printed charts. BMI has shown a good correlation with total body fat and is relatively unaffected by height. Overweight is defined as BMI of at least 25 kg/m$^2$,

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**Table 1.** Weight Classification by Body Mass Index

| | Obesity Class | BMI, kg/m$^2$ | Disease Risk |
|---|---|---|---|
| Underweight | | < 18.5 | |
| Normal | | 18.5–24.9 | Normal |
| Overweight | | 25.0–29.9 | Increased |
| Obesity | I | 30.0–34.9 | High |
| | II | 35.0–39.9 | Very high |
| | III | ≥ 40 | Extremely high |

Adapted from the Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—the evidence report. National Institutes of Health. National Heart, Lung, Blood Institute. Bethesda (MD): National Heart, Lung, and Blood Institute and the National Institute of Diabetes and Digestive and Kidney Diseases; 1998:xvii. NIH publication no. 98-4083.

**Table 2.** Adult Treatment Panel III Clinical Identification of the Metabolic Syndrome

| Risk Factor | Defining Level |
|---|---|
| Abdominal obesity (given as waist circumference) | |
| Men | > 40 in (> 102 cm) |
| Women | > 35 in (> 88 cm) |
| Triglycerides | ≥ 150 mg/dL |
| High-density lipoprotein cholesterol | |
| Men | < 40 mg/dL |
| Women | < 50 mg/dL |
| Blood pressure | ≥ 130/≥ 85 mm Hg |
| Fasting glucose | ≥ 110 mg/dL |

Adapted from Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III): final report. Bethesda (MD): National Cholesterol Education Program, National Heart, Lung, and Blood Institute, and the National Institutes of Health; 2002:II–27. NIH publication no. 02-5215.

obesity as BMI of at least 30 kg/m$^2$, and extreme obesity as BMI of at least 40 kg/m$^2$ (**Table 1**).[6] Epidemiologic data have shown that the vast majority of people with BMI of at least 30 kg/m$^2$ do not exercise regularly and have a sedentary lifestyle.[7] Higher BMI values are also associated with an increased number of comorbidities, such as CVD, hypertension, dyslipidemia, obstructive sleep apnea, insulin resistance and type 2 diabetes mellitus, cholelithiasis, and osteoarthritis.[5,8,9] Epidemiologic evidence suggests that regional distribution of fat plays a significant role in patients with increased BMI; abdominal obesity (android or male-type obesity) correlates with multiple comorbidities and increased overall mortality compared with gynoid obesity (female-type or gluteo-femoral obesity).[10–13]

Obesity is not a homogenous condition, and additional parameters besides BMI are used to better characterize obese patients. Waist-to-hip circumference ratio (WHR) is a simple and convenient method to estimate the proportion of abdominal obesity, [14,15] although it does not differentiate between subcutaneous and deep abdominal fat. Fat distribution is important because it mediates detrimental effects on glucose and lipid metabolism.[16–18] Waist circumference measured at the midpoint between the over border of the rib cage and iliac crest has been reported to be more closely correlated with the level of abdominal visceral adipose tissue and associated metabolic abnormalities than the WHR in both men and women.[19–21] Therefore, waist circumference is the preferred anthropometric index to estimate abdominal visceral fat and related cardiovascular risk profile in obese patients. Abdominal obesity is associated with insulin resistance[16] and atherogenic dyslipidemia,[17,18] which is characterized by increased triglyceride level, increased levels of small, dense atherogenic low-density lipoprotein (LDL) particles, and decreased high-density lipoprotein (HDL) cholesterol concentration. Additional measures such as skinfold thickness, body density and composition from underwater weighing, and lean body mass obtained from dual x-ray absorptiometry are used more frequently in research settings.

In 1988, Reaven[22] described a cluster of metabolic abnormalities that he called the insulin resistant syndrome.This cluster was subsequently renamed "metabolic syndrome" to more accurately reflect the group of proinflammatory, prothrombotic, prediabetic, and proatherogenic conditions that comprise the syndrome. Different diagnostic criteria for the metabolic syndrome have been suggested,[23–25] but in the United States, the Adult Treatment Panel III (ATP III) criteria are the most widely used (**Table 2**). To fulfill the diagnosis of metabolic syndrome, 3 or more criteria out 5 should be present.[23] Early diagnosis of metabolic syndrome is important because it increases the risk of CVD betweeen 1.5- and 1.8-fold[26,27] and raises relative risk of coronary artery disease death 4.2-fold.[28] The etiology of this significant increase in mortality is multifactorial; however, many of the risk factors (eg, obesity, sedentary lifestyle, and high-carbohydrate, high-fat diet) are well documented and amenable to modification.

## CASE PRESENTATION

### Initial Presentation and History

A 42-year-old man with a history of hypertension and hyperlipidemia for the past 5 years presents as a new patient. The patient recalls having been told by his previous health care provider that his hypertension was mild, his triglyceride level was high, and the "good" cholesterol was low, but the "bad" cholesterol was normal. He had been advised to modify his lifestyle with increased physical activity and follow-up in clinic; however, relocation from another state and life demands kept him from making his return appointment. The present visit was triggered by the death of his father, who had diabetes, hyperlipidemia, and hypertension, and died from acute myocardial infarction at age 62 years. The patient works as a clerk in a large law firm, his lifestyle can be described as sedentary, he does not exercise on a regular basis, and he walks a short distance daily from the parking garage. He has never been diagnosed with diabetes mellitus, quit smoking 5 years ago, and consumes 2 or 3 alcoholic drinks per week in social settings. He denies any cardiac symptoms and considers himself relatively healthy, except he admits that he is slightly overweight.

### Physical Examination

On physical examination, the patient's height is 5 ft 9 in, weight is 210 lb, BMI is 32 kg/m$^2$, and waist circumference is 43 in. Heart rate is 82 bpm and regular, and blood pressure is 140/85 mm Hg. There is no jugular venous distension or carotid bruits. Point of maximal impulse is not displaced, no cardiac murmurs are noted, $S_4$ is present, lungs are clear, and peripheral pulses are equal and normal. The remainder of the physical examination is unremarkable.

### Laboratory Test Results and Diagnosis

Laboratory testing reveals the following: fasting blood glucose, 109 mg/dL; total cholesterol, 188 mg/dL; triglycerides, 245 mg/dL; HDL cholesterol, 29 mg/dL; and LDL cholesterol, 110 mg/dL. The remainder of the laboratory values are within normal limits. The patient's electrocardiogram is unremarkable. The physician makes a diagnosis of metabolic syndrome. Based on the patient's history and physical examination, his 10-year Framingham risk score is calculated at less than 10%. He is advised to initiate structured lifestyle modification, including daily aerobic physical activity of brisk walking for 30 minutes at a speed of 3.5 mph and a 2400 mg/dL sodium diet[29] with low glycemic index. He is provided with instructions on ways to monitor and record his activity and written materials regarding how to implement the diet changes. No medications are started. A follow-up appointment is scheduled in 12 weeks.

- **How does obesity contribute to the metabolic abnormalities seen in the metabolic syndrome?**

## PATHOGENESIS

A relatively small number of Americans diagnosed with the metabolic syndrome have a BMI less than 25 kg/m$^2$ and a waist circumference that does not meet the ATP III diagnostic criterion (< 40 in for men and < 35 in for women). Therefore, most of the patients with metabolic syndrome are overweight, which indicates that obesity in conjunction with genetic susceptibility may link the major components of the metabolic syndrome.[30] The mechanism by which the abdominal fat unmasks the genetic susceptibility of an individual to the metabolic syndrome is complex and not fully understood.

As noted earlier, abdominal fat consists of both subcutaneous and intraabdominal fat. Intraabdominal fat is composed of visceral (intraperitoneal) fat and retroperitoneal fat.[31] Increased visceral fat is associated with both hepatic and peripheral biochemical abnormalities observed in the metabolic syndrome.[32] On the other hand, subcutaneous abdominal fat has as strong an association with insulin resistance as visceral fat and retained independent significance after adjusting for visceral fat.[33] However, it is generally agreed that increased abdominal fat contributes significantly to the biochemical disarray observed in patients with the metabolic syndrome.

Visceral adipose tissue is drained by the portal venous system and is directly connected with the liver. Free fatty acids (FFA) are mobilized more rapidly from visceral than from subcutaneous fat cells because of the higher lipolytic activity in visceral adipocytes.[34] This higher activity is due to regional variation in the action of the lipolysis-regulating hormones; specifically, the lipolytic effect of catecholamines is more pronounced and the antilipolytic effect of insulin is weaker in visceral than in subcutaneous adipose tissue.[35] Thus, visceral fat contributes significantly to the FFA level in systemic and portal circulation. The increased flux of FFA into the liver decreases hepatic insulin extraction by inhibiting insulin binding and degradation,[36] which leads to hyperinsulinemia and inhibits the suppression of hepatic glucose production by insulin,[37,38] accelerating gluconeogenesis.[39] The increase in FFA flux inhibits insulin-stimulated peripheral glucose utilization, which in the context of the associated reduction in hepatic insulin extraction results in still greater peripheral hyperinsulinemia.[39] FFA induces insulin resistance in obesity

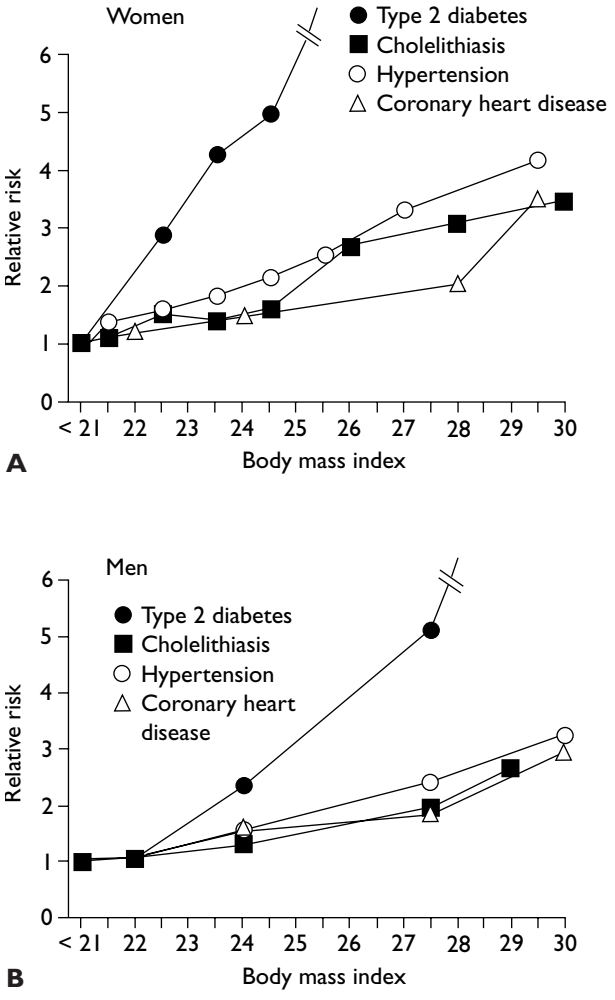


**Figure 1.** Adult weight change and risk of disease. Disease risk is shown for (**A**) women in the Nurses' Health Study, initially 30 to 55 years of age, who were followed for up to 18 years,[43–46] and (**B**) for men in the Health Professionals Follow-up Study, initially 40 to 65 years of age, who were followed for up to 10 years.[47,48] (Adapted with permission from Willett WC, Dietz WH, Colditz GA. Guidelines for healthy weight. N Engl J Med 1999;341:430. Copyright © 1999 Massachusetts Medical Society. All rights reserved.)

by initially inhibiting glucose transport and possibly by directly stimulating the pancreatic beta cell, further promoting hyperinsulinemia. Chronic exposure to high levels of FFA contributes to beta-cell failure and the development of type 2 diabetes mellitus.

It is now well documented that obesity is associated with a chronic, low-grade inflammatory state. The levels of several proinflammatory cytokines, including tumor necrosis factor-α (TNF-α), interleukin (IL)-6, and leptin are significantly higher in the plasma of obese patients, which can lead to increased synthesis and serum concentrations of a number of inflammatory markers, such as C-reactive protein, fibrinogen, or serum amyloids. It is well established that adipose tissue itself can be a source of this excess of circulating proteins.[40] Besides FFA and their metabolites, cytokines such as TNF-α and IL-6 also contribute to insulin resistance.[40] These factors may activate components of the inflammatory pathway such as nuclear factor-κB (NF-κB) and inhibit insulin signaling.[40] Finally, in response to the increase in FFA availability, an increased esterification of FFA and reduced degradation of apoprotein B in the liver lead to an increased synthesis and secretion of small, very-low-density lipoprotein (VLDL) particles,[41] with a decreased ratio of VLDL triglyceride to apoprotein B compared with the normal state. Furthermore, central obesity with insulin resistance and increased FFA levels is associated with increased hepatic lipase activity, which leads to the removal of lipids from LDL and HDL, making them smaller, more dense, and more susceptible to oxidation.[41] Thus, visceral obesity leads to a state of insulin resistance, increased inflammatory response, atherogenic dyslipidemia, and significantly enhanced lipid oxidation.

- **What comorbidities are associated with obesity?**

## CLINICAL SEQUELAE

Obesity may be a factor predisposing patients to a myriad of different comorbidities that increase the associated mortality rate (**Figure 1**).[42–48] Several large prospective trials have documented that obesity is an independent risk factor for all-cause mortality from CVD.49,50 Considering the major metabolic and biochemical changes that occur in obesity, such as atherogenic dyslipidemia, insulin resistance and hyperinsulinemia, endothelial dysfunction, and chronic inflammatory and prothrombotic state, it is not surprising that obesity plays a role in the pathogenesis of systemic atherosclerosis and its clinical complications. The metabolic syndrome, where obesity is one of the major components, may be responsible for up to 25% of all newly diagnosed CVD in the Framingham study. Obesity is also linked to cardiac autonomic neuropathy and is associated with decreased parasympathetic tone, which is followed by an increase in heart rate.51 These alterations in autonomic nervous system function may also contribute to increased CVD morbidity and mortality in the metabolic syndrome.

There is a strong association between obesity and type 2 diabetes. The risk of developing diabetes increases

with the degree and duration of central obesity. Insulin resistance follows impaired glucose removal and hyperglycemia and leads to hyperinsulinemia. Hyperinsulinemia is a significant contributing factor in the development of atherogenic hyperlipidemia, overactivity of the sympathetic system, endothelial dysfunction, increased sodium reabsorption, volume overload as well as increased intracardiac filling pressures, and changes that contribute to the development of hypertension, with subsequent progression of left ventricular hypertrophy, heart failure, and arrhythmias.[52–54]

Two other clinical sequelae frequently associated with obesity are nonalcoholic fatty liver disease (NAFLD)[55] and obstructive sleep apnea.[56] NAFLD is suspected when elevated serum transaminases are found in the absence of alcohol abuse or other causes of liver disease. A liver biopsy documents steatosis, which in some patients may progress to severe fibrosis and cirrhosis. The association of obstructive sleep apnea with obesity is well known.[56] Unrecognized and untreated obstructive sleep apnea can lead to pulmonary hypertension and worsen systemic hypertension, right and left ventricular dysfunction, and cardiac arrhythmias; thus, obstructive sleep apnea may contribute to increased morbidity and mortality in obese patients.

The social and emotional consequences of obesity are greater than those seen in other chronic conditions and may result from stigma, prejudice, and discrimination.[57] It is important to understand cultural influences on eating and exercise behaviors, which are linked to variations in acceptable body size and shape and subsequent motivation to participate in therapy.

- **What are the components of the current management of obesity?**

## THERAPEUTIC OPTIONS

As noted earlier, increased weight and BMI in the population has been associated with increased risk of many diseases, including hypertension and diabetes (Figure 1).[42] What is the best way to approach the clinical challenges stemming from the epidemic of obesity and metabolic syndrome? For the clinician working with individual patients, attention and acknowledgment of obesity through early diagnosis and treatment using nonpharmacologic approaches and medical therapy are essential. Early diagnosis and treatment of the known risk factors of the metabolic syndrome, especially abdominal obesity, is important. Several studies have documented reduced cardiovascular risk with weight reduction,[58,59] although no randomized controlled clinical trial to date has shown that weight loss alone decreases CVD event rates or mortality in obese persons.[59] These negative results can be partially explained by the difficulty associated with achieving prolonged periods of sustained weight reduction.[60]

Primary prevention of obesity as a means of stemming the obesity epidemic is obviously very important, but it cannot be done without major lifestyle changes across the population. The goal of obesity prevention should be improved health, not just changes in body size and appearance. To facilitate prevention, health care providers must approach non-obese patients using a comprehensive strategy that focuses on energy expenditure and energy consumption. To address the problem of obesity from a public health perspective, the epidemiologic triad has been developed (**Figure 2**).[61] According to this triad, the best results can be achieved by aggressive attention to each of the 3 interrelated components rather than concentrating solely on one.

Current treatment of obesity is guided by the principle of weight loss caused by inducing a negative energy balance. Approaches include lifestyle changes focused on dietary restriction and increased physical activity, accompanied by behavior modification, pharmacotherapy, and bariatric surgery (**Table 3**).[6] Appropriate management of persons with obesity should include the development and implementation of an individual treatment plan with realistic goals and frequent, close follow-up to monitor progress and to modify the plan as needed over time.

### Lifestyle Modification

Behavioral modification therapy is designed to help patients understand and change their lifestyle habits that have contributed to obesity. This process is complex and is based on developing the patients' ability to set specific small goals that can be easily measured and reached. Goal setting is part of a process referred to as self-monitoring, which helps patients regularly observe and record steps toward small individual goals. Patients are asked to track their progress toward calorie, fat, and physical activity goals. (Tracking dietary sodium would also be important for the patient in the case presentation.) Additional behavioral strategies can be incorporated to maximize goal achievement. These strategies include stimulus control, cognitive restructuring, problem solving, relapse prevention, tailored "readiness for change" counseling, and stress management. Comprehensive group behavioral therapy in conjunction with appropriate diet and physical activity can be beneficial for weight loss.[62] Attention must be directed to maintaining lifestyle changes given the

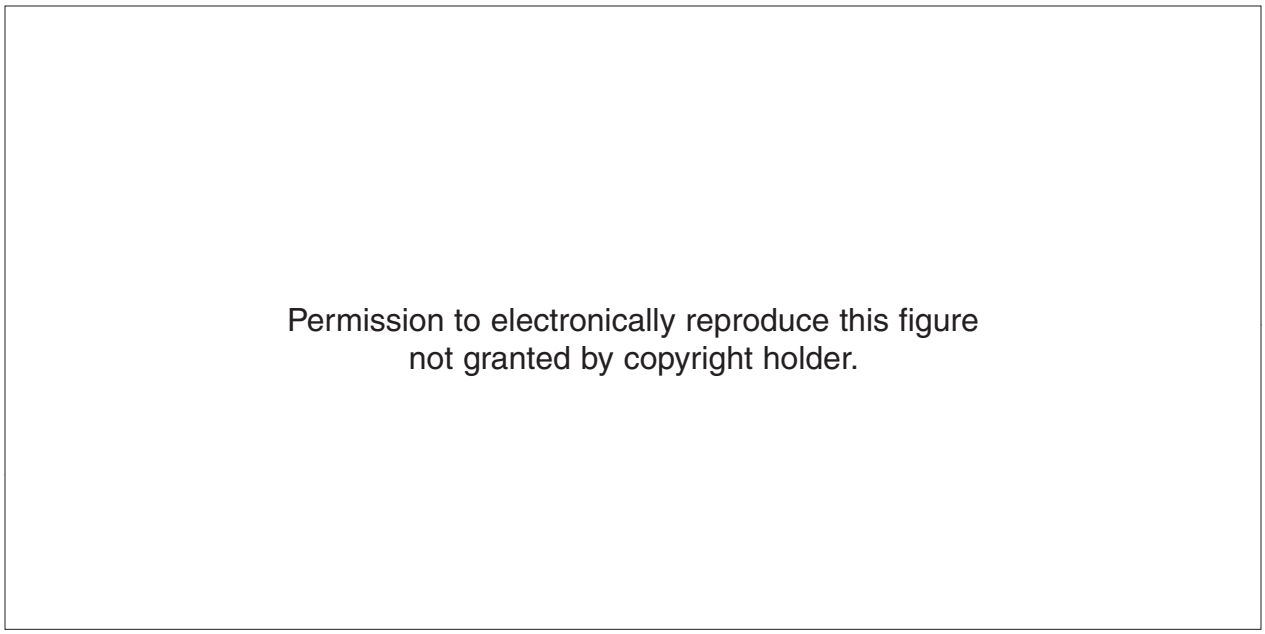


**Figure 2.** The epidemiological triad for obesity management. (Adapted with permission from Swinburn B, Egger G. Preventive strategies against weight gain and obesity. Obes Rev 2002;3:289–301. Copyright © 2002, Blackwell Publishing Ltd.)

of at least moderate-intensity physical activity (eg, brisk walking, jogging, dancing) on most days of the week.[64] Obese patients should be counseled to gradually increase their physical activity by 10 to 20 minutes each day until the goal of 30 minutes each day is achieved. The effectiveness of physical activity counseling can be increased by assessing the patient's readiness and motivation to start an exercise program and perceived barriers and benefits and by tailoring suggestions and problem solving to the individual.

Persons with central obesity lose more visceral fat, regardless of the weight loss intervention applied, because visceral fat has a higher lipolytic rate.[34] The importance of dieting in managing obesity is well known and obvious, but the process of choosing the optimal diet for an individual patient is complex. The energy content of a diet is the major determinant of weight loss. Because it is often difficult to accurately determine a patient's daily energy requirement, the energy content of the initially prescribed diet is determined by the patient's initial body weight. This calorie content must be adjusted regularly based on the patient's weight-loss response and therapy goals. Diets may be classified into 3 groups: very-low-calorie (< 800 Kcal/day), low-calorie (800–1500 Kcal/day), and balanced-deficit (> 1500 Kcal/day). The energy content in the daily diet can be decreased by specifically reducing fat or carbohydrates. Studies comparing low-fat to low-carbohydrate age therapeutic diets. Additionally, several general dietary suggestions can be offered to obese patients who are attempting to lose weight. First, encourage the patient to set several small easily achievable goals for weight loss over the first few months. Second, recommend a diet low in caloric content, incorporating low glycemic index foods with attention to portion sizes. Third, recommend limited intake of foods that are high in saturated fat, trans-fatty acids, and cholesterol. Teach the patient how to read food labels, and in situations like the case presentation, assist with information about lowering dietary sodium. Encourage the patient to use self-monitoring strategies of diet to document effective strategies and problematic situations. Finally, encourage regular follow-up with the health care provider to adjust the diet based on weight-response.

Recent studies also have suggested positive benefits from structured meal plans in which meals are replaced with a nutrition shake or meal bar. Initial approaches replace 2 meals a day and include 1 high-nutrient meal of 500 to 700 calories. This approach improves weight loss by controlling portions and nutrition, is easy to self-monitor, and facilitates meal planning.[69] Once the maintenance stage is reached, replacement is reduced to 1 meal a day.

### Pharmacotherapy

Current guidelines for pharmacologic treatment

**Table 3.** Weight Loss Treatment Guidelines

| | BMI Category, kg/m² | | | | |
|---|---|---|---|---|---|
| **Treatment** | **25.0–26.9** | **27.0–29.9** | **30.0–34.9** | **35.0–39.9** | **≥ 40.0** |
| Diet, physical activity, behavior therapy, or all 3 | Yes | Yes | Yes | Yes | Yes |
| Pharmacotherapy* | | With obesity-related disease | Yes | Yes | Yes |
| Surgery† | | | | With obesity-related disease | Yes |

*Pharmacotherapy should be considered only in patients who are not able to achieve adequate weight loss by available conventional lifestyle modifications and who have no absolute contraindications for drug therapy.

†Bariatric surgery should be considered only in patients who are unable to lose weight with available conventional therapy and who have no absolute contraindications to surgery.

of obesity indicate that medications should be started when BMI is 30 kg/m² or higher or when the BMI is between 27 kg/m² and 29.9 kg/m² and obesity-associated comorbidities are present (Table 3). The best results of long-term drug therapy can be expected when medications are part of a comprehensive weight-management program.[70] Currently only 2 drugs, sibutramine and orlistat, have been approved by the US Food and Drug Administration for long-term use.

Sibutramine blocks the reuptake of norepinephrine and serotonin and reduces hunger. Weight loss is facilitated by early satiety and delayed initiation of the next meal. The recommended starting dose is 10 mg/day, with further adjustment based on response. Doses greater than 15 mg/day are not recommended. Sibutramine therapy is more effective in inducing weight loss when it is combined with behavioral and dietary therapy.[71] The most common side effects of sibutramine are dry mouth, constipation, and insomnia. Sibutramine increases heart rate and systolic and diastolic blood pressure; therefore, it should not be used in patients with uncontrolled hypertension, CVD, heart failure, or a history of cardiac arrhythmias. Combination with monoamine oxidase inhibitors or selective serotonin reuptake inhibitors is contraindicated.

Orlistat is a reversible lipase inhibitor that blocks the digestion and absorption of dietary fat by binding to intestinal lipases.[72] At the recommended dose of 120 mg with a meal 3 times a day, orlistat inhibits dietary fat absorption by approximately 30%. The resulting caloric deficit has a positive effect on weight control. Because less than 1% of ingested orlistat is absorbed, the drug has no effect on systemic lipases. Besides its ability to decrease body weight by approximately 5% to 8%,[73] orlistat has beneficial effects on blood pressure, insulin sensitivity, and lipid profile.[74,75] The most common side effects are gastrointestinal tract related. Orlistat can also inhibit lipid-soluble vitamins and lipophilic medications if taken simultaneously. Thus, patients who are treated with orlistat should be given a daily multivitamin supplement, which should be taken more than 2 hours apart from orlistat.

Current research in developing new anti-obesity agents is ongoing, with emphasis on central nervous system agents that affect neurotransmitters or neural ion channels; leptin/insulin/central nervous system pathway agents; gastrointestinal-neural pathway agents; and agents that may increase resting metabolic rate. The goal is to develop antiobesity agents that not only reduce fat mass but also correct fat dysfunction.

### Bariatric Surgery

In certain patients, surgery is suggested as a therapy for obesity. The number of bariatric surgeries in United States increased dramatically within the past decade and has reached more than 100,000 procedures per year.[76] Surgery is considered the most effective therapy for patients with morbid obesity. Current recommendations for bariatric surgery (Table 3) were proposed at a consensus conference in 1991.[77] There are 5 primary surgical procedures used to treat obesity: gastric bypass, gastroplasty, gastric binding, biliopancreatic diversion, and biliopancreatic diversion with duodenal switch. Gastric bypass accounts for more than two thirds of the bariatric surgical procedures conducted in the United States. The perioperative mortality rate is around 1%; approximately 75% of deaths are caused by peritonitis and other intraabdominal complications, and 25% by pulmonary embolism.[78] The effects of bariatric surgery on cardiovascular and total mortality

are not documented, and, therefore, the decision regarding the need for these procedures must balance expected benefits with potential risks.

## CASE PRESENTATION: FOLLOW-UP

The case patient returns in 12 weeks and is seen in the clinic. He has begun a walking program 3 days a week and has attempted to follow the diet recommendations with moderate success. The patient's blood pressure is 130/80 mm Hg, heart rate is 68 bpm at rest, and weight is 191 lb. His BMI is 29 kg/m$^2$, and waist circumference is 37 in. The following fasting lipid profile and blood glucose values are obtained: total cholesterol, 167 mg/dL; triglycerides, 201 mg/dL; HDL cholesterol, 33 mg/dL; LDL cholesterol, 94 mg/dL; and blood glucose level, 97 mg/dL. Since all the parameters, including the lipid profile and body weight, have improved, the patient is advised to continue the same diet and increase physical activity with follow-up in the clinic in 12 weeks.

## CONCLUSION

Control of the epidemic of obesity and metabolic syndrome requires a multidimensional approach and should consist of both prevention and treatment. Incorporating aggressive diagnosis and treatment of obesity, hypertension, atherogenic dyslipidemia, and insulin resistance with or without hyperglycemia are essentials of treatment of the metabolic syndrome.

## SUMMARY

Obesity is a state of chronic imbalance between energy intake and energy expenditure. Its prevalence has reached epidemic levels and is a major public health issue in the United States. Metabolic syndrome is a proinflammatory, prothrombotic, and proatherogenic state. Obesity is 1 of the 5 components of the metabolic syndrome. Obesity is not a homogenous condition. Several simple indexes such as body mass index, waist-to-hip ratio, and waist circumference help standardize definitions of the degree of obesity and characterize the type of obesity (abdominal versus gluteofemoral). Abdominal obesity is associated with multiple comorbidities and increased mortality and may play a major role in the development of the metabolic syndrome. High levels of free fatty acids in the portal and systemic circulation observed in patients with metabolic syndrome and central obesity contribute to insulin resistance and hyperinsulinemia and, in combination with increased hepatic lipase activity, to atherogenic dyslipidemia.

Current therapy of obesity consists of lifestyle modifications achieved through behavioral modification, dietary restriction, and increased physical activity; pharmacotherapy; and bariatric surgery. Primary prevention of obesity and metabolic syndrome cannot be accomplished without major lifestyle changes within American society. **HP**

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