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What is the ideal body weight?

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This paper attempts to answer five questions. (1) How should we best measure overweight? Although life insurance tables and relative weights have been used, I propose that body mass index (BMI; wt/ht^2) is the preferred method. It is currently used in most epidemiologic studies and can be used in clinical evaluation of individual patients. (2) What is a healthy body weight? A healthy body weight can be defined from normative population data as well as from mortality experience. The National Center for Health Statistics has used the normative approach by defining overweight as a BMI above the 85th percentile of the weight distribution curve. Super overweight is defined as weights above the 95th percentile. There are three problems with this approach. First, the normative weight changes as the population weight changes, so standards differ with each survey. Second, this approach automatically defines 15% of the population as overweight. Finally, and of most concern, is the implication that a normal weight is a healthy weight. The alternative approach is to use mortality data. The life insurance companies have done this, using this data as the basis for the Metropolitan Life Insurance Table. This table uses three weight ranges based on frame size. However, frame size was never measured, and it appears that they were assigning the smallest quartile to small frame, the middle two quartiles to average frame, and the heaviest quartile to the large frame. The problem with this approach is that the same weight range is used for all ages and that the standard differs for men and women. A third approach is to use the mortality experience from large epidemiologic studies. Here the lowest death rates can be defined as the best and a range around this can be considered "healthy." Using this risk approach, BMI units separated by five BMI unit intervals have been defined, beginning with the healthy range of BMI between 20 and 25/27 kg/m^2. (3) Should we also measure body fat? I will conclude that, except for research purposes, there is no clinical value in measuring body fat. (4) Should we measure body fat distribution? Because body fat distribution is related to health risks, a measure of fat distribution is important. (5) What are some other measures that may be needed to establish whether a given weight is healthy? The first of these is the amount of weight gain since age of 18 to 20 years. The second is the presence of comorbidities: The fasting insulin level can be used to assess the degree of insulin resistance; blood pressure measurement will determine the presence of hypertension; measuring triglyceride and high-density lipoprotein cholesterol both reflect hyperinsulinemia and insulin resistance. Finally, the presence of sleep apnea is an important variable that must be noted. With this information, it is then possible to use an algorithm to decide whether an individual is overweight and, if so, whether this is a risky form of overweight. (J. Nutr. Biochem. 9:489–492, 1998) © *Elsevier Science Inc. 1998*

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Introduction

This paper will examine the criteria needed to define a healthy weight. It will be developed by answering a series of questions concerning weight and fat distribution, and their health implications.

How should we measure overweight?

It has been known since before the turn of the twentieth century that excess weight increases health risks and insurance costs of insured individuals who are overweight. The first standard weight tables were developed in the 1850s. It

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was also at this time that criteria for overweight began to appear in the scientific literature. One set of such criteria were defined by the insurance companies based on their mortality experience.[1] Beginning in the early twentieth century, the Metropolitan Life Insurance Company, in particular, began to publish tables of ideal, desirable, or what might be more appropriately called *healthy* weights. These were in general divided into three categories based on frame size. Although frame size was not a part of the initial measurement procedures for the insured lives, most of the tables contain frame size as a descriptor. It appears that the small frame size represents the lower quartile; the middle frame size, the middle two quartiles; and the large frame size, the upper quartile of body weights.

An alternative approach to the development of criteria for overweight was provided by Quetelet[2] in the mid-nineteenth century. In his famous monograph of 1835, Quetelet said:

> *. . . if we compare two individuals who are fully developed and well formed with each other, to ascertain the relations existing between weight and stature, we shall find that the weight of developed persons of different heights is nearly the square of the stature. Whence it naturally follows that a transverse section, giving both the breadth and thickness, is just proportional to the height of the individual. We furthermore conclude that, proportion is still being attended, width predominates in individuals of the same stature.*

It was this argument that led to the proposal that weight divided by stature squared (wt/ht^2) be used as an index of weight status.[3]

A third approach to assessing overweight was the idea of an index of relative weight, that is, the ratio of actual weight divided by a standard weight (usually taken from an insurance table) and multiplied by 100. Over the last 25 years since the Fogarty Center Conference in 1975,[4] body mass index (BMI) as a tool for evaluating overweight in epidemiologic studies as well as evaluating individuals has gradually achieved ascendancy.

What is a healthy weight?

There are two strategies for obtaining criteria for a healthy body weight. The first of these is to use normative data based on the frequency distribution of weights within the population. With this technique, the 85th and 95th percentile could be defined as overweight and superoverweight, respectively. These have been the criteria used by the National Center for Health Statistics (NCHS).[5] For comparative studies, they defined the 85th and 95th percentile as the BMI for men and women ages 20 to 29 years in the 1976 through 1980 national survey in the United States. These percentiles translate to a BMI of 27.3 kg/m^2 for women and 27.8 kg/m^2 for men. Unfortunately, these are not whole numbers and therefore are difficult to remember. In addition, the use of normative data will change with each survey because it is unlikely that the 85th percentile will fall precisely at the same point in every survey. Thus an arbitrary point is selected based on one survey. If such an arbitrary cut-off is taken, it might be simpler to take one with which one can handle more easily. The final problem is that the 85th percentile automatically defines 15% of the population as overweight. The Year 2000 goal for weight was for no more than 20% of the population to be overweight, using NCHS criteria. With 15% defined as overweight, this leaves little leeway for improvement.

Table 1 Classification of overweight and obesity in adults according to BMI

Classification	BMI (kg/m^2)[1]	Risk of comorbidities[2]
Underweight	<18.5	Low (but risk of other clinical problems increased)
Normal range	18.5–24.9	Average
Overweight	25.0–29.9	Mildly increased
Obese	≥30.0	
Class I	30.0–34.9	Moderate
Class II	35.0–39.9	Severe
Class III	≥40.0	Very severe

Note: Obesity is classified as body mass index (BMI) ≥30 kg/m^2.
[1]BMI = Body Mass Index (kg/m^2).
[2]Comorbidities = diabetes; hypertension; sleep apnea; heart disease; gall bladder disease.

A second approach to determining healthy body weight is in relation to the risk of morbidity and overall mortality associated with different weight levels. A growing number of studies have examined this issue, which is beyond the scope of this paper. Suffice it to say that the minimal mortality rates and lowest risks for developing diseases associated with obesity appears to occur in individuals with a BMI in the area of 22 kg/m^2. Most experts would agree that a BMI that ranges between 20 and 25 kg/m^2 would be a healthy weight range. The Committee on Dietary Guidelines adopted a BMI range of 19 to 25 kg/m^2 as “normal.” This reviewer would suggest that for women aged over 40 years, the upper limits of this BMI might appropriately be raised to 27 kg/m^2. However, for simplicity, the division of BMI into five BMI units has been adopted almost universally in defining a healthy weight as a BMI of 20 to 25 kg/m^2, overweight as a BMI of 25 to 30 kg/m^2, and various degrees of increasing risk with a BMI of 30 to 35 kg/m^2, 35 to 40 kg/m^2, and greater than 40 kg/m^2 (*Table 1*).

Should we measure body fat?

To this point, the entire discussion has focused on healthy body weight defined in terms of the BMI, with five-unit intervals selected for this purpose. However, most people believe that it is “obesity,” or an increase in body fat, that is the culprit, not simply an increase in body weight. Over the past 50 years, the sophistication of methods for measuring body fat has increased substantially.[6] *Table 2* shows a list of methods for measuring body fat and several descriptive terms including ease of measurement, accuracy, and relative cost. Height and weight can be accurately measured and are used to define overweight. The anthrometric measurements provided by skinfold thickness alone or in combination with circumference have been widely used to estimate body fat. In general, the variability in repeat measurements of skinfolds is considerably larger than circumferences, which are in turn larger than height or weight. Indeed, in many obese individuals the current instruments will not allow a satis-

Table 2 Methods of estimating body fat and its distribution

Method	Cost	Ease of use	Accuracy	Measures regional fat
Height and weight	$	Easy	High	No
Skin folds	$	Easy	Low	Yes
Circumferences	$	Easy	Moderate	Yes
Ultrasound	$$	Moderate	Moderate	Yes
Density				
Immersion	$	Moderate	High	No
Plethysmograph	$$$	Difficult	High	No
Heavy water				
Tritiated	$$	Moderate	High	No
Deuterium oxide, or heavy oxygen	$$$	Moderate	High	No
Potassium isotope (40K)	$$$$	Difficult	High	No
Total body electrical conductivity (TOBEC)	$$$	Moderate	High	No
Bioelectric impedance (BIA)	$$	Easy	High	No
Fat-soluble gas	$$	Difficult	High	No
Absorptiometry (dual energy x-ray absorptiometry (DEXA); dual photon absorptiometry (DPA)	$$$	Easy	High	No
Computed tomography (CT)	$$$$	Difficult	High	Yes
Magnetic resonance imaging (MRI)	$$$$	Difficult	High	Yes
Neutron activation	$$$$	Difficult	High	No

$ = low cost; $$ = moderate cost; $$$ = high cost; $$$$ = very high cost.

factory measurement of skinfolds in some areas. In addition, the equations for converting skinfold thicknesses into body fat are often population-specific. Thus, as a general rule, skin folds are primarily applicable to large populations and not to individuals.[7]

The preferred methods for measuring body fat are underwater weighing, which provides a two compartment model of fat free mass and body fat, and dual X-ray absorptiometry (DXA), which provides a three compartment model. Because some people will not submerge their head underwater and because of the need to measure residual pulmonary volume at the same time, this procedure is limited. The current favored method, providing it is done correctly, is dual-energy DXA. This technique was developed for providing estimates of bone density using two X-ray beams of very low energy. With the current instruments used for DXA, radiation exposure is comparable to that of being outside for 6 hours. Body fat can be measured by this technique reproducibly and reliably. Bioelectric impedance, a measure of the conductance in the aqueous portions of the body, can be used to provide an index of the body water, and by various formulas, provide a calculation of body fat. Because approximately 80% of the variance in body fat is known from the other measures, including height and weight, the bioelectric impedance only improves this by the order of 10%. *Table 3* shows the ranges of body fat for normal, borderline, and obese individuals. Because of the fairly wide range of fat values, methodologic limitations, and gender differences, there is no clinical reason to determine body fat measurements.

How do we measure body fat distribution?

Having said that measurement of body fat provides little, if any, more information than one can obtain from the BMI, it is important to note that fat distribution is an extremely important parameter of body fatness. Increased central, abdominal, and particularly visceral adipose tissue substantially increase the risk for diabetes, high blood pressure, heart disease, and cancer compared with lower body fat distribution.[8] The correction for differences in body fat distribution between men and women eliminates most of the difference in longevity between the genders. A precise measure of subcutaneous and visceral fat can only be obtained with magnetic resonance imaging or computed tomographic scans. Because of the expense and radiation exposure of these modalities, there are clear limitations to their use. From a clinical perspective, measurement of waist circumference or the ratio of the waist circumference divided by the hip circumference have been the most widely used measures of central fat distribution. *Table 4* shows criteria for assessing low, moderate, and high risk for men and women based on the waist circumference or the waist:hip ratio.

What else do we need to know besides BMI and fat distribution to evaluate overweight patients and to determine whether they have a healthy body weight?

The first criterion is weight gain since late adolescence. In the Health Professional Study and in the Nurses Health

Table 3 Criteria for obesity in males and females

Category	Body fat	
	Males	Females
Normal	12%–20%	20%–30%
Borderline	21%–25%	31%–33%
Obesity	>25%	>33%

Table 4 Risk associated with central fat

	Risk		
	Low (0)	Moderate (+2)	High (+4)
Men			
Waist circumference			
in	<37	37–40	>40
cm	<94	94–102	>102
WHR	<0.90	0.90–1.00	>1.00
Women			
Waist circumference			
in	<32	32–35	>35
cm	<80	80–88	>88
WHR	<0.75	0.75–0.85	>0.85

This evaluation and adjustment of body mass index (BMI) for the added risk of central fat is done for individuals with a BMI below 30 kg/m^2.

Study, the greater the weight gain since ages 18 to 20 years, the greater the risk of diabetes or early death. From a clinical perspective, weight gains in excess of 10 kg (22 lb) in adult life before age 50 years carry a greater risk than weight gain of less than 5 kg during this same period. A weight gain between 5 and 10 kg increases the risk somewhat.[9]

A second important factor is the level of physical activity. A sedentary lifestyle for men or women carries enhanced risk of early death compared with a moderately active lifestyle.[10] Thus determining weight gain and sedentary lifestyle are two additional important variables that we need to evaluate. In all likelihood these two are related in individuals who are less active and are gaining more weight.

The final set of parameters needed for an effective evaluation of a healthy weight are the presence of risk factors for diabetes, high blood pressure, and dyslipidemia. A family history of type II diabetes, steady weight gain, being a heavy baby, or being a woman who bears heavy children or who has multiple pregnancies are all risk factors for diabetes. The magnitude of this risk can be given some quantitation when coupled with the level of fasting insulin, a value above 20 μU/ml in the fasting state being cause for concern. Blood pressure is the second variable of concern. African Americans and individuals from families with hypertension are at increased risk for hypertension. Measurement of blood pressure is an important evaluation in overweight individuals. Hyperinsulinemia is one factor in enhancing very low density lipoprotein production by the liver, which leads to increased circulating levels of triglyceride. In addition, the level of high density lipoprotein cholesterol is an important determinant in evaluating the risk associated with obesity and plasma lipids. Finally, the presence of sleep apnea, by history or from the plethoric appearance is also of concern.

Conclusions

In summary, this paper has examined the question of how we measure overweight and suggested that the BMI is the preferred criterion. A healthy BMI is between 20 and 25 kg/m^2 with risk rising as BMI increases above that number. Although measurements of body fat are not clinically valuable, measurements of fat distribution are of great value in assessing the overall importance of a given degree of overweight. Coupling this estimate of fat distribution with weight gain since age 18 years and estimates of diabetes, hypertension, and dyslipidemia can provide an effective profile for evaluating whether a given weight status is healthy.

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