Body Composition

Key Points

- Women, on average, carry a greater percentage of their weight in fat tissue. This appears to be tied to the reproductive role.

- Amenorrhea = Three or more consecutive months without a menstrual cycle in a woman or girl who has previously experienced menstruation, or absence of menstruation (menarche) by age 16.

- Hydrostatic weighing estimates the percentage of body weight due to fat by estimating body density.

- Skinfold measures are based upon hydrostatic weighing values, and estimate the body’s fat percentage by the thickness of the subcutaneous (below the skin) layer of fat at a few key sites.

- Bioelectrical impedance analysis (BIA) is also based upon hydrostatic weighing values, and estimates the body’s fat percentage by measuring the body’s resistance to a minute electrical current.

Reading Comprehension

Reading: Chapter 6

Define the following terms:
essential fat
storage fat
adipose tissue
obese (including numbers)
amenorrhea
body mass index

Why is spot reduction ineffective?
How does exercise affect body composition?
What is cellulite, and how can it be decreased?

Supplemental Knowledge

When I was teaching *Lifetime Health and Fitness*, one of my students complained to me after the body composition lab, highly indignant, about the accuracy of the skinfold measures. “The skinfold says I am 26% fat,” she said, "when my bioelectrical impedance analysis (BIA) said I was only 22% fat.” When I asked her why it was she assumed the BIA measure was more accurate, she replied “Because it’s lower.”

Truly we live in a society that is obsessed with thinness, virtually all of our popular culture icons are on the extreme thin end of the population distribution. And yet, the average fat percentage of our society continues to increase with each passing decade, a product of abundant calories and a sedentary lifestyle. Even more good news, Missouri is one of the heaviest, least fit states in the nation. I mean way up there at the top (or bottom, depending upon your perspective), with only one or two other states competing with us for the honor of being in worse shape than we are. Many students do not enjoy knowing their body fat percentage, and at least some of them avoid this knowledge under the “no news is good news” theory of health promotion.

Some have even argued that the body composition lab contributes to the incidence of disordered eating behavior on campus, but there is little evidence to suggest that a student who does not already struggle with these issues would be influenced in this direction by their participation. (Especially since an alternate assignment is always available for those who feel they do not want to participate.) It is true that our highly-focused, achievement-oriented student body has a higher than average incidence of disordered eating behavior, something that we will address in a subsequent lecture. But it is also true that our highly-cerebral, largely-Midwestern student body is disproportionately at risk for unhealthy body composition, when compared to other college students across the nation. Speaking for the HES faculty, I feel safe in saying we have no desire to pressure anyone towards the super-lean, contemporary fashion standard of body composition. But we are concerned about some students’ risk for early cardiovascular disease and other obesity-related health problems.

So let us examine body composition and the measurement thereof: If you think about it for a minute, there are a lot of problems determining how much of someone’s weight is due to fat, how much is due to bones, how much is due to muscle, etc. The only way to know for sure
would be to dissect the person in a biology experiment and place each different category of tissue on a separate scale. This is not a popular procedure, and so the best we can do is to estimate these components.

And there are wide ranges of error.

The first theoretical action exercise physiologists perform is to separate the body into two components, and two components only: Fat mass and lean mass. Fat mass is pretty self-explanatory, but lean mass includes bones, muscles, organs, dreams, aspirations, fond memories, frequent flyer points — anything that is not fat mass. This division assumes that fat mass is of uniform density, comparing one person to another (a pretty safe assumption, given the nature of fat tissue), but it also assumes that lean mass is of uniform density as well. We know this is a bogus assumption, because one person’s bones may be more dense than another person’s, etc., but it is an assumption we have to make to proceed, accepting the error potential involved.

The second theoretical action exercise physiologists perform is to separate the fat component itself into two compartments: Essential fat and storage fat. Some fat tissue is essential to life, cushioning the internal organs, providing insulation against the cold, acting as a reservoir of energy, and insulating the nerves. If an individual dips below his or her “essential fat” level, they would become ill, and if they dipped too far, they would die. In addition, teenage girls and adult women have a much higher essential fat level than their male counterparts, as a certain level of fat appears to be essential for reproductive health. (Indeed, much of the classic female form that advertises “reproductive health,” as they say, to interested males is associated with patterns of fat storage in the breasts, hips, buttocks, etc.) Lack of adequate fat stores may be one of the reasons (there are several others) for amenorrhea, or a clinically significant lapse of the menstrual cycle.

** Side note: While it is perfectly normal for a teenage girl or adult woman to “skip” occasionally, clinical amenorrhea is defined as three or more consecutive months without a menstrual cycle in a woman or girl who has previously experienced menstruation, or absence of the first menstrual period (menarche) by age 16. Women or girls who are amenorrheic should consult their physician, as serious health issues are at stake.

The real difficulty here is that the essential fat level varies from individual to individual. One adult male may be perfectly healthy at 3% fat, while another man needs 7%. One woman may be...fully functional...at 11% fat, while another woman needs 15% to maintain her health status. As you can imagine, it is almost impossible to determine someone’s essential fat level, and it is the essential fat level that determines the final compartment — storage fat — which is all the nonessential fat that could (theoretically) be safely lost in a weight reduction program.

Finally, while new (currently very expensive) techniques are being developed which are more accurate, the three most common body fat percentage estimation methods are fairly unreliable, from a purely scientific viewpoint. We stand by the principle that some knowledge is more important than no knowledge, and if the skinfold is performed correctly by a trained operator the margin is acceptable. For example, if someone's skinfold estimate says they are 18% fat, we are fairly comfortable (given the limitations of the technology) with the knowledge that their actual fat percentage probably lies somewhere between 15% and 22%, and is most likely between 16% and 20%.

As far as technology, hydrostatic weighing estimates the body fat percentage through determining body density. In short form, fat floats; muscle and bone sink. By weighing someone underwater, we can determine their tendency to float, and from this calculate their body fat percentage. This is all well and good, except fat is not the only thing that causes us to float. Air is wonderfully buoyant, and it is impossible to completely empty the lungs to obtain an accurate
measure. Measuring the air in the lungs at any given moment is extremely tricky, and it requires some pretty expensive equipment, not to mention being quite annoying to the person being weighed. But, in the absence of actual measurements, any estimate of lung air volume is prone to wide ranges of error. To add insult to injury, the other two most common body composition estimation methodologies are dependent upon equations developed from hydrostatic weighing studies, so the most accurate they can be is however accurate the hydrostatic weighing was.

One of the methods developed from hydrostatic weighing comparisons is skinfold measurements. Skinfold measurements estimate the body’s fat percentage by the thickness of the subcutaneous (below the skin) layer of fat at a few key sites. With a trained operator (someone who has done a lot of these), these values compare favorably to hydrostatic weighing, and they are a lot less work to obtain. Bioelectrical impedance analysis (BIA) estimates the body’s fat percentage by measuring the body’s resistance to a minute electrical current, but this methodology is quite fickle, heavily dependent upon the body’s state of hydration, and the equations used to generate a percent fat estimate have been unreliable in the past. The technique is constantly improving, but the jury is still out at this time.