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The Gravity of Weight

Location, Location, Location: The Distribution of Fat

Where fat accumulates in the body may have serious health consequences.

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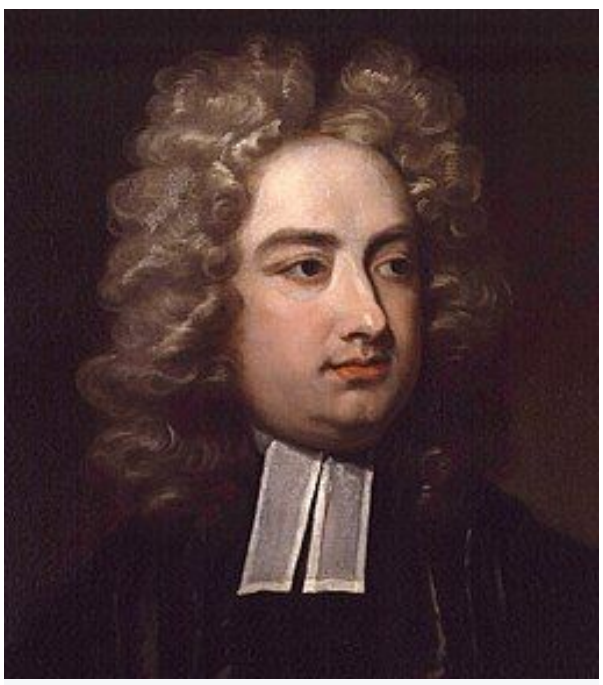
Gulliver in Lilliput, from Jonathan Swift's "Gulliver's Travels," 1726.
Source: Alamy stock images, used with permission. Credit: Chronicle

In the land of Lilliput, natives are typically six inches tall. Mathematicians, by taking the height of Gulliver's body and finding it exceeded theirs by a proportion of 12 to one, scientifically calculated that Gulliver required enough food and drink to support 1728 Lilliputians. Sometimes, the inhabitants thought to starve him as his diet "would be very expensive and might cause a famine." (p. 38, Jonathan Swift, *Gulliver's Travels*, 1726.)

Gulliver eventually escapes from Lilliput and arrives home to his wife and family for a mere two months before his "insatiable" wanderlust drives him to set out again, this time to Brobdingnag where his small size makes him seem to those inhabitants a "freak of nature" and "beyond all degrees of comparison." (p. 109) Even his dear nine-year-old "nurse," small for her age, is 40-feet tall. (p. 101) Says Gulliver, "Undoubtedly philosophers...tell us that nothing is great or little otherwise than by comparison." (p. 93)



Jonathan Swift, author of "Gulliver's Travels," 1726. Painting by Charles Jervas, 1710. National Portrait Gallery, London.
Source: Wikimedia Commons/Public Domain

While researchers on obesity are hardly confronted with the extremes of size to which Gulliver is exposed, they have sought far more sophisticated ways of measuring the body, including how much fat it contains and where the fat is located, than those available to the Lilliputians. As obesity rates have continued to rise throughout the world, metabolic disturbances such as diabetes, hypertension, abnormal lipid levels, and cardiovascular disease have risen concurrently. Where fat accumulates may be as important to health as how much adipose tissue we have.

Adipose (fat) tissue can be classified as *subcutaneous*, i.e., fat between the skin and muscles and *internal*, i.e. *visceral* fat around our abdominal organs. Approximately, 70 to 90% of total fat in our bodies is subcutaneous. (Heymsfield, Allison, et al in Bray and Bouchard, *Handbook of Obesity*, 2nd Edition, 2004, pp. 33-79.)

Fat used to be considered an inert substance whose major function was to store energy and aid in thermal regulation and cushioning of organs. We now know that adipose tissue is a “highly dynamic endocrine and immune organ” that is involved in many physiological processes, including energy balance, inflammation, and metabolic functioning. Visceral fat is more metabolically active and produces more “pro-inflammatory cytokines" than subcutaneous fat. (Hamdy et. al, *Current Diabetes Reviews,* 2008) (For a thorough discussion of the many adipocytokines, including many newly discovered ones, that are secreted by "sick," inflamed, and dysfunctional adipose tissue, see Barchetta et al, *Journal of Endocrinological Investigation,* 2019.)

"Apples gathered in Dr. Jenner's garden." Painting by Stephen Jenner, circa 1800s. Body shapes have been compared to apples, with adipose tissue accumulating around the middle more typical in men, and pears, with accumulation around the hips and thighs, more typical of women. No one seems to know who first referred to body shapes as "apples" and "pears."
Source: Wellcome Trust Collection, Public Domain.

Initially writing in French in the 1940s and later in the 1950s in English, Jean Vague, using skin calipers, reported two major patterns (with an intermediate pattern as well) of fat accumulation—what he called the *gynoid* pattern where fat accumulated in the lower body (e.g. thighs and hips) more typical of women and the *android* pattern, where fat accumulated around the middle abdominal area and seen more typically in men, and which led to metabolic disturbances, including "vascular accidents" and diabetes. Concluded Vague, "Fat distribution is very definitely a sexual characteristic" and differences begin in puberty. He further noted that around menopause, as estrogen levels fall, this android pattern can be seen in women. (Vague, *American Journal of Clinical Nutrition*, 1956). Reportedly, about 40% of women between age 30 and 79 store fat predominantly in the abdominal area, as assessed by a waist-to-hip ratio greater than .85. (Karastergiou et al, *Biology of Sex Differences*, 2012) Over the years, these body shapes have been universally referred to as the *pear-shape* and the *apple-shape;* these terms were not used by Vague. The first reference I could find (from PubMed) was in the abstract in a paper by Rimm et al, *Journal of Clinical Epidemiology*, 1988, who also noted that anatomical distribution of fat in the abdominal area is a significant predictor of morbidity. According to obesity investigator and scholar, Dr. Claude Bouchard, though, it was the obesity researcher Per Bjorntorp, a mentor of Dr. Lars Sjöström, who was the first to use these more colloquial terms.

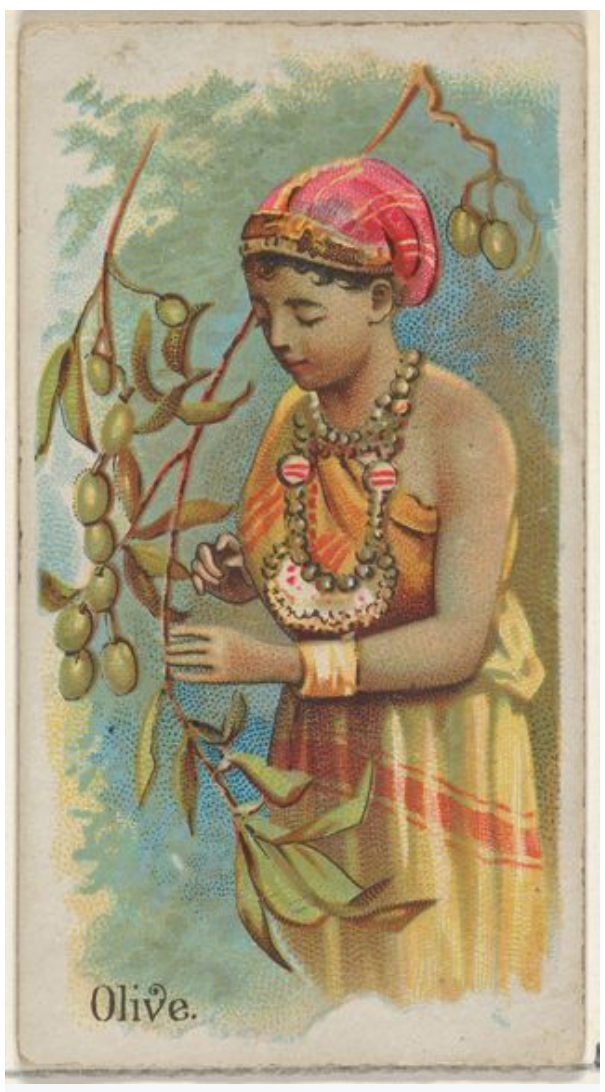
Researchers, such as Sjöström et al, (*Obesity Research*, 1995), in a study of over 2400 severely obese men and women, assessing adipose tissue patterning by CT scan and measurement of neck and thigh circumferences, confirmed Vague's observations, namely that visceral fat was positively associated with cardiovascular morbidity. Others, focusing on the measurement of waist circumference, such as Klein, Allison, Heymsfield and colleagues (*Diabetes Care*, 2007) and Jacobs et al (*Archives of Internal Medicine*, 2010), have also emphasized the metabolic consequences when adipose tissue accumulates around the abdominal area. There is even the suggestion that waist circumferences have been increasing in population samples since the late 1950s. (Allison and colleagues, in Elobeid et al, *Obesity,* 2007.)

"One young boy is caught by an irate farmer while stealing apples..." Color wood engraving, 1880, Kronheim & Co.
Source: Wellcome Trust Collection, Public Domain

Most recently, Sun et al (*JAMA Network/Open*, 2019) reported on a long-term study of over 156,000 postmenopausal women from the Women's Health Initiative. They found that even those women of *normal weight* who had central obesity had a higher risk of all-cause mortality, as well as higher risk of specific mortality from cardiovascular disease and cancer as compared to those of normal weight but without accumulation of fat around the abdomen. While accumulation of adipose tissue in the hip and thigh area was actually linked to improved metabolic and cardiovascular risk (an observation made by other researchers), excessive visceral fat was associated with insulin resistance, hyperinsulinemia, dyslipidemia, and inflammation. The researchers suggest their study "challenges the current paradigm" that measurement of abdominal fat is not necessary when someone is of normal weight.

In their editorial accompanying Sun et al's research, Allison and colleagues (Golzarri-Arroyo et al, *JAMA Network/Open*, 2019), emphasize that this study is a "reminder that the scale is not everything," namely that "the simple anatomical distribution of fat may be predictive." They explain that the accumulation of fat in the upper part of the body in "an otherwise thin figure--what might be called an *olive on a toothpick*" may be deleterious. But they caution that the study was done in a specific population (e.g. postmenopausal women) and may require refining cutoffs in other populations that vary by age, sex, ethnicity, and age. Further, they explain that the use of waist circumference "still remains something of a black-box predictor," rather than an explanation for the

Pear-shaped bottle with birds, 17th century ceramic from Iran.
Source: Metropolitan Museum of Art, NYC, Public Domain. Credit: Gift of William B. Osgood Field, 1902.



Olive, from the Fruits series (N12) for Allen & Ginter; Lithographer George S. Harris & Sons, Philadelphia, 1891. Some researchers describe the body shape,"olive on a toothpick," as a variant of the "apple shape" where fat accumulates around the abdominal area in an otherwise thin person. Source: Metropolitan Museum of Art, NYC. Public Domain. Credit: The Jefferson R. Burdick Collection, Gift of Jefferson R. Burdick

physiology. And they note that identifying a body shape associated with higher risk does not necessarily imply that body shape is "malleable" or even if it is, whether this would change the underlying risk.

For example, Xiao and Fu (*European Review for Medical and Pharmacological Sciences,* 2015) review the effects of exercise, including the type, duration, and intensity on adipose tissue. They note that individual factors, such as age, gender, and different ethnic and racial populations may be important variables influencing the effect of exercise on the body. They also found that those with co-morbidities such as diabetes are less likely to lose visceral fat as easily with exercise. Aerobic exercise can reduce visceral fat and improve metabolic functioning, but the exact influence remains "controversial" and with weight gain, fat will tend to accumulate in the same location. When aerobic exercise is paired with resistance training, it is not clear whether any effect is due to the "synergistic" effect of the combination or simply the greater total amount. Furthermore, they note that there have not been studies that demonstrate the effect of exercise intensity on visceral fat,

van Gogh's, "Women Picking Olives," 1889. These women do not have the "olive on a toothpick" body type seen in otherwise thin women who have accumulation of fat only in their abdominal area. Both seem to be obese. Credit: The Walter H. and Leonore Annenberg Collection. Gift of Walter H. and Leonore Annenberg, 1995. Source: Metropolitan Museum of Art, NYC, Public Domain.

Bottom line: The three most important rules when purchasing a home are "location, location, location." Location is, after all, the one aspect of a house that cannot be changed. Likewise, the location of where fat accumulates in our body is significant and may not be particularly modifiable, and if it is, exactly how much it affects and changes any underlying risk. There is considerable evidence that visceral fat that results in the so-called "apple" shape is associated with consequences to health, as evidenced by increased morbidity and mortality. In all likelihood, genetics plays a significant role in determining our shape. There are theories but the actual mechanisms responsible for the connection between excess visceral fat accumulation and cardio-metabolic disease remain unknown. Nevertheless, obtaining an accurate assessment of body composition, including the anatomical distribution of fat, is an important step in our understanding this connection.

My subsequent blog will focus on methods of measuring body composition.

Note: The expression, "location, location, location," according to former *NY Times* columnist and wordsmith extraordinaire, William Safire (6/26/09), was first used in a real estate classified ad in 1926.

About the Author

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

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