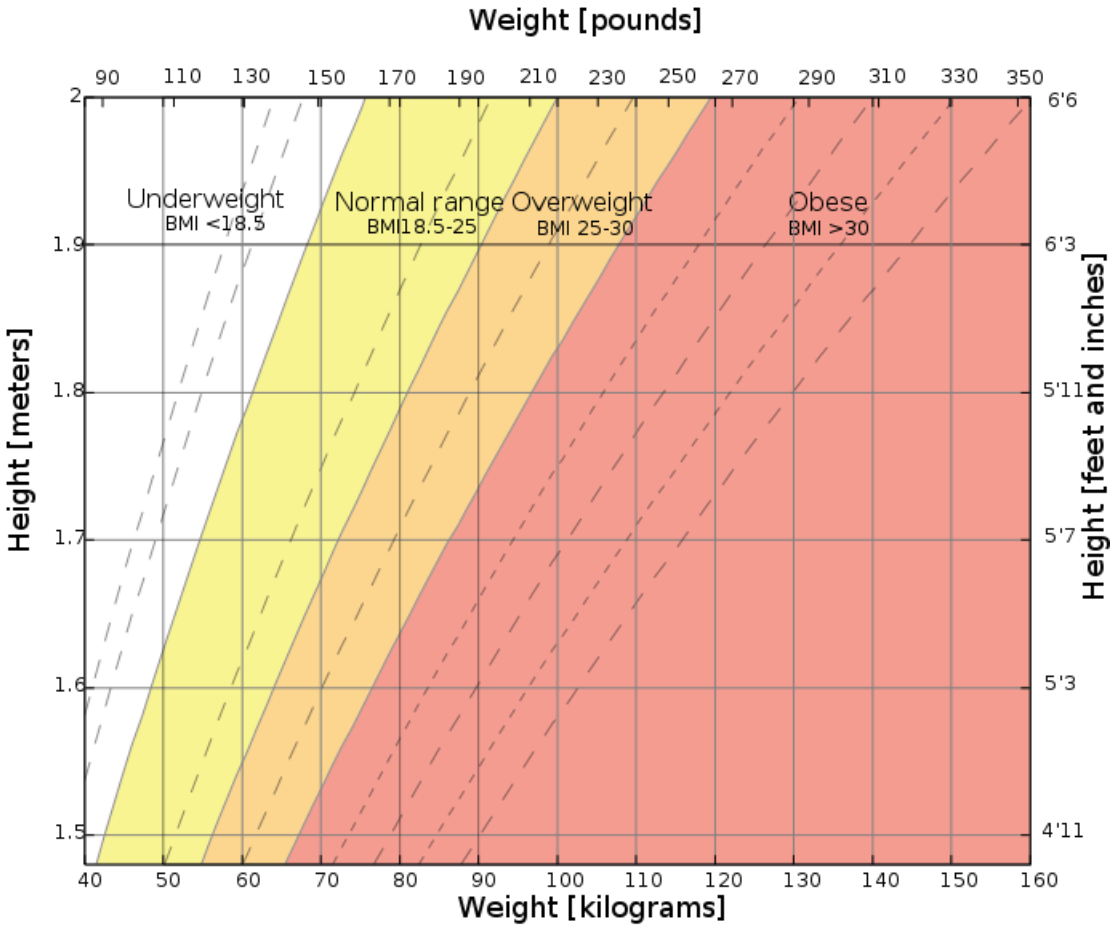
How Fat Are You - Really?
By Jeff Tesch (7/12/2012)

The increasing use of body mass index (BMI) as an indicator of body fatness is an unfortunate trend. BMI is based on two things only, body weight and body height. It is simply the ratio that results when the body weight (in kilograms) is divided by the square of body height (in meters). It is no more sophisticated than the height and weight charts used by insurance companies more than a century ago.

The shortcomings of the BMI should be immediately obvious when we see that very fit individuals with greater than average muscle mass are deemed "overweight", classified as unfit for military service and not qualified for first class insurance rates.

The body mass index (BMI) and its interpretation.
From Wikipedia (Based on World Health Organization data):



How do you define "obesity"?

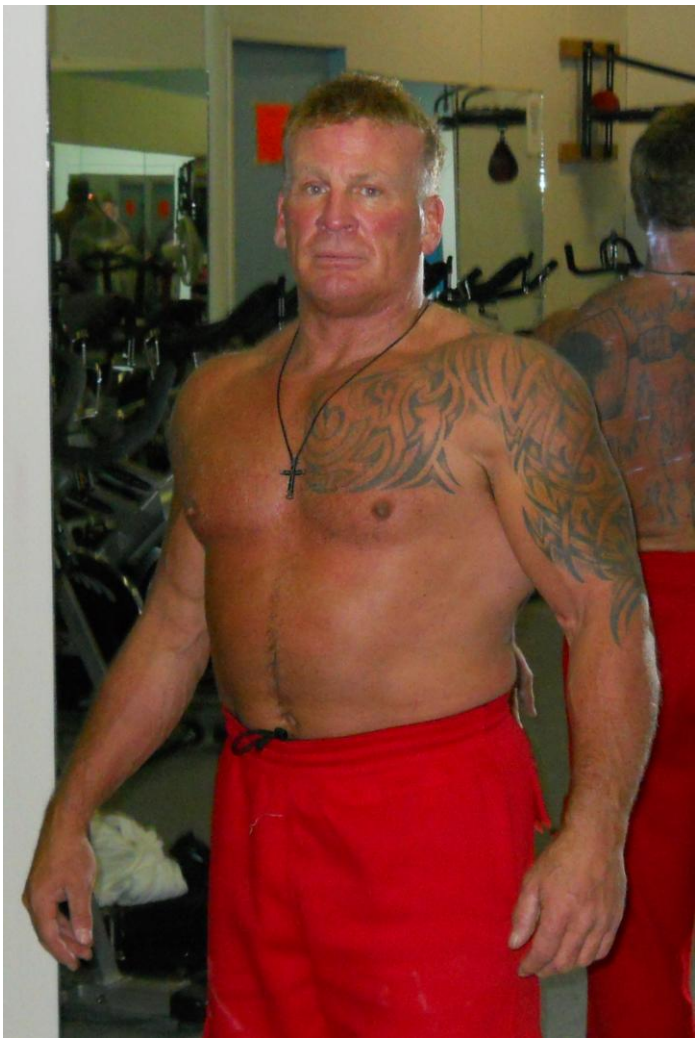
"(Bill) Becker (photo at right) set a world record in the squat, lifting 705 pounds at the Wisconsin State Powerlifting Championships in Madison, WI. The previous world record was 660 pounds."

Source: Jeff Theis, Winona Daily News (10/3/2009)

At a body weight of 192 pounds, and height of 67 inches, his BMI = 30.1 "Obese".

Actual body fat = 9.2 % "Very lean". (From body density determined by underwater weighing.)

Although his actual body fat percentage shows him to be a very lean individual, Bill was not happy to discover his medical records indicated that he was "obese" based upon the calculation of the "body mass index" (BMI). And he is not alone in this respect. Very muscular individuals are routinely being classified as "overweight" or "obese" due to the inappropriate use of BMI as an indicator of body fatness.



Dr. Ancel Keys, a world famous pioneer in research on body fat measurement who is credited with popularizing the term in 1972, warned that the BMI is inappropriate for individual diagnosis of obesity. Yet the BMI has somehow re-emerged as a "scientific" number that has been promoted by such prestigious organizations as the World Health Organization and the National Heart and Lung Institute as a "measure of body fatness". But those of us who actually measure body fatness know that an above-average BMI means only that someone weighs more than the average of other people of the same height. This additional weight could be composed primarily of fat tissue or muscle tissue and would only indicate high body fatness if the tissue was mostly fat. The important thing, which is missing from the BMI concept, is to be able to actually determine how much of an individual's body weight is fat, commonly expressed as "body fat percentage". Fortunately, there is a very simple way to estimate the fat content of the body with great accuracy. Conveniently, it turns out that human fat weighs almost exactly 10% less than an equivalent volume of water, whereas the fat free tissue weighs almost exactly 10% more than water. As a result, very lean people do in fact weigh more in water than fatter people of the same size. This makes possible an accurate estimate of body fat percentage from body density.

How to estimate body fat percentage

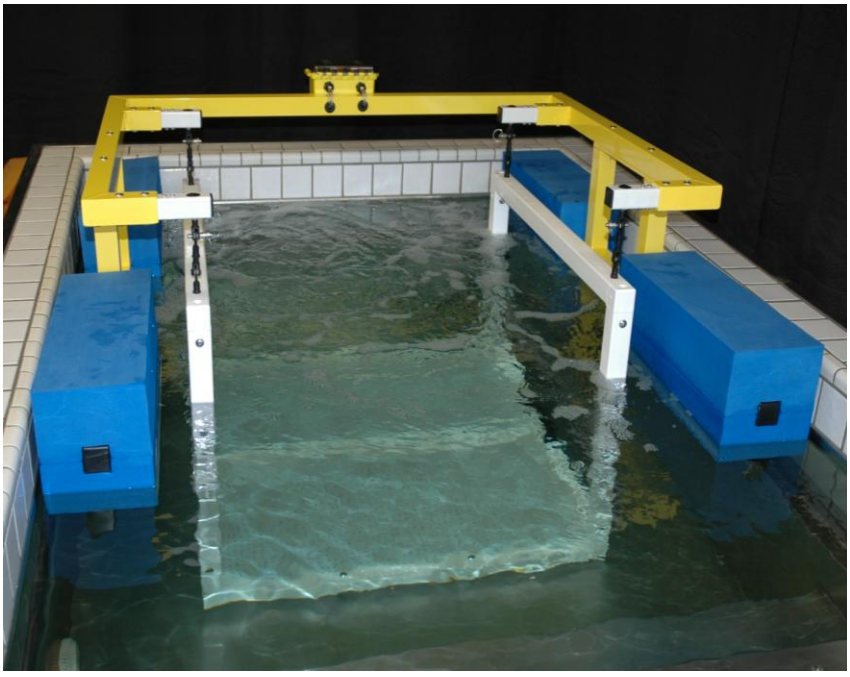
The only way to actually "measure" the exact fat content of a human body is to dissect a cadaver, remove the fatty tissue, extract the fat with a solvent and weigh the extracted fat. Only a very small number of human cadavers, widely varying in fatness and hydration level, have ever been analyzed in this way. However, certain data from these cadaver studies provide a good basis for estimating the body fat content in a living person.

Irrespective of the location from which they are obtained, the fat cells in humans are composed almost entirely of pure triglycerides with an average density of about 0.9 kilograms per liter. Most modern body composition laboratories today use the value of 1.1 kilograms per liter for the density of the "fat free mass", a theoretical tissue composed of 72% water (density = 0.993), 21% protein (density = 1.340) and 7% mineral (density = 3.000) by weight.

If a body consists of only two compartments (fat and the fat free mass), then the percentage of weight from fat can be calculated from the overall body density by the following popular equation of Dr. William E. Siri, a biophysicist at the Donner Laboratory of Biophysics and Medical Physics, Univ. of California – Berkeley:

Body Fat Percentage = (495 ÷ Body Density) - 450 (Siri, 1956)

With a well engineered weighing system, body density can be determined with great accuracy by completely submerging a person in water and calculating the volume of the displaced water from the weight of the displaced water. A correction is made for the buoyancy of air in the lungs and other gases in the body spaces. If there were no error whatsoever in measuring body density, the uncertainty in fat estimation would be about ± 3.8% of the body weight, primarily because of normal variability in body constituents.



Underwater Weighing System
(manufactured by EXERTECH)

A subject, immersed in water up to the neck, sits on a weighted platform, expels as much air as possible and then ducks under the water surface for a few seconds .

Electronic sensors measure the weight of the totally immersed subject and transmit the data to a computer alongside the pool.

Body volume, density and fat percent are then calculated.

Estimation of body fat percentage from underwater weighing has long been considered to be the best method available, especially in consideration of the cost and simplicity of the equipment. Most other ways to estimate body fatness, such as by skin folds, body girths, body impedance, air displacement volume and body scanners are based on equations which only predict body density. In contrast to other methods, underwater weighing gives an actual measurement of body density rather than a prediction.

It is time for all health and fitness professionals to take another look at how they are assessing body fatness and to make certain that they are not inadvertently putting the obesity label on very fit people.

For further information on underwater weighing systems, contact:

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