More than one-third of adults and one-sixth of adolescents in the United States are obese.¹ A patient is considered obese if he or she has a body mass index (BMI) greater than 30.² The prevalence of obesity has doubled since 1994,³ and between 2000 and 2010, the prevalence of morbid or extreme obesity (BMI ≥40) increased 70% in the United States, from 3.9% to 6.6%.⁴ During the past 20 years, the number of people in the United States with BMIs greater than 30, 40, and 50 have doubled, quadrupled, and quintupled, respectively.² Approximately 100 million people are overweight (BMI, 25-29.9), 85 million people are obese, and 15 million people are morbidly obese.³ In this article, we describe the tools that have been used historically to diagnose obesity and outline new efforts to redefine important early markers for obesity and obesity-related health risks in patients.

Definition of Obesity

Body mass index is the standard for classifying weight and is the most practical method to determine the extent of obesity. It also correlates fairly well with underlying body fat. There are some pitfalls in using BMI to determine body fat, however, as it does not differentiate between lean muscle mass and fat mass. In a young healthy athlete, BMI can overestimate body fat, especially if it is in the overweight range. In older people, BMI can underestimate underlying body fat, owing to the loss of muscle mass with aging, called sarcopenia. This age-related loss of muscle mass in addition to an increase in fat mass is called sarcopenic obesity and represents a redistribution of fat mass and fat-free mass. Patients with sarcopenic obesity have a relative increase in

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**Comprehensive Evaluation for Obesity: Beyond Body Mass Index**

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Many factors contribute to the diagnosis of obesity in a patient. Anthropometric measurements, such as the waist circumference and percentage of body fat, are used in the newly released obesity algorithm to risk stratify patients. Staging methods, which use the identification of comorbidities and disease burden to assess the severity of obesity, can result in treating a patient sooner than if the traditional body mass index is used. Obesity is a growing concern in the medical field, and providing additional avenues through which to diagnose obesity and address obesity-related health risks can improve prevention efforts and lead to expedited weight management. Obesity is a growing concern in the medical field, and providing additional avenues through which to diagnose obesity and address obesity-related health risks can improve prevention efforts and lead to expedited weight management.

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intra-abdominal fat that is greater than subcutaneous or total body fat and a relative decrease in peripheral fat that is greater than central fat-free mass resulting from the loss of skeletal muscle.8

Ethnic Differences in Measuring Obesity

A 2006 study7 suggested that current overweight, obesity, and central adiposity guidelines based on white populations are not appropriate for other ethnic populations, such as Asians, Hispanics, and blacks. The Nurses’ Health Study highlighted the ethnic differences in BMI.7 In the study, 78,000 US women without type 2 diabetes mellitus (T2DM) had their weight tracked for 20 years to determine whether any ethnic differences in the development of T2DM existed. It was observed that Asians had more than double the risk of T2DM compared with whites with the same BMI.7 The risk of T2DM was also increased in Hispanics and blacks, but to a lesser degree.7 Similar findings were noted in a multiethnic cohort study of 59,824 nondiabetic adults.8 Type 2 diabetes mellitus developed in South Asian, Chinese, and black participants at a lower BMI, younger age, and higher rate compared with their white counterparts.8 The expert opinion of the World Health Organization concluded that Asians, in general, have a higher percentage of body fat compared with whites of the same age, sex, and BMI.9 The report also concluded that the Asian population has a higher risk for T2DM and cardiovascular disease at a lower BMI (25) compared with other ethnicities.9 Observed risk in different Asian populations was noted at BMI cutoff values between 22 and 25, with high risk between 26 and 31.9

The expert opinion made no attempt to redefine the existing BMI cutoffs and did not indicate a specific BMI cutoff for overweight and obesity. Rather, increased risk was identified for the BMI continuum, and public action points were recommended for intervention at lower BMI cutoff points.8 Using the recommended BMI cutoff points ensured earlier screening and diagnosis of T2DM. In 2006, the International Diabetes Federation (IDF) suggested ethnic-specific values for waist circumference (WC) in an effort to identify central obesity, a causitive factor in metabolic syndrome, in specific ethnic groups (Table 1).10

Obesity-Associated Disease Risk

BMI and Waist Circumference Determinants

Body mass index is not only used to classify obesity but also to determine life expectancy and prevalence of obesity-related issues and comorbidities. The risk of developing a comorbid condition increases with increasing BMI.11

Additional factors that increase disease risk in the overweight and class I and II obesity groups are large WC (>40 in [102 cm] in men and >35 in [88 cm] in women), poor aerobic fitness, and ethnicity.11 The rationale for measuring the WC in clinical practice is to identify metabolically obese and overweight patients whose BMI is normal and thus would not be considered for lifestyle intervention and treatment. The WC measurement has been highlighted as a key component in several recently released algorithms for overweight and obesity management.11,12 Waist circumference is also a method often used to diagnose metabolic syndrome in overweight and obese patients. When a large WC is factored into BMI-associated disease risk, there is an increased disease risk in the overweight and class I obesity groups (Table 2).

The additional risk brought on by a large WC remains unchanged in obesity classes higher than class II because WC has little added predictive power of disease risk beyond that of BMI. The WC, therefore, is less useful as an independent marker of medical risk when the BMI is greater than 39. Overall risk is independently associated with excess abdominal fat (WC >40 inches
According to the clinical criteria developed by Adult Treatment Panel III, it has been estimated that 1 in 3 adults living in the United States has metabolic syndrome. The finding of central or visceral obesity is a prerequisite risk factor for metabolic syndrome according to the IDF consensus definition. For a diagnosis of metabolic syndrome, central obesity is required in addition to any 2 of the following conditions: elevated triglyceride level (≥150 mg/dL), low high-density lipoprotein level (<40 mg/dL in males, <50 mg/dL in females), elevated blood pressure (>130/85 mm Hg or current hypertension treatment), and impaired fasting plasma glucose (>100 mg/dL).

The intra-abdominal deposition of visceral fat is a major contributor to the adverse metabolic consequences mediated by the release of proinflammatory cytokines, resulting in insulin resistance and endothelial dysfunction. Hence, abdominal obesity is associated with multiple cardiometabolic risk factors, such as atherogenic dyslipidemia (hypertriglyceridemia and low high-density lipoprotein level), elevated blood glucose level, and inflammation, which are major drivers of cardiovascular disease and T2DM. To appropriately diagnose metabolic syndrome, patient ethnicity must also be considered. Not only does metabolic syndrome affect 1 of 3 adults in the United States, it is estimated that one-fourth of adults worldwide have this condition.

### Comorbid Conditions

More than 30 comorbid conditions associated with severe obesity exist, including dyslipidemia, hypertension, sleep apnea, and T2DM. Obesity is also associated with an increased risk for coronary heart disease. A recent meta-analysis noted a 29% increase in coronary heart disease for each 5-unit increase in BMI. Risk is accelerated by the coexistence of other factors, such as those listed above. In the Framingham Heart Study, obesity was observed to be an independent risk factor for all-cause mortality in a 30-year

<table>
<thead>
<tr>
<th>Population</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>≥102 cm or 40 in</td>
<td>≥88 cm or 35 in</td>
</tr>
<tr>
<td>Whites</td>
<td>≥94 cm or 37 in</td>
<td>≥80 cm or 31 in</td>
</tr>
<tr>
<td>South Asians, Chinese, Japanese</td>
<td>≥90 cm or 35 in</td>
<td>≥80 cm or 31 in</td>
</tr>
<tr>
<td>South and Central Americans</td>
<td>Use criteria for South Asian until more specific data are available</td>
<td></td>
</tr>
<tr>
<td>Sub-Saharan Africans, Eastern Mediterranean and Middle East (Arab)</td>
<td>Use criteria for whites until more specific data are available</td>
<td></td>
</tr>
</tbody>
</table>

* In the United States, the values shown based on the Adult Treatment Panel III are likely to continue to be used for clinical purposes.

follow-up of male participants. Multivariate analyses revealed a strong positive association between baseline weight and death rate for nonsmoking men who were overweight (3.9 times higher than that of men of normal weight). Another prospective study that followed more than 1 million adults for 14 years noted a strong relationship between BMI and increased risk for all-cause mortality and death due to cardiovascular disease in nonsmokers and in men and women with no history of coronary heart disease.

In the Nurse’s Health Study, among 43,581 women who did not have T2DM, after adjustments for age, family history of diabetes, smoking, exercise, and dietary factors, the relative risk for developing T2DM at a BMI of 29 vs 20 was 11.2.

### Defining Obesity Beyond BMI

In 2013-2014, 3 algorithms for the treatment of overweight and obese adults were released. In 2013, the American Society of Bariatric Physicians, now called the Obesity Medicine Association (OMA), released the *Obesity Algorithm*. In 2013, the American Heart Association (AHA), American College of Cardiology (ACC), and The Obesity Society released the updated Guidelines for the Management of Overweight and Obesity in Adults. The American Association of Clinical Endocrinologists (AACE) and the American College of Endocrinology (ACE) released a position statement on the 2014 Advanced Framework for a New Diagnosis of Obesity as a Chronic Disease. All 3 guidelines use BMI and WC to establish the diagnosis of overweight or obesity and take into account the ethnic differences established by the IDF.

Our comparative analysis of all guidelines revealed common recommendations on when to initiate weight loss medications, refer a person for bariatric surgery, and establish goals for treatment. All of the recommendations stress that weight loss between 3% and 10% should improve overall health and health-related targets. The OMA also included the most complete recommendations for appetite suppressants for weight loss. The AACE/ACE and the OMA endorse the earlier use of appetite suppressants in patients who are overweight or obese, especially if medical complications exist. The AACE/ACE and the AHA/ACC will include updates on weight loss medications in future supplements to the initial algorithms.

### Table 2.

<table>
<thead>
<tr>
<th>Weight</th>
<th>BMI</th>
<th>Obesity Class</th>
<th>Men, &lt;40 in; Women, &lt;35 in</th>
<th>Men, &gt;40 in; Women, &gt;35 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
<td>...</td>
<td>Increased</td>
<td>High</td>
</tr>
<tr>
<td>Obese</td>
<td>30.0-34.9</td>
<td>I</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td></td>
<td>35.0-39.9</td>
<td>II</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Extreme obesity</td>
<td>&gt;40.0</td>
<td>III</td>
<td>Extremely high</td>
<td>Extremely high</td>
</tr>
</tbody>
</table>

**Abbreviation:** BMI, body mass index.

**Source:** National Heart, Lung, and Blood Institute; National Institutes of Health; US Department of Health and Human Services.
**AACE/ACE Advanced Framework for a New Diagnosis of Obesity**

The algorithm developed by AACE/ACE recommends that the goals for treatment should be based on the severity of obesity-related complications, such as metabolic syndrome, prediabetes, T2DM, dyslipidemia, hypertension, nonalcoholic fatty liver disease, polycystic ovary syndrome, sleep apnea, osteoarthritis, gastroesophageal reflux disease, and difficulties with mobility. The AACE/ACE guidelines developed an advanced framework for a new diagnosis of obesity that does not totally depend on BMI. They define normal weight, depending on ethnicity, as a BMI less than 25 and a WC that does not exceed the cutoffs recommended by the IDF worldwide definition of metabolic syndrome.

In certain ethnic populations, a BMI of 23 to 25 and increased WC for ethnic-specific values indicates obesity. Patients with a BMI of 30 and those with a BMI of 25 to 29 with no obesity-related complications are categorized as overweight. If BMI is greater than 25, the presence or absence of severity of specific obesity-related complications defines whether the patient is overweight or obese. The presence of 1 or more mild to moderate obesity-related complications defines stage 1 obesity. The presence of 1 or more severe obesity-related complications defines stage 2 obesity.

**Metabolically Normal Obesity**

Overweight or obesity stage 0 may represent the metabolically normal obese (MNOB) population. This designation was noted in a prospective study of 6011 obese men and women participating in the Third National Health and Nutrition Examination Survey (NHANES III). It was determined that 6% of the MNOB group (or 1.6% of the general obese population) did not have insulin resistance and did not meet any of the metabolic syndrome criteria. The metabolically abnormal obese (MAOB) group was defined as having 2 or more metabolic syndrome criteria or the presence of insulin resistance. Thirty percent of this group had insulin resistance, and 38.4% had 2 or more criteria for metabolic syndrome. Although the MNOB phenotype is rare, an increase in all-cause mortality was noted in this group, with a hazard ratio of 2.58 for insulin resistance and 2.80 for metabolic syndrome criteria. In the MAOB, the hazard ratio was 3.09 for insulin resistance and 2.74 for metabolic syndrome criteria. This study emphasized the importance of treating the obese population even if insulin resistance and metabolic syndrome are absent. Intensive lifestyle modification, behavioral therapy, and weight management should be the cornerstone for reducing morbidity and mortality in the MNOB population.

**Primary, Secondary, and Tertiary Prevention and Treatment**

The AACE/ACE’s algorithmic approach to the diagnosis, evaluation, and care of obese patients takes into account BMI and the extent to which being overweight or obese has affected patients’ health or the severity of a specific health condition.

For patients whose weight is normal, the treatment algorithm focuses on primary prevention. Educating patients to adopt healthy eating patterns, increase physical activity, and improve sleep hygiene are some of the strategies used to prevent weight gain in these patients. For patients who have overweight or obesity stage 0, the focus is on secondary prevention. Strategies that prevent progressive weight gain and the emergence of obesity-related complications are similar to the treatment techniques for normal-weight patients but with intensive lifestyle and behavioral therapy and the consideration of pharmacotherapy for weight loss. Emphasis on weight loss is recommended if the BMI is 30 or higher or if weight gain has been progressive. Patients with stage 1 or 2 obesity enter a tertiary pre-
vention pathway that provides strategies to prevent worsening of the underlying health conditions and to manage complications.

A 5% to 10% weight loss through diet and increased physical activity has been shown to induce a 30% or more loss of visceral adipose fat. Mobilization of atherogenic visceral fat substantially reduces the risks of adverse consequences of metabolic syndrome. Preferential mobilization of visceral fat explains the improvements in atherogenic dyslipidemia, insulin sensitivity, and hypertension. Studies are in progress to assess the cardiometabolic risk profile after weight loss and mobilization of visceral fat.

Once complications develop in patients with overweight or obesity stage 0, it is assumed that the increased weight is affecting their health. At this point, treatment should transition from the secondary to the tertiary phase of treatment. Patients with stage 1 obesity can achieve improvement in obesity-related complications with weight loss in the range of 3% to 10%. Patients with stage 2 obesity tend to have a greater burden of associated complications in overall health. Recommendations for this group are weight loss of 10% or more. Intensive lifestyle and behavioral therapy and weight loss medications are also recommended for patients with stage 1 or 2 obesity. Bariatric surgery is a consideration for patients with T2DM and a BMI of 35 or higher. Laparoscopic gastric banding is also indicated for a BMI greater than 30 and 1 or more adverse health consequences. Since the mid-2000s, however, more bariatric surgeons have been performing the laparoscopic sleeve gastrectomy than gastric banding.

The treatment of overweight and obese patients always recognizes the importance of managing complications even when a patient is not involved in a weight loss program. The goals of the treatments outlined in the AACE/ACE algorithm focus on improving health conditions such as hypertension, T2DM, and hyperlipidemia, which can be achieved with targeted weight loss. If the health condition cannot be improved because of suboptimal weight loss, then pharmacotherapy and, eventually, bariatric surgery are considered.

The Bariatric and Metabolic Institute at the Cleveland Clinic applies 2 of the fundamental principles of osteopathic medicine to treat patients with obesity. Every patient on track for weight loss surgery must be counseled and cleared by a physician, dietician, psychiatrist, and surgeon before proceeding to surgery. The process to become eligible for weight loss surgery evaluates the body and mind to confirm that each patient is prepared to make this drastic change. The goal of the surgery is to lose the excess weight so the body can begin to heal itself.

Conclusion
At any given BMI, an elevated WC is a good surrogate marker of increased abdominal fat, as increased visceral fat vs subcutaneous fat distribution is not only a key feature of metabolic syndrome but also a driver of increased cardiometabolic risk. The OMA, AHA/ACC, and AACE/ACE guidelines go beyond BMI and WC measurements, however, and use staging systems that analyze body fat percentage and determine the burden of fat mass or adiposity on patients’ health. The AACE/ACE staging system uses lower BMI and WC cutoffs than the OMA, and their guidelines emphasize identifying the disease burden at an earlier stage and recommend strategies to prevent the progression of the disease process. All 3 obesity guidelines recommend initiating treatment strategies before complications develop. These guidelines are available as tools to screen patients who may have an increased burden of disease, including metabolic syndrome, especially those with normal-weight obesity (normal body weight but high fat percentages), in an effort to prevent cardiovascular events and reduce morbidity and mortality.
References


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