Psychology Today

Sylvia R. Karasu M.D.
The Gravity of Weight

Adolphe Quetelet and the Evolution of Body Mass Index (BMI)

A 19th century 'Renaissance man' devised a ratio we use today.

Posted Mar 18, 2016

Detail from an Ancient Greek red figure amphora of Theseus killing Procrustes, Louvre Museum.

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Procrustes (literally the “one who stretches”) was a robber who had an inn beside a road that led away from ancient Athens. He boasted that his bed could fit anyone who came to stay the night but instead of making the bed fit the person, he made the person fit the bed. So for those travelers who were too tall, he amputated their legs and for those too short, he stretched them to fit his one-size-fits all bed. In both scenarios, so the ancient Greek myth goes, the unlucky traveler was killed. But Procrustes got his due—Theseus, of Minotaur and labyrinth fame, killed him in the same way he had killed his guests, i.e., by making him fit his own bed, and according to one version, decapitated him. The myth is referenced by the Greek historian Plutarch in *Parallel Lives* and by the Roman poet Ovid in *Metamorphoses*, as well as on Greek red figure pottery. Nassim Taleb used this myth as inspiration for his book —*The Bed of Procrustes*, a book of aphorisms that relate to situations of changing the wrong variable.

Procrustes, though, with his focus on a one-size-fits all mentality, may have been the first in history to mandate standardization. In his new book, *The End of Average*, Todd Rose writes how society has used

standards and norms as a means of understanding individuals. From our regulation of size proportions of military uniforms and airplane cockpits, cut-offs for test scores in education and college admissions, and the selection of applicants for employment, Rose notes that we have created an emphasis on conformity and the rise of "averagarians." Instead, we should focus on the "science of the individual" that involves appreciating that our behavior is often context-dependent and acknowledging that people don't all have to follow the same path for success.

Belgian 'Renaissance man' Adolphe Quetelet, Brussels (1796-1874), one of the founders of statistics as a scientific discipline.

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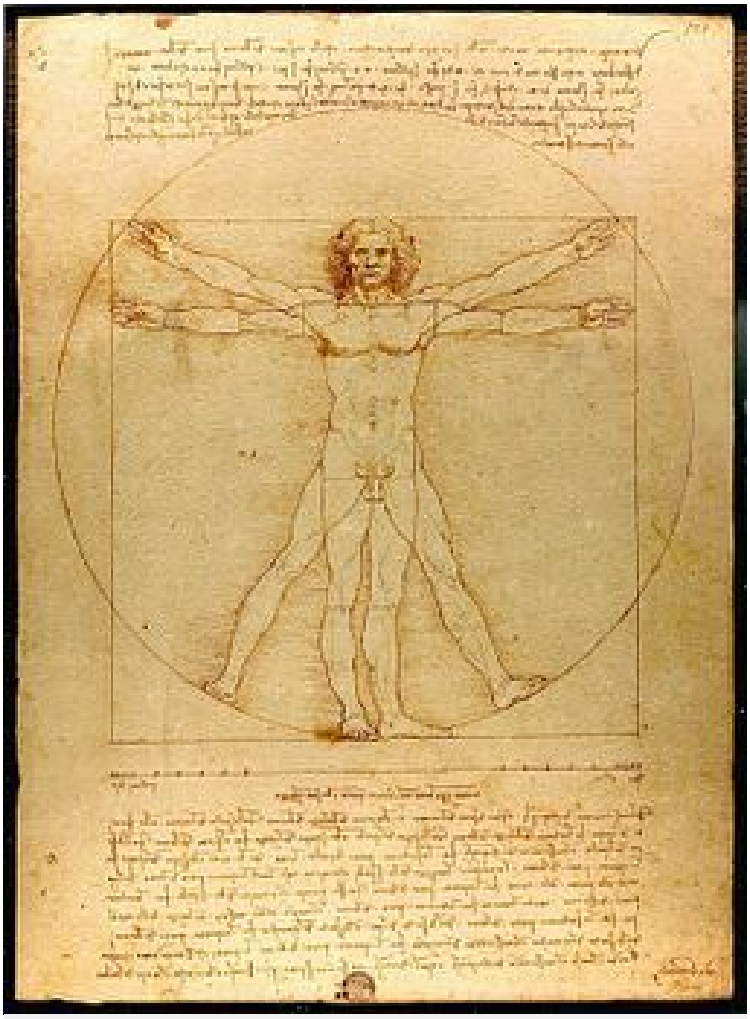
Where, though, did this concept of average originate? Rose discusses numerous sources, but for our purpose here, Adolphe Quetelet deserves much of the responsibility and for Rose, some of the blame.

Quetelet (1796-1874), though, was responsible for far more than a concept of average. Belgian born, he has been described as a 'Renaissance man' (Rössner, *Obesity Reviews*, 2007), with equal interests in the arts and sciences and reportedly fluent in six languages. (Eknoyan, *Nephrology Dialysis Transplantion*, 2008) Early on, he dabbled in painting and poetry (Landau and Lazarfeld, *International Encyclopedia of the Social Sciences*, 2008) but received his doctorate in mathematics at age 23. (Faerstein and Winkelstein, *Epidemiology*, 2012) He was a prodigious letter-writer and influenced the thinking of people as diverse as Karl Marx, Emile Durkheim, Francis Galton, Goethe, and Florence Nightingale. (Jahoda, *Springerplus*, 2015; Landau and Lazarfeld, 2008) Until he had a stroke in his later years, he was extraordinarily productive. Interested in astronomy, he established the Brussels Observatory and was its director for fifty years, but his major interest was statistics. (Porter, *British Society for the History of Science*, 1985) He established the first international conference on statistics, and some consider him one of the founders of statistics as a scientific discipline. He was most fascinated with regularity in statistical patterns (Desrosières, *The Politics of Large Numbers*, 1998) and collected data on rates of crime, (with an interest in what he called "moral anatomy"), marriage, mental

illness, and mortality, including suicides. (Porter,1985) He believed that conclusions come from data of large numbers--populations--rather than from a study of individual peculiarities. For Quetelet, perfection in science was related to how much it could rely on calculation. Many of these original ideas are found in his classic *A Treatise on Man and the Development of his Faculties*, initially published in French in 1842 and not translated into English until recent years by R. Knox of Cambridge University Press.



Leonardo da Vinci's 'Vitruvian Man," Academy of Venice. Like Leonardo, Quetelet was interested in ideal proportions of his 'average man.'

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Perhaps as a result of his interest in painting, Quetelet became absorbed in measurements of the human body. (Eknoyan, 2008) At the time, he was most known for his concept of the *l'homme moyen*—the "average man." For Quetelet, this average man was hardly the "average" (read "mediocre") that is our present connotation. *L'homme moyen* was an ideal. Says Quetelet, "If the average man were completely determined, we might consider him as the type of perfection; and everything differing from his proportion or condition, would constitute deformity or disease...or monstrosity." He gathered information on the height and weight of different populations. Most notably, though he had no particular interest in the study of obesity, (Eknoyan, 2008) Quetelet was the first to devise the equation that relates weight to height, i.e., w/h^2 (with weight in kilograms and height in meters squared),(Caponi, *História,Ciências,Saúde-Manguinhos,* 2013) now known as our own standard for indicating obesity, the body mass index (BMI) and called quite appropriately, by those in the field, *Quetelet's Index*. (de Waard, *Journal of Chronic Diseases*, 1978; Garrow and Webster, *International Journal of Obesity,* 1985)

Throughout the years, researchers have grappled with standardizing the measurement of overweight and obesity as well as with comprehending obesity's medical implications. It was at the beginning of the 20th century that scales became available for home use and insurance companies began to associate excessive weight with decreased life expectancy. (Harrison, *Annals of Internal Medicine,* 1985; Pai and Paloucek, *Annals of Pharmacotherapy*, 2000) These early tabulations, though, were hardly random samples: they were data compiled on customers who had purchased life insurance policies during a particular time period.

Furthermore, there was absolutely no attempt at standardization. Some of those in the sample reported their own height and weight, often notoriously inaccurate. Those who were actually measured wore their own clothing and shoes that could distort both measurements. In the early 1940s, one of the companies, the Metropolitan Life Insurance Company, had developed tables of "desirable weight" that did not include a person's age and introduced an initially arbitrary and subjective measure of body "frame"—small, medium and large. (Pai and Paloucek, 2000) The Metropolitan Life Insurance Company revised its tables over the years, and some may remember these were very popular benchmarks, particularly in the late 1950s and 1960s, that were used by physicians to assess "ideal weight" in their patients. During these years, Quetelet's Index was apparently lost to history.

Detail of Pieter Bruegel the Elder's "The Fight Between Carnival and Lent," 1569, Kunsthistorisches Museum, Vienna. An artistic rendering of a fight between the fat and the lean.

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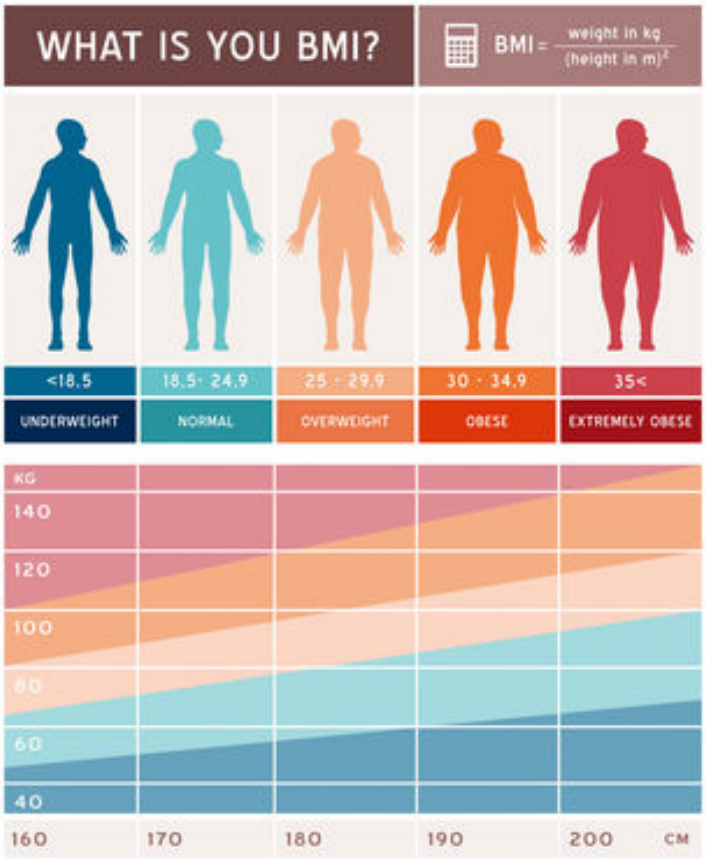
The term "index of bodily mass," also referred to as the "ponderal index," first appeared in the 1940s book *The Varieties of Human Physique* by William H. Sheldon, famous for his division of body types into ectomorph, endomorph, and mesomorph. Sheldon used a different ratio, of height in meters/weight in kilograms^3 that he described as "long been used in attempts at bodily classification…(but) by no means an infallible index." The first reference to the term "body mass index" (even using the initials BMI) appeared in a 1959 paper (Di Mascio, *Psychological Reports*) on the somatotypes of dogs, but the ratio used was also not the one devised by Quetelet, but rather the ratio of weight in kilograms to height in meters cubed (w/h^3). References to the different indices (including mentioning *Quetelet's Index* and a simple w/h ratio) continued to appear in the scientific literature during the 1960s. Quite presciently, Billewicz et al (*British Journal of Preventive and Social Medicine*, 1962) wrote in the early 1960s that no formula that related weight to height could actually measure fat.

It was not until 1972, though, when researcher Ancel Keys and colleagues popularized the use of Quetelet's original index, claiming it was superior to other indices after they compared the index with measurements of fat by skin calipers and underwater weighing (body density) in an analysis of over 7400 healthy men in five countries. (Keys et al, *Journal of Chronic Diseases*) In this paper, Keys and his

colleagues proposed that Quetelet's ratio, w/h^2 be termed *body mass index*. In that paper, Keys and colleagues refer to Quetelet but ironically, despite an extensive bibliography, do not directly reference any of Quetelet's many papers. They also note Quetelet never actually advocated his ratio as any kind of general measure of body 'build' or fat. Belgium, though, issued a stamp honoring Quetelet in 1974.

Since Keys and his colleagues' classic paper, body mass index (BMI) has become the standard indicator for obesity, though cut-off values have gotten more stringent over the years and have led to more people being labeled obese. At present, those with a BMI of 30 kg/m^2 or higher are considered obese, and those over 25 kg/m^2 to 29.9 kg/m^2 are considered overweight. But as noted, BMI is just an estimate of the amount of adipose tissue we have; it does not differentiate fat from muscle and can be particularly inaccurate in certain populations such as athletes or those who are very tall or very short. One reason for its popularity is that it is convenient to use: a physician, who often now has a BMI chart in the office, requires no more than a balance scale for weight and a tape measure for height. There is even a means of converting our ratio in pounds and inches to the metric system by multiplying by 703. More recently, researchers have suggested using waist-to-height ratios as an indicator of health risk. (Ashwell and Gibson, *British Medical Journal,* 2016)



Despite all its limitations, BMI has become a standard for indicating our body's level of overweight or obesity. The original ratio came from 19th century Adolphe Quetelet.

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There are, of course, more accurate means of assessing body composition, such as underwater weighing (densitometry), MRIs, CT scans, or DXA (dual-energy X-ray absorptiometery, used for bone density evaluation), but these require a laboratory setting or special equipment and cannot be used in all populations (e.g. pregnant women) if radiation is involved. (Karasu and Karasu, *The Gravity of Weight*, 2010)

Despite all the progress we have made in science since Quetelet's 19th century index, we are still far from being able to measure our body's fat conveniently and accurately in a physician's office. Body Mass Index is one approximation we have at present but sometimes it may seem like the modern day Procrustean equivalent of attempting to force people into simple paradigms.

About the Author

Sylvia R. Karasu, M.D., is a clinical professor of psychiatry at Weill Cornell Medical College and the senior author of *The Gravity of Weight.*

In Print: *The Gravity of Weight: A Clinical Guide to Weight Loss and Maintenance*

Online: my own website