What Does Body Composition Mean?

Posted By lylemcd On December 3, 2008 @ 2:50 pm In Fat Loss Fundamentals, Fat loss | 6 Comments

At long last, more and more people are finally becoming aware of the concept of body composition and that it somehow differs from simply focusing on changes in body weight.

However, this is all too commonly leading to confusion as people ask "**What does body composition mean?**". They know that it's important but aren't quite sure why it's important or what the concept is about. I want to help take some of the confusion out of the topic here.

What Are You Made Of?

I'm not talking here about the scientifically proven fact that little girls are made of sugar and spice and everything nice while boys are made of slugs, and snails and puppy dog tails; rather, I want to talk about what the human body is composed of in biological terms.

Let's imagine that I could magically (and hopefully painlessly) separate your body into all of its different components and put them on a slab somewhere (putting you back together might be a problem). What would we find? Well, there'd be some skeletal muscle, some fat cells (possibly too many fat cells), your bones, your organs, your brain, a whole bunch of different minerals, your blood, some water and probably a few other minor components that make up the totality of what makes you you

Depending on which type of tissue we're talking about, we'd find massively varying amounts. Skeletal muscle can make up 25-40% of someone's total weight, fat can range from less than 10% of the total in extremely lean individuals to 40-50% in the morbidly obese. Everything else I listed accounts for some proportion of your weight as well. The average brain is about three pounds, organs take up some space, blood weighs so much, you get the idea. If you add up the weights of all of these individual parts, you would end up with the total weight of your body. When you get on the scale, that's what it's telling you, the sum total of every different bit of your body and what it weighs.

So why is this relevant to the question of "**What does body composition mean**?"

Body Weight vs. Body Composition

When you talk about dieting and diet books (or even weight gain for those who are trying to increase rather than reduce weight), it's safe to say that the majority of information out there focuses on weight loss. People want to see the scale drop, the faster the better. Diet books talk about weight loss, quick weight loss centers try to get the scale to go down as quickly as possible, even the TV show *The Biggest Loser*, which should be doing more to educate (and less to try and kill its contestants) focuses only on the weekly weigh-in to determine success or failure. It's all about weight.

Why is this a problem?

Let's say you step on the scale after dieting or exercising for a few weeks. And, happy days, the number has gone down by a few pounds (or kilos for my foreign readers).

Here's my question to you: What did you lose?

Now, unless something very strange is going on, odds are it wasn't bits of your brain or organs, it's not likely to be bone either. But was it body fat? Was it skeletal muscle? Was it just water? Did you just have a rather large bowel movement that morning and that's why you weigh less?

The typical bathroom scale that only measures weight can't answer those questions. All a typical scale can tell you is whether or not your weight has gone down or up (if that's the case). It can't tell you what type of tissue (e.g. muscle, fat, water) was gained or lost.

That's where body composition comes in.

Models of Body Composition

Recall from above how I listed a whole bunch of different tissues in your body that comprise your total body weight. Well, researchers, depending on how difficult they want to be, will group those organs in various ways and use that to develop body composition models. There are a number of different ones ranging from simple 2-component models to far more complex models involving 4 or more components.

Thankfully, for the majority of non-research applications (e.g. dieters or athletes), the 2-component models are just fine. In that model, the body is divided rather simply into:

- **Fat Mass:** This is the sum total of all of the fat in your body. I'll discuss this in detail in another article but there are three or four different 'types' of fat in the human body. All of it goes under fat mass.
- **Fat Free Mass:** This is simply everything else. Everything that isn't fat mass, including muscle, bone, organs, minerals, blood, etc. is fat free mass (often abbreviated FFM). I'd note that both glycogen (carbohydrate stored in the muscle) and water count as FFM; I'll explain why in a second.

Put simply: Total body weight = Fat Mass + Fat Free Mass.

And even that simple 2-component model gives dieters and athletes the tools that they need to far more accurately track what's happening in their body. As I mentioned above, it would generally be rare for people to be losing bone, brain or organs in any significant amount. So if someone is losing weight and they are not losing fat free mass, that means that what is being lost is fat mass (body fat). That's good.

However, in some situations (including diets with insufficient dietary protein, or without the right type of exercise), it is possible to lose fat free mass; and since brain, organs, etc. aren't likely to be going down, a decrease in FFM often means a loss of muscle mass.

This is generally (but not always) a bad thing, for reasons beyond the scope of this article. I would note that water loss can show up as fat free mass on certain types of diets and this can cause athletes and lean dieters to get very concerned; they think they are losing skeletal muscle mass but they really aren't. This is a topic I'll discuss in more detail in a later article.

I'd note that measuring body composition can also be useful when someone is trying to gain weight. An athlete usually wants to be gaining muscle mass, not body fat. By tracking body composition while in a gaining phase, they can determine what is actually being gained.

You might be wondering how body composition is actually measured. There are a number of methods available ranging from very low- to very high-tech and low- to high-cost. Many gyms will use skinfold calipers (small pinching devices which measure fat thickness), there are also handheld monitors and specific scales (such as Tanita) that use body water to estimate body composition. I'd note that, for the most part, I don't find Tanita scales terribly useful. Other methods such as DEXA scans (a very high-tech method) and others exist. This will be the topic of a forthcoming article with specific recommendations.

In any case, by looking at changes in body composition, rather than just changes in weight, it becomes possible to tell what is actually changing in the body. Is muscle being gained or lost? Is fat being gained or lost? Are the changes just water being shifted on and off the body? While only looking at weight can't tell you any of that, measuring and tracking changes in body composition can.

In a future article, I'll go into more details about body composition, what some typical values are, how it's measured, etc. Of course, most of the articles on this site and all of my books are aimed at improving body composition (e.g. more muscle with less fat) so you can read more there in the meantime.

But now you know the answer to the question "**What Does Body Composition Mean?**"

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Body Composition Calculations

Posted By lylemcd On January 16, 2009 @ 12:53 pm In Fat Loss Fundamentals, Fat loss | 7 Comments

Back in December I ran an article called What Does Body Composition Mean where I looked a little bit at the different components of the human body and how they integrate to determine body composition. Following up from that piece, I want to talk more about body fat percentage, what the numbers tell you and how they can be used to determine how changes in body composition will affect the overall percentage.

Determining Body Composition from Body Fat Percentage

As I discussed in the article What Does Body Composition Mean, when you know the amounts of fat and lean mass present in the body, you can calculate body fat percentage. Now, I'm not going to talk about different methods of measuring body fat percentage in this article; that will be the topic of a future article.

For the time being let's assume I have a magic wand which I can wave to determine someones body fat percentage. I want to show you how to do some basic calculations with those numbers in hand.

So I wave my wand it tells me that the 200 pound athlete standing in front of me has 10% body fat. First let's determine what his actual body composition, in terms of pounds of lean body mass and fat are.

To calculate how many pounds of fat he has, we simply multiply his total weight by the body fat percentage (expressed as a decimal, so 10% becomes 0.10) that I determined with my magic wand.

200 pounds * 0.10 = 20 pounds of fat

Now we subtract the total amount of fat that he has from his total weight to determine how much LBM he has; keep in mind that LBM includes muscle, bone, organs, etc. It's not just muscle mass.

200 pounds – 20 lbs fat = 180 pounds of lean body mass (LBM).

So our hypothetical athlete has 10% body fat, 20 pounds of fat and 180 pounds of lean body mass. We can now use those values to do a number of calculations which I'll show below.

How Will Changes in Body Composition Affect Body Fat Percentage

Since folks usually want to alter their body fat percentage, it's instructive to look at how changes in either total fat mass or lean body mass will change overall body fat percentage. I want to look at the situation where our hypothetical athlete either loses pure fat, gains pure muscle, or gains muscle while losing fat.

Keep in mind from above that our athlete is 200 pounds with 20 pounds of body fat. Let's look at what happens if he gains 5 pounds of fat with no change in LBM, gains 5 pounds of LBM with no change in fat, or manages to gain 5 pounds of LBM while losing 5 pounds of fat. The changes to his overall body composition appear in the table below.

Condition	Fat Mass	LBM	Total Weight	Body Fat Percentage
Starting	20	180	200	20/200 = 10%
Lose 5 pounds fat	15	180	195	15/195 = 7.7%
Gain 5 pounds muscle	20	185	205	20/205 = 9.7%
Lose 5 lbs. fat/Gain 5 lbs. muscle	15	185	200	15/200 = 7.5%

One thing to note about the above calculations is that losing fat has a much larger impact on body fat percentage than gaining the same amount of muscle. I bring this up as it’s often recommended that people gain muscle to lower their body fat percentage. Except that it doesn’t work very well; simply losing fat has the major effect.

In the above example, losing 5 lbs of fat decreased body fat percentage by 2.3%; gaining 5 lbs of muscle only decreased it by 0.3%. Even gaining muscle while losing fat only dropped the total percentage by 2.5%, a small effect over just losing fat.

I’d also note that you don’t have to do the calculations as if pure fat loss or muscle gain is occurring. You can plug any changes you want into the above values to see how varying changes in fat mass and LBM will affect the overall body fat percentage.

Determining Goal Weight for a Given Body Fat Percentage

A question that comes up quite a bit is how much fat someone will need to lose to reach a certain body fat percentage, given that they know where they are now. Assuming you have starting numbers for fat mass and total weight, there is a fairly easy calculation to do this. I’d note that this calculation assumes that the total weight lost is fat mass; that is, there is no muscle loss. This isn’t always such a good assumption.

The equation to determine goal weight is the following:

Goal Weight = Current Lean Body Mass / (1-Goal Body Fat percentage as a decimal)

By percentage as a decimal I mean this, if the goal is 10% body fat, that becomes 0.10. 20% becomes 0.20. 15% body fat becomes 0.15. 5% body fat becomes 0.05. Got it?

So let’s take our same lifter from above who is 10% body fat at 200 pounds, he has 20 pounds of fat and 180 pounds of lean body mass. Let’s say he wants to get to 5% body fat (in decimal form, 0.05), how much weight does he have to lose?

Goal Weight = 180 / (1 – 0.05) = 180/0.95 = 189 pounds

That means that his goal weight is 189 pound down from a starting point of 200 pounds. So he’d have to lose 11 pounds of fat to drop from 10% body fat to 5% body fat.

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URL to article: **http://www.bodyrecomposition.com/fat-loss/body-composition-calculations.html**

Body Composition Numbers

Posted By lylemcd On February 3, 2009 @ 12:18 pm In Fat Loss Fundamentals, Fat loss | 18 Comments

In previous articles, I've explained What Does Body Composition Mean as well as showing folks how to do a variety of Body Composition Calculations. Continuing on in that theme, I want to talk a little bit about specific body composition numbers and what a 'good' or 'bad' body fat percentage might actually be. For the record, in a future article, I'll look at various methods of measuring body composition and their pros and cons, along with giving some guidelines for how to apply them. So please be patient in the comments, all will be discussed.

What's a Good Body Fat Percentage?

As it pretty much always the case with questions of this sort, the answer you get depends on the context of the question itself. Is the person simply trying to be 'healthy', or do they want to compete in bodybuilding/figure/fitness shows; is the goal competition in a specific sport or is appearance the only goal? The specific goal will determine what body fat percentage will be required, ideal, 'good' or 'bad'.

That said, let's look at some different numbers and categories.

For health or at least reducing health risks there is some debate regarding optimal body fat percentages. Some groups don't even use body fat percentage, preferring the Body Mass Index (BMI) method, which correlates roughly with health risk, instead.

Semi-tangentially, it actually turns out that, in untrained individuals, BMI can be used to get a *very rough* estimation of body fat percentage. I used this method in both The Rapid Fat Loss Handbook and A Guide to Flexible Dieting.

I'd also note, and this is something I'll discuss in a later article, that not only is BMI inadequate for folks who are training, it will often put people in the 'obese' or 'overweight' category even if they have healthy levels of body fat; this is because BMI can't distinguish between increases in weight from muscle mass and body fat. Again, I'll address this in more detail in a later article.

As it turns out, both too much and too little body fat can carry health risks although they typically do so for different reasons. And while groups still use the fairly archaic concept of 'overweight' and 'underweight', body composition and body fat percentage is a far more accurate indicator of what's going on. The terms 'overfat' and 'underfat' would be a lot more accurate but simply aren't in very common use.

Put differently, a 200 pound active athlete at 7% body fat isn't at the same risk level as a 200 pound sedentary individual at 25% body fat, although they weigh the same amount (and have an identical BMI, assuming their height is the same). Saying that 200 lbs is 'overweight' (by BMI or some other method) misses the point.

Although the values are probably going up in recent years, average body fat percentage are usually listed around 12-18% for men and 21-28% for women. By extension, body fat in excess of those values correlates with increased health risks. 'Healthy' body fat levels are in the realm of 10-15% or men and 18-25% for women.

I should mention that there is abundant evidence that body fat patterning is as critical to overall health as total levels. Individuals who carry more of their fat around the midsection (central or android body fat patterns) are at more risk for negative health problems than people who carry it in the lower body (peripheral or gynoid fat patterns). This is at least part of the reason that, on average, men (who typically carry their fat more around the midsection) are at a higher health risk than women (who typically carry it in the lower body).

I would also note that, even if the above values are not attainable, a great deal of research shows that even small fat/weight losses (10% of current body weight) increases overall health and decreases the risk of many diseases. So even if someone can't reach suggested 'healthy' levels, there is still indication that reducing body fat by even moderate amounts still has health benefits.

In a related vein, research is also showing that individuals who carry extra fat (weight) but are active are healthier (from a metabolic standpoint) than if they are inactive. They may even be healthier than thin individuals who are inactive although this point tends to be contentious in the literature.

That is, assuming one is active, even if they don't lose a lot of fat/weight, they may still be healthy in a metabolic sense. Focusing solely on body composition, to the exclusion of all else can ignore this fact and it would be remiss of me not to mention it.

At the low end of body fat levels, folks run into other sorts of health problems; this usually starts to occur for males in the 4-5% range, females the 10-12% range (note, problems can start at higher levels depending on the specifics). I'll come back to these at the end of the article.

Physique Athletes and Body Fat Percentage

Individuals in the physique sports (bodybuilding, fitness, figure) often don't have much say in the body fat requirements of their sports, regardless of what may be healthy (based on my comments above). Generally, male contest bodybuilders will be 3-5% body fat on the day of the contest.

Females may be anywhere from 6-8%. In theory, a body fat percentage of 6% is impossible for a female (her essential fat levels should be higher than that) but this tends to be more of an artifact of problems with the equations than reality.

It's worth noting that natural bodybuilders don't maintain that level of leanness year round, at least not if they want to gain size or feel particularly energetic . The exception is those genetic rarities who maintain a very low body fat year round without effort but who are otherwise healthy. There are not many of these in the world.

And while it's not unheard of for professional bodybuilders to maintain insanely low body fat levels year round, this is accomplished with a lot of drug use. Any hormonal problems that would otherwise occur can be offset by taking the right cocktail of drugs. I discuss this in more detail in Calorie Partitioning Part 1 and Calorie Partitioning Part 2.

I can't honestly comment on the body fat requirements for fitness or figure competitions since they seem to be changing the requirements of what they want every few weeks and I simply haven't worked with anybody involved in those activities. I would note that many female fitness/figure competitors have been penalized for being too lean since that doesn't seem to meet the (ever-changing) desires of the judges.

As a kind of semi-related topic, I want to make a couple of comments on starting body fat levels for people with goals of competing in physique contests. An altogether too common problem, and this is especially true in individuals new to the sports, is underestimating current body fat levels and how long it will take to get into contest shape.

A natural male at 15% body fat may need 20 weeks or more to get to contest shape, assuming that they do everything correctly. But many will think they can do it within 12 weeks. And even if they can get there in those 20+ weeks in one straight shot, the effort will be momentous. A female in the mid to high 20's body fat wise pretty much has no chance of getting to contest bodybuilder levels in a straight shot.

Rather, natural bodybuilders will benefit from keeping their body fat at an overall lower level year round so make getting to contest shape more realistic. A male should probably not go much higher than about 12% body fat, a female about 18-20% in the 'off-season' if they want to have a chance of getting to contest bodybuilder levels of leanness in a reasonable amount of time (again, fitness and figure, due to less stringent requirements for exceedingly low body fat levels are in a different situation that I'm not qualified to comment on).

This will not only allow them to gain some muscle (it generally being exceedingly difficult to gain muscle while keeping body fat low and unchanging). What I actually generally recommend to naturals with bodybuilding aspirations is to alternate short periods of active mass gaining with active dieting so that they can gain muscle while keeping body fat in a reasonable range for contest prep.

This is discussed in more detail in General Muscle Gain Philsophies.

So in practice, a male bodybuilder with contest aspirations would first want to diet down to the 8-10% range or so. Then they can do a mass gaining phase until they reach the top end cutoff of

~12% body fat. Diet down while holding the muscle, gain back up, diet back down. When it's time for contest prep they will be in a much better place to reach contest levels of leanness without dieting for 6 months straight.

Female bodybuilders, again, would use a higher range (reflecting differences in inherent body fat percentage). A low end of 14-15% and a high end of perhaps 18-20% would be a good range.

Athletes and Body Fat

While many sports (figure skating, gymnastics) often have an aesthetic aspect to them (that is, part of the athletes score is based on appearance), this isn't true of the majority of sports. Rather there, performance is being judged and the simple fact is that the amount of body fat being carried can impact on performance.

As a general rule, and this is especially true of sports where the athlete has to move themselves against gravity, more body fat tends to mean poorer performance. That is because body fat is just dead weight, mass to be carried that doesn't improve performance (and often actively hurts it). Please note that this isn't true of all sports and some sports (including many of the combative sports such as football, rugby, etc.) benefit from higher levels of body fat.

At the same time, I'd note that extremely low body fat levels can cause problems as well. That is, while it's logical that if body fat is just dead weight, then reducing body fat as far as possible must be better. But this has to be weighed against some of the hormonal effect that i mentioned above.

Also, the amount of caloric and food restriction that is required to reach extremely low body fat levels often tanks performance and many athletes find that they simply perform better at a slightly higher body fat level. It can be a real balancing act, getting lean enough to improve performance but without harming performance.

With that said, let's look at some representative numbers for various athletes, mainly of the endurance type. The power sports tend to be more highly variable. Sprinters and runners are invariably lean, throwers such as shot putters and discus are typically pretty big boys (although javelin throwers, due to the importance of the sprint to their throw are generally lean), football depends on the position (linemen need to be walls of meat, running backs and recievers need speed and tend to be built more like sprinters), you get the idea.

Typically, elite male runners clock in around 6% body fat, cyclists around 8-10% and swimmers at 10-12%. Female are, on average, a little bit fatter because of the difference in essential fat. A male at 6% total body fat is carrying 3% fat on top of the 3% essential fat, which is equivalent to a woman carrying 15% total body fat (3% on top of 12% essential fat).

This is part of the reason males outperform females in most sports: less dead fat weight to carry around. More muscle mass, for any given body weight, is another part of the reason. Basically, at any given weight, a male will carry more muscle and less fat at the elite level

Speaking of swimmers, now you know why some people think swimmers are 'fat' ; it's because they carry slightly more fat than other elite athletes (a whopping 10-12% compared to 6-8%). Obviously they are still leaner than the majority of folks out there.

The reasons for this are a bit obscure and there seem to be changes recently in the physiques of top swimmers; old ideas held that the increased body fat made them float better, meaning less energy went into keeping them on top of the water. I'm not sure this idea is still supported or whether it matters with the current crop of suits.

It is worth noting that those crazy cold-water swimmers, who do stuff like swim the English channel have to carry more body fat to keep themselves warm and prevent hypothermia. They're still nuts, in my opinion, but at least they stay warm.

As I noted above, when you start getting into other sports, there tends to be a lot more variability in body fat percentage depending on the specifics. For athletes who will have other large men slamming into them, carrying more body fat can be beneficial because it will cushion the impact.

I should probably mention powerlifters and Olympic weight lifters and do my best to dispel a very common myth. There is an idea that gets floated all the time that these athletes are fat. This is because, altogether too often, the only athletes that get much viewing are the super heavy weights since they lift the most weight. They are also in a class where there are no weight limits, they can weigh as much as they want.

And while fat can't move the weight, there are other hidden benefits for being that big (not the least of which is being able to eat enough to handle the heavy training). And while the athletes in those classes often carry a lot of body fat, this simply isn't the case in the lower weight classes. Not in the guys who are good anyhow.

In the lower weight classes, where athletes must make a certain weight, the top athletes in powerlifting and Olympic lifting are invariably extremely lean. This, of course, makese sense; if you only have a fixed amount of weight to carry, the more muscle and less fat you can carry (within the limits of health, performance, energy), the better you're likely to perform.

General Appearance and Body Fat

The reality, mind you, is that not everyone wants to step on stage for bodybuilding or fitness, and not everyone is an athlete. Some people just want to 'look buff' or what have you. What's a good body fat percentage here?

That is, what level of body fat will generally be required to reach the oft-stated goals of men and women who simply want to meet some standard of appearance (typically visible abs for men, lean thighs and a flat tummy for women)?

While there is some variance, on average a male will need to have a body fat percentage below 10% to have visible abdominals (i.e. the much coveted 6-pack) and get rid of their love handles. Unless a woman is genetically blessed, her legs may carry a lot of fat until she hits the 15% range (or so), although she'll usually have abdominals showing at that level.

These are fairly low levels of body fat and getting there is often a problem for a lot of reasons. Not the least of which is that the last bit of fat (men's ab/love handle/low back and women's hip/thigh fat) is often quite stubborn for a number of related physiological reasons. All of which I discuss (along with solutions) in my Stubborn Fat Solution.

This is actually one of those amusing ironies, men will generally have lean legs but still have fat on their abs; females will get a visible six-pack long before they get lean legs. And both will want what the other has. The man would happily trade a bit of fat on their legs to have a six-pack and the female would rather have her legs get lean without the ripped upper body. Grass is always greener, folks.

As well, some men have more 'female' type body fat patterning and have visible abs at high percentage body fat levels but fat legs. Post-menopausal females who don't go on hormones may develop a 'male' body fat patterning with a lot of fat around their midsection. There are also a lucky few who carry their body fat very evenly on their bodies and won't look 'fat' even while carrying quite a high percentage body fat. Again, these topics and more are discussed in my Stubborn Fat Solution.

So, in practice, from a purely aesthetic standpoint, a male would be aiming for the 8-10% body fat range and the female around 15% to achieve the types of physical standards that are being presented in the media.

Lower Isn't Better

Before winding up this article, I really want to drive the point home: lower body fat is not better. Not from a performance standpoint and not from a health standpoint. Although it's probably as related to energy balance as body fat per se, the point is that when folks get beyond a certain point of leanness, hormone levels are disrupted in both men and women (and a great deal of this is controlled by leptin, discussed in detail in other articles on the site).

The normal menstrual cycle in women may stop (this is called ammennorrhea), indicating a problem with estrogen production. This tends to cause bone loss which is a very serious problem.

In men not using drugs to maintain their hormone levels, testosterone can approach near-castrate levels as they reach the lower limits of body fat. Complaints of zero sex drive (and not being able to get it up even if the drive were there) are common among natural bodybuilders who get extremely lean.

And that's just the tip of the iceberg. Thyroid, growth hormone, IGF-1, metabolic rate, and the immune system are all severely depressed under situations of extremely low body fat (genetic oddities excepted). Cortisol goes through the roof at extremely low body fat levels especially when a lot of training is being done.

This is all just part of a coordinated set of adaptations that occur with both starvation and dieting (dieting is just starvation on a smaller/slower scale) to try to keep you alive. It's frustrating but actually makes perfect sense, at least to your body.

A body fat of 5% in a man is likely occurring because there is no food. Your body can't tell the difference between you starving it because you're a crazy bodybuilder or you starving because there's no food available ; it reacts the same way.

If there is no food, the last thing your body wants is for you to get your mate pregnant. Either there isn't enough food to keep it alive or you'll be dead before it's born, and unable to fulfill your fatherly duties (watching TV, drinking beer, changing the oil and killing the occasional spider). So testosterone crashes to make it impossible in the first place. If you're starving, chances are so is your mate so that's a double whammy.

A woman dieting to 12% or lower body fat wouldn't be able to bring a baby to term safely in the first place, so the body prevents it by shutting down the menstrual cycle. I should note that the reasons for the shutdown are actually more complex and some dieting women will lose their period at higher body fat percentages. It's actually more an issue of energy balance than body fat per se but that's beyond the scope of this article.

Some women look upon the loss of their period as a benefit, just one less monthly messy (sorry) hassle. But the bone loss and estrogen issue is not a joke, and can (will) cause problems down the road. Studies of female gymnasts and ballerinas are finding low bone densities similar to post-menopausal women. Certainly not the picture of a healthy athlete. And if the bone doesn't develop during puberty, it may never develop at all.

For those truly obsessed with body image, body fat percentages of ~8 for men and 14-15% for women should be safely sustainable year round although it will require nearly fanatical devotion to daily diet and training (or having picked the right parents to start with). As long as the person is at least eating at maintenance, hormones shouldn't be too mucked up.

The same probably holds for athletes (most claims of insanely low body fat levels like 2-3% in athletes being gross over estimations). Without drugs, most athletes won't perform well trying to compete at 5% body fat. They certainly won't train effectively at that level, if for no other reason than the caloric restriction needed to get to that low of a body fat level will hurt training performance and adaptations.

As I noted above, bodybuilders usually don't have a choice, they have to be walking anatomy charts when they step on stage. But with few exceptions, they don't maintain that body fat level for any extended periods in the first place.

Summing Up

So those are body composition numbers with a look at what might be good, bad or ideal under a given set of circumstances. To avoid simply retyping the article, I've summarized everything in the handy chart below.

	Men	**Women**
Average	11-18%	21-28%
Recommended for health	10-15%	18-25%
'In Shape'*	8-10%	~15%
Attainable year round with meticulous food control	~8%	~15%

High end for natural bodybuilder off-season	10-12%	18-20%
Contest ready bodybuilder	3-5%	6-8%
Performance athletes	Varies	Varies

* Visible abs for men, lean legs for women; this assumes standard body fat patterning

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Measuring Body Composition: Part 1

Posted By lylemcd On March 4, 2009 @ 1:12 pm In Fat Loss Fundamentals, Fat loss | 3 Comments

In previous articles, I've addressed the question What Does Body Composition Mean?, showed you how to do Body Composition Calculations, and taken a look at Body Composition Numbers.

Consistently in the comments section of each article there has been at least one question asking how I suggest people measure body composition; as promised I'm finally going to answer them.

Over the next two articles, I want to look at various methods of determining 'body composition' (you'll understand why I'm putting that in quotations in a second) that are available. These range from low- to high-tech and from extremely useful to useless (or at least impractical).

Somewhat arbitrarily, I'm going to divide the different methods into two distinct categories; today I want to talk about measurement methods that don't strictly measure body composition (in terms of the proportion of fat and lean body mass you have) but which may still have use in tracking changes. On Friday, I'll look at the 'truer' body composition measurement methods.

Even if the methods I'm going to discuss today aren't 'true' ways of measuring body composition, I still think they can be useful; if nothing else since they tend to get trotted out a lot in the media, this article will give you a background to know if what is being talked about is correct or not.

Mirror/Pictures

Certainly the lowest tech method of seeing what's going on with your body is the mirror; and while it doesn't measure any aspect of body composition, that doesn't make it useless. At the very least, you can usually look in the mirror (naked, or semi-clothed, mind you) and get a rough idea if you're underweight, overweight or just about right (whatever those terms might actually mean).

At the very least, you can determine if you're happy with the way that you look. That is, if you can be honest with yourself. This is not always a safe assumption.

The problem is that we tend to see what we want to see, good or bad. Anorexics see a fat person where a skinny person is standing, and some bodybuilders see a skinny person where a muscular person is standing. Some researchers call this 'reverse anorexia', 'body dysmorphia' or 'bigorexia' (I find that last term really stupid for some reason).

Without getting into a huge tangent about how we perceive 'reality', the fact is that our brains lie to us sometimes and we don't always see reality. This makes the mirror useful but you have to be careful.

I should note that folks can often find magic mirrors; there seems to be one in every gym that makes people look drastically better than they actually do. The lighting is just right, the mirror of whatever quality, that people see definition that doesn't exist and that sort of thing. If someone could figure out what physical characteristics make up these magic mirrors, they could make a million dollars selling it to dieters and bodybuilders alike. For athletes in the physique sports, these magic mirrors can add up to a lot of disappointments on contest day.

Basically, the mirror, while good, is subject to normal human frailties in being honest with ourselves. I'd rarely recommend it as the sole mode of tracking progress, there's just too many possibilities for people to go screwy. Use it but with caution.

In a semi-related vein, I should probably mention the use of photos to track progress in body composition. Many coaches recommend taking pictures (front, back, side) to keep a visual comparison of progress over time. Basically, you can put the pictures next to one another and see visual changes over time.

This actually avoids another huge problem inherent to the mirror: when you pose in front of them daily (admit it, you do), the small changes that may be occurring may not be visible. In contrast, if you take pictures every 4 weeks, the changes should be large enough to show visually. I'd note that it's critical that, if you use the picture method, that you be consistent. Take them in the same lighting, wearing the same clothes, with the camera the same distance from you every time. If you don't do this, it makes it much harder to tell if real changes are occurring.

Scale weight

For years and years and years dieters focused primarily on changes in scale weight. If the scale went up, that was bad (unless weight gain was the goal); if it went down, that was good (assuming weight loss was the goal). Of course, we know now that things are a lot more complicated than that and now we know to focus on body composition (discussed in more detail in What Does Body Composition Mean?).

In pretty much all of my books, I go into a rather length discussion of body weight vs. body composition and weight vs. fat loss. You can go read the article on the site if you're still unclear but the short-version is that your total weight is made up of every part of you: fat, muscle, brain, organs, bone, fluid, undigested food in your gut, etc.

In general, when the goal is body re-composition, you're looking to lose fat, gain muscle or some combination of the two.

When you just 'lose weight', you don't know what you actually lost. Was it fat, muscle, water, you had a huge bowel movement? The standard bathroom scale can't tell you.

I would note that, for people carrying a lot of fat, changes in scale weight will *generally* scale with changes in true fat (excepting the initial water weight loss, which can be considerable in large individuals). That is, typically, of the total weight loss in a very fat individual, 90% or so will be fat. So changes in scale weight are a fairly good indicator of changes in fat mass.

For leaner individuals, this stops being the case. Muscle loss can make up 1/4-1/3rd of the total weight loss under some conditions, just looking at scale weight by itself doesn't provide enough information; the scale MUST be used with another method to accurately track changes.

I should at least mention the supposed 'body fat' scales such as Tanita while I'm at it; there are expensive scales that are supposed to estimate true body fat percentage and body composition using a method called Bio-electrical Impedance Analysis (BIA); I'll talk about them on Friday.

Body Mass Index (BMI)

The BMI is probably the current favorite method to measure 'body composition', especially in large groups. The reason for this is that it's easy, if you have height and weight, it's a quick calculation to get BMI. Essentially, BMI is like the old optimal height-weight charts that the insurance companies used back in the day but in nifty graphical form.

Now, in the average, non-athletic folks, BMI is actually a decent indicator of overall health with both high and very low BMI's correlating with various health risks. I'm not saying it's perfect but it is decent. Please read that sentence again in case you're unclear on what I said.

In fact, it actually turns out that BMI can be used to get a *rough* indicator of body fat percentage (that is true body composition), I use this method in both The Rapid Fat Loss Handbook and A Guide to Flexible Dieting. Again, I'm not saying it's perfect or 100% accurate but it will get people within shooting distance. For non-lean individuals, that's usually good enough.

However, in athletic individuals (who tend to bitch about BMI a LOT on the Internet), BMI is basically useless and I want to explain why. The basic problem is that, outside of the method in my books, BMI doesn't actually distinguish between fat and muscle mass. All it does is relate weight and height and higher numbers are bad (very low numbers are also bad).

But, this misses the whole point of body composition as a 200 pound individual at 10% body fat and a 200 pound individual at 30% body fat are clearly not identical. The first is a lean athlete, the second is not. And relative health risk will likely be very different. But BMI will say that they are identical in terms of their relative health risk or what have you.

But this is pretty much a big part of why it works just fine for the non-training population: you simply don't see individuals who aren't training carrying a ton of muscle mass when their weight is high.

Not in general anyhow. So, in that population, BMI will give a good indicator of how much fat someone is carrying and, by extension, relative health risk. I hope that makes sense

Tangentially, I should note that some researchers feel that the BMI/height-weight charts are unrealistic for most people or provide unrealistic expectations (e.g. the average overweight individual won't ever reach 'normal' BMI levels and the charts will have a negative impact). Research has consistently shown that even a 10% reduction in body weight carries health benefits so even if overweight individuals can never reach a 'normal' BMI, that doesn't mean all is lost.

In any case, back to BMI. As noted above, in relatively inactive, non-training populations, BMI gives at least a rough indicator of health risk. A BMI > 25 kg/m^2 is considered overweight, > 30 kg/m^2 is obese. Higher numbers correlate with more health risks. So do BMI's that are excessively low (indicating severe underweight or eating disorders).

If you want to know your BMI, there's a calculator here:

http://www.nhlbisupport.com/bmi/

As mentioned, non-athletic folks can even use their BMI to get a rough estimate of body fat percentage (the conversion charts are in both books mentioned above).

Athletic folks shouldn't even consider using BMI for any application. Not to determine relatively health risk and not to estimate body fat percentage. They must use another method.

Waist/Hip ratio (WHR)

While early research into health and body composition/body fat focused primarily on total body fat levels, it became clear fairly early that not all fat is the same in terms of the impact it has on overall health and health risks.

Simplistically, fat on the body can be divided into several different 'types'. I actually described five different types in The Stubborn Fat Solution but I'm only going to talk about two here: subcutaneous and visceral fat.

- Subcutaneous fat: This is the fat that you can see and most are worried about when they want to 'lose fat'. It's found under the skin ('sub' = under; 'cutaneous' = skin) and comprises something like 40-60% of the total fat on your body.
- Visceral fat: This fat is found internally, surrounding the organs and such.

Now, as it turns out, carrying excessive amounts of visceral fat tends to correlate with various health risks including insulin resistance and Syndrome X (aka the metabolic syndrome). It's still being debated whether visceral fat is a cause or the result of Syndrome X. But the bottom line is that carrying large amounts of visceral fat tends to be related to various health problems. In contrast, having a lot of subcutaneous fat doesn't carry nearly the same risk.

And that's where the waist/hip ratio comes in; it's a quick method to determine relative body fat distribution and therefore health risk. It's less about body composition and much more to do with overall health risk and fat patterning.

In common parlance, people are typically either pears (skinny upper body/fat lower body which means low visceral fat and high subcutaneous fat) or apples (round in the middle tapering at either end which usually means large amounts of visceral fat).

I've never quite figured out what people who carry their body fat very evenly are supposed to be called. A banana?

Generally speaking, women tend to be pears and men tend to be apples. However, extremely fat women will eventually start to accumulate visceral fat (and just become generally round) and post-menopausal women who don't go on hormone replacement therapy typically show a shift from a pear to an apple shape.

And tying this in with my comments above, Individuals who are apples (having a high waist/hip ratio), because they are carrying more visceral fat, tend to have more health problems than those who are pears.

Excess body fat can always be a health risk but having an apple shape is worse than having a pear shape. For example, it's thought that one reason women are protected from heart attacks/disease before menopause is because they store most of their fat in their lower bodies, instead of viscerally (around their gut and stomach).

Determining WHR is as easy as getting out the tape measure and throwing it around your waist and hips and comparing the two. Or just look down, if your stomach sticks out more than your hips, your WHR is probably too high. If you want a more accurate method, you can use the calcuator at:

http://www.healthcalculators.org/calculators/waist_hip.asp

To get a true measure of the WHR.

Circumference Measurements

Another commonly used method of tracking changes in body composition is to measure circumferences, arms, waist, thighs, etc. The method is simple and fast, just throw a tape measure around whatever you want to measure and see what the number is.

Now, there are methods of using circumference to truly estimate body fat percentage. The various equations seem to range from reasonably accurate to horrible. The main benefit, and this will make more sense after Part 2 on Friday is that it's faster than other methods; groups like the military often use circumference methods since they can be done quickly on a large number of recruits. I'll discuss circumference methods for estimating body composition more in Part 2 on Friday.

Of more relevance to today's article, circumference methods are primarily used to track progress on a diet or training program without being used to measure body composition specifically.

Folks trying to gain muscle mass (or improve a certain muscle group) will often use the tape measure to track changes; is the size of the muscle going up, down or not changing (when combined with caliper measures, discussed on Friday, this can be an extremely valuable method of tracking progress).

Dieters can use the method similarly; men may track waist circumference while females might track thigh circumference to see if the diet and training is working as it should. Whether it's to track overall changes or simply trying to reach some specific goal (e.g. 32 inch waist), circumference measures indicate what's going on.

I should note that, to be accurate at all, a tape measure has to be used correctly. One issue is that any measurement you make must be made at the same place every time. Folks who do this for a living use very very specific methods of determining where to take measurements. But even small differences in where you take the measurement can give different results. It has to be consistent to be meaningful.

As well, it's altogether too easy to pull the tape to a different tightness if you're not careful. Dieters will tend to pull the tape measure a little tighter to get a lower value and folks seeking muscle gain may let it run a little bit loose. Some companies actually sell expensive little tape measures with built-in springs to ensure that the tension on the tape is identical every time.

Basically, circumference methods are good but only if you respect their limitations: you must measure at an identical place every time and you have to pull the tape to the same tension every time. These can be difficult to achieve sometimes. Unfortunately, it would take another article to address both in any useful detail.

Summing Up

So that's a quick look at what are probably best termed non-body composition methods. The mirror/taking pictures, the good old bathroom scale, Body Mass Index (BMI), Waist/Hip Ratio, and circumference measures can all give some indications about changes in body composition even if they don't actually tell you what your body fat percentage is (the BMI method I talked about above being one exception). So use them, just with the cautions and caveats above.

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Measuring Body Composition: Part 2

Posted By lylemcd On March 6, 2009 @ 12:28 pm In Fat Loss Fundamentals, Fat loss | 7 Comments

In previous articles, I've addressed the question What Does Body Composition Mean?, showed you how to do Body Composition Calculations, and taken a look at Body Composition Numbers. On Wednesday, in Measuring Body Composition: Part 1, I took a look at some methods of tracking changes in body composition that, strictly speaking, don't actually measure body composition. These include the mirror/photos, the good old scale, BMI, the waist/hip ratio and circumference measures.

Today, I want to look at methods, some of which will be repeated from Wednesday, that allow actual tracking of changes in true body composition. That is, they can be used (to some degree anyhow) to estimate actual body fat composition which can then be used, using the method in Body Composition Calculations, to determine actual fat and lean body mass and track changes.

For no real reason I'll move from lower to higher tech (more or less) as I go examining body mass index, circumference measurements, underwater weighing, calipers, Bio-Electrical Impedance Analysis, Infrared Reactance, the BodyMetrix 200, Bod Pod and finally DEXA in terms of how they measure body composition.

Body Mass Index (BMI)

I talked about the BMI on Wednesday and mentioned, at least passingly, that it can be used to get a very rough estimate of actual body fat percentage. As noted, this can only be done for non-training individuals. Anyone who has been training consistently will not find the BMI method (which can be found in both The Rapid Fat Loss Handbook and A Guide to Flexible Dieting) to be accurate.

Again, ONLY non-trained individuals can use this method; anyone who has been training for any period of time **must** find another method. Attempting to use BMI to estimate body fat percentage will simply give drastically incorrect results.

Circumference Measurements

As I also mentioned on Wednesday, while circumference/tape measure measurements, are just as often used simply to track changes (e.g. I lost 4 inches on my waist), methods exist to use them to estimate body fat percentage.

Many books use this approach because it tends to be simpler and faster than other methods. When large groups of people have to be tested (such as in the military), it also provides a quicker way to get a rough idea of where everybody stands.

Now, somewhat surprisingly, some of these equations actually give decent estimates of body fat percentage. Not perfect, mind you, but as I'll discuss in another article, no method is perfect short of full-body dissection (and you can only do that once). They will at least get folks within shooting distance.

Now, the various methods and equations that use circumference measures vary quite a bit. Some of them use circumference along with weight/height, some use circumference measures with a couple of caliper methods, there's a lot of variance. How accurate these various systems are tend to depend a lot on what sites are being used. This also varies quite a bit.

One thing to consider is that, depending on the method, a large bone structure or heavy muscle mass can throw off the numbers quite a bit. I had a client years ago who had a particularly wide hip structure and one circumference method that used hips estimated her at a far high body fat percentage than she actually was (based on calipers). One equation uses the neck and I'm not sure how it can separate people with a lot of fat on their neck and folks who have built up a lot of muscle there. I think you get the idea.

In any case, here are two circumference equations that seem to give at least shooting range estimations for body fat percentage. I'd note that the same caveats I gave for general circumference measurements apply here equally: if you pull your tape measure extra tight, you'll get a low estimate. Don't cheat.

http://www.freeweightloss.com/calculator1.html

http://zone.cust.he.net/prothd2.html

Underwater Weighing

Underwater weighing is often described as the 'gold standard' for body composition measurement and, in some ways, I probably should have led off this piece with it.

The reason is that underwater weighing is usually what's used to determine the accuracy of other methods. So researchers will underwater weight a bunch of people and then measure their body composition in some other fashion (e.g. calipers, circumference, etc.) and that's how they develop the equations for the other method. Basically, it's assumed that underwater weighing gives the 'correct' value for body composition and the other methods are developed so that they give the same values.

For a while underwater tanks were very popular and could be found in a lot of different places. Lately they are only found in performance labs at universities for the most part. There's a reason for that which primarily has to do with the hassle involved in doing it.

The basic premise of underwater (or hydrostatic) weighing is that 'fat floats'. Ok, it's a bit more technical than that but that's the gist of it. Basically, different tissues in the body have different densities, and they will all have a relatively greater or less likelihood of floating in water.

Very strictly speaking, underwater weighing is estimating what's called body density, that is it tells you what the average density of the tissues in the body are, that goes into a separate equation that converts body density into body fat percentage. But that's getting a little bit more embroiled in details than I want for this article.

To get underwater weighed, you report to the lab in your bathing suit. First they weigh you out of water, then you get into the tank (filled with cool but not cold water). Then you breath out as much air as possible and then dunk your head under and let them weigh you again. The difference in your weight on land vs. underwater allows them to do a bunch of neat calculations and determine body density.

However, there are problems with underwater weighing. One is that few can blow all of the air out of their lungs before dunking their head underwater (would you do it?). I suppose if you find the idea of suffocating fun, maybe. But for most people, some air will be left. This is actually pretty important as gas floats and air in the lungs will cause folks to be 'lighter' underwater. Amusingly, one study found that a big gas producing meal, containing beans, threw off the measurement. I guess beans really are good for fat loss.

Even then, it' s impossible to get all the air out. Humans simply can't do it. So researchers use other methods to try to measure (or at least estimate) how much air is left but this just introduces another potential source of error. Some methods let you keep your head above water but this too reduces accuracy.

Finally, relatively speaking, underwater weighing tends to be somewhat pricey; as noted tanks are usually only found in performance labs these days. Since you have to do at least two measurements to see if a diet is working, this can add up quickly. Unless you have a friend in the exercise physiology lab who can get you in cheap or free, I'm not sure that there's much point.

It might be useful to get a caliper measurement done and get dunked on the same day to see how close to reality the calipers are. But that's about it.

Calipers

Possibly one of the most common methods for measuring body fat percentage are calipers. Calipers are small spring loaded devices that have been used for literally decades to measure body composition; given a few criteria are met, they are surprisingly accurate (that is, giving values similar to underwater weighing).

As I noted on Wednesday when talking about the Waist/Hip Ratio, there are two primary places that fat is found in the human body, under the skin (subcutaneous) and in the gut (visceral fat) with something like 40-60% of the total fat being found under the skin.

This is a big part of what lets calipers be fairly accurate: since you can get to the fat that is under the skin (measuring visceral fat takes more complex methods), you can measure it. That's what calipers do.

When making a caliper measurement, specific sites on the body are used and very specific methods are used to make the measurement. As with circumference measures, folks who worry about this stuff, spend a lot of time being very specific about where and how to take the measurements to get accurate results.

The basics of caliper measurements are:

1. The person doing the measurement pulls the fat away from the muscle so that the sides are parallel, and applies the calipers, which give the thickness of the skin fold in millimeters.
2. Readings are taken after 2 seconds (this is important, if you wait longer, the caliper will squeeze water out of the area and give you an artificially lower reading).
3. Three readings are taken at each site and they should be within one-two mm of one another. If they aren't, the results won't be accurate and the skin fold should be re-measured.
4. Between readings, a short break is given to avoid squeezing water out of the area, otherwise you get progressively smaller measurements as you go.

Anywhere from 3 to 10 (or more) sites may be measured to get an idea of total body fat percentage and distribution and, the last time I looked anyhow, a total of 19 sites have been described in various studies. Traditionally, the right side of the body is measured, I have absolutely no idea why this is the case.

Typical sites include triceps, biceps, abdominal, iliac crest (love handles essentially), subscapular (underneath the shoulder blade), axilla (under the armpit), pectoral and thigh. You'll sometimes see calf and chin or a few others in there. Perhaps the oddest skinfold site I have seen is the hump; apparently some of the HIV drugs cause a fat redistribution to the back of the neck and researchers are measuring the fat hump to track changes.

Once the chosen number of sites has been measured, the numbers (which are in millimeters of thickness) are totalled and plugged into an equation, usually along with age. This cranks out body fat percentage. As I mentioned above, technically speaking, the equation spits out body density, which goes into a second equation to give body fat percentage.

While you used to have to hand crank the values through the equation, there are many online calculators and here's one of them that includes a bunch of different methods.

http://www.linear-software.com/online.html

You'll note that on that page, a variety of equations using different numbers of sites can be found and there are pros and cons of each. Equations using more sites tend to be more accurate but give the person doing the calipering more opportunities to screw up. Equations using fewer sites are faster but can drastically mis-estimate body fat percentage if they don't measure a place where a given individual happens to carry a lot of fat. So there are always trade-offs.

In terms of equipment, calipers can vary massively in both range in price. Clinical models, as used in research studies, such as Lange and Harpendon will run to $200 and there are even electronic models such as the Skyndex which has the estimation equations built into them; those will run you about $400.

I imagine everybody has seen the home versions which can often be had for $10 or so, they are often packaged with books because they are cheap. I don't think they are very accurate though, slight differences in how quickly you squeeze the calipers can drastically affect the measurement you get. I do not recommend these even if they are super-cheap.

My standard suggestion for people who want their own calipers are the Slimguide calipers which are about $30 from Creative Health Products (item C-120). I've had my set for over a decade now, they are indestructible and I've checked them against more expensive Lange calipers and they show extremely high accuracy. In terms of cost:accuracy ratio, I think these are the best.

I'd note that, depending on the spring tension, all calipers can give slightly different measurements, although they are usually within a millimeter or two of one another. As long as you are using the same calipers each time, this is irrelevant; you'll still get consistent measurements.

In the hands of a trained operator, calipers are surprisingly accurate, giving values anywhere from 3-5% different from hydrostatic weighing. In the hands of an untrained operator, they aren't very accurate at all. There are a lot of untrained operators out there and this causes problems (it's usually suggested that someone do at least 100 measurements to get even remotely skilled at the method).

Most health clubs and gyms, as well as a lots of other places, can do caliper measurements. Since caliper technique can vary quite a bit, it's important to have the measurements done by the same person if at all possible. With the high turnover rate of employees at most commercial gyms, this can be tough to do.

For that reason alone, I usually recommend that people learn to do at least some of their own skin folds. You won't be able to reach all of them unless you're a contortionist but the key skinfolds (usually abdominal and iliac crest for men and thigh for women) can be gotten to.

As a final comment, caliper equations can be problematic at best, for reasons I sort of glossed over above in the section on underwater weighing. A lot of assumptions are being made about things like body density that aren't turning out to be that correct and this can cause the equations to throw out some strange values. It's not unheard of for athletes to come up with negative body fat estimates; this is just a consequence of the equations being wrong for them (researchers are constantly developing new equations for this reason).

A current trend is to simply use the sum of skin folds and look at changes. If your skin folds are going down, you're losing fat; if they're going up, you're gaining fat. Depends on what the specific goals are, trying to put specific body fat numbers to that may or may not be valuable.

Bioelectrical impedance Analysis (BIA)

BIA is another popular method for measuring body composition; much of this has to do with it being fairly easy to measure. Unlike calipers, it doesn't require training and since it's high-tech (looking anyhow), people tend to put a lot of stock in the results.

Gyms will often use BIA methods, they can be found at all kinds of health fairs and, as I mentioned on Wednesday, there are now scales (such as the Tanita) that use BIA to give body fat estimates. BIA is used in some research studies as well. Basically, BIA is quick and easy.

But is it accurate?

Yes and no. If strict hydration protocols are adhered to, BIA is actually reasonably accurate. The problem I see is that, in the real world, these protocols aren't followed and this will throw off the measurements completely. To understand why, I should probably actually explain how BIA is done and what it's measuring.

A typical BIA machine will have an operator attach one electrode to the back of your hand and one to your foot, there are also hand-held models where you just hold onto two handles, the scales obviously run through your feet. Usually some data is entered such as age, height and weight (some will let you choose from athlete or non-athlete and give different results depending on which you pick) and then the machine runs a current from one electrode to the other (no, it doesn't hurt).

BIA works by estimating total body water. Now, water is conductive, that is electricity can move through it (if there are minerals present) and different tissues such as bone, muscle and fat all contain different amounts of water. So by measuring how fast the current moves from one electrode to the other, BIA machines can estimate how much water is present in the body and use that to determine how much fat, muscle, etc. you have. Or at least that's what it is trying to do.

And that brings in the problem I mentioned above: hydration state can throw off BIA tremendously. Both dehydration (as might occur when carbohydrates are lowered) or hyper-hydration can throw off BIA completely. Even a large urination or a big glass of water can throw off a BIA measurement by a few percentage points.

So unless you're following those strict hydration protocols, BIA can be terribly misleading. If you're slightly differently hydrated from the last measurement you took, what looks like an actual change in body fat percentage may actually just be a difference in water balance.

Now, in BIA's defense, assuming someone kept their hydration state constant (i.e. measuring themselves every Monday after urinating but before breakfast), BIA may give at least comparative measurements. Just make sure you always measure under consistent conditions.

Infrared Reactance (IR)

While rarely seen anymore, IR had a brief stint in the sun, mostly at health fairs and some gyms. Originally developed to measure body composition in cattle, IR worked by bouncing a beam of infrared light off your upper arm bone and seeing how long it took to get back.

Since infrared light travels faster through muscle than fat, the machine could estimate how much fat you had. Since it only measured the biceps (upper arm), it was quick and easy. It was also pretty inaccurate. I can't recall ever measuring anybody who had a lot of fat on their upper arm so that one measurement won't tell you much about the rest of the body.

When measuring cattle to determine price at slaughter, a few percentage points aren't that big a deal. For humans, I consider IR unusable and do not recommend it.

BodyMetrix 2000

In a related vein to Infrared Reactance, I should probably mention a new method of measuring body composition (someone asked about this in the comments section of Wednesday's article) which is the BodyMetrix 2000. Using ultrasound, the BodyMetrix claims to measure the thickness of fat, apparently using the same sites that are used for standard caliper measurements.

I'll be 100% honest that I can't say much about this; the entirety of my knowledge comes from what information they have on their site. I've seen no validation data (they have a few PDF downloads on their site including ones showing good correlation with caliper data) and never seen nor used one.

The Bodymetrix device is far more expensive than calipers but if it avoids some of the inherent issues with caliper methods (operator accuracy, etc.) this might be a worthwhile tradeoff. While it seems too expensive for home use, it wouldn't surprise me if health clubs and such moved to this if it turns out to be accurate.

The Bod Pod

One of the recent high-tech developments in body composition methods is the Bod-Pod; essentially this is a dry version of hydrostatic weighing. The Bod-Pod measures how much air you're displacing, measures body mass and body volume and uses that to estimate body density and body fat percentage.

To be honest, I've never seen one of these in the real world and they are exceedingly expensive. The Bod-Pod site doesn't even list prices and you know the rule…if you have to ask.

Anyhow, I'm not sure anybody would ever actually come across a Bod-Pod outside of an absurdly high-end health club or research center. I mention it only for completeness.

Dual-Energy X-ray Absorbtiometry (DEXA)

DEXA is another high-tech method that, recently, has become more prevalent and at least affordable. DEXA basically does a full body scan from head to toe; it's primary use has been to examine changes in body density. But it also does a good job of measuring body composition since it's able to differentiate between bone, muscle and fat tissue (because of how each absorbs the X-rays).

One neat aspect of DEXA in terms of body composition is that it will give you a measure of regional body composiion (it will also measure visceral fat which none of the other methods can do). That is, it will tell you if you carry more fat in the upper body, legs, arms, etc. Then again, so will caliper or looking in the mirror and they are both a lot cheaper.

DEXA scans have come down in price considerably, however, and they might be useful to correlate a method such as calipers or the circumference equations. That is, go drop the cash for a DEXA and either run a set of caliper measurements or one of the circumference equations and see how the simpler/cheaper/faster methods correlate in terms of accuracy.

It would be ideal to do a second set of each after some time on your diet simply to see if the simpler methods are also tracking changes with decent accuracy. If so, you can just use the simpler methods from then on.

Summing Up

So that's a look at both some non-body composition body-composition methods along with true methods of measuring body composition. A question I get often is "What's the best/most accurate method of measuring body composition?"

That's actually easy, full dissection. Let a medical school cut you up, separate everything out and weigh it. Bingo, now you know your exact body composition. Unfortunately, you can only do it once and it won't be very useful to you since you'll be dead.

Moving away from that, all methods have their own inherent pros and cons. Calipers are cheap but require a trained operator, BIA is quick and easy but can be thrown off drastically by hydration state, DEXA is accurate as hell but expensive. Which is best? That depends on the applications.

In a future article, I'll address some of the problems with body composition measurement along with giving some specific recommendations on what method (or combination of methods), I think are best for different applications.

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Problems with Measuring Body Composition

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In previous articles on the topic of body composition, I've addressed the question What Does Body Composition Mean?, showed you how to do Body Composition Calculations, and taken a look at Body Composition Numbers. In the last two articles, Measuring Body Composition Part 1 and Measuring Body Composition Part 2, I looked at different methods that, even if they don't measure body composition exactly, will at least allow tracking of progress of some sort.

Today, I want to back up a bit and get a little more technical and look at some of the problems inherent to tracking body composition accurately. This will lead me to finally round out this series by giving some specific recommendations on how to use the various methods to get the best measure of what's going on.

While each of the methods that I discussed in the previous two articles have their own individual issues (some of which I discussed in those articles), the underlying issue with most methods of body composition measurement is that they have any number of inherent assumptions that, as often as not, are turning out to be false.

As well, calipers (which tend to be used most commonly for measuring body composition) have their own specific set of problems that I want to look at in some detail.

Assumptions about Body Density

As I mentioned in Measuring Body Composition Part 2, most of the methods that I've described don't actually measure body fat percentage. Rather, they measure body density which is then used to estimate body fat percentage. What does that mean?

Every tissue in your body (e.g. muscle vs. bone vs. fat cells) has a different density. Taking you back to the horror of high-school science class, density is a measure of how much weight there is in a given volume of something. Stuff that has more weight in a given volume has a higher density than something with less weight in that same volume.

Quick tangent: One of my major pet peeves is when folks say that muscle weighs more than fat; which doesn't make any sense at all. One pound of muscle weighs exactly the same as one pound of fat, the difference is that the fat is less dense and takes up more space on the body. The graphic below shows one pound of muscle (the red stuff) versus one pound of fat (the yellow stuff). As you can see, the fat takes up more space (it is less dense) but both weigh the same. Ok, enough pedantry.

So every tissue in your body, muscle, fat, bone, organs has some density and the various body composition methods are actually making an estimate of body density. That estimation goes into a second equation which then churns out the actual body fat percentage number.

So what's the problem?

Well one of the key assumptions underlying most methods of body composition is about the specific densities of each of the different tissues and that that density is unchanging, and that it is identical from person to person. All of which turn out to be more or less incorrect.

The original body density values were determined from a small sample of old white male cadavers way back when and, so far as I can tell, haven't been updated. To determine the values, first the cadavers were underwater weighed prior to dissection so that each tissue could be weighed and the true density determined.

The problem is that older sedentary white males are not going to have the same tissue density as a young male or female athlete but researchers have used the same values regardless. As I mentioned in discussing underwater weighing, one of the problems there is the issue of blowing all of the air out of the lungs; this wasn't an issue in dunking dead people.

As well, training often increases bone density and this can generate some really amusing results on body composition estimates (some equations will give negative values because of this). There are also ethnic differences with blacks having, on average, denser bones than whites, and Asians having slightly less dense bones. Tissue density can also change with age (e.g. bones often become less dense) and assumptions about these age related changes may be incorrect for individuals involved in heavy training. This makes a set of assumed density values based on old white guys a little problematic.

It's worth nothing that newer methods of body composition measurement such as DEXA allow for the tissue density values to be determined for an individual (DEXA is often used specifically to measure bone density) and avoids this particular problem.

Now, while there may not be absolutely massive differences in tissue densities between individuals or ethnic groups, my point is that the values aren't identical or constant as many of the equations assume either. As I noted, heavy training (especially weight training) tends to increase bone density and female bodybuilder I trained was found to have the bone density of a 20 year old despite being in her 40's. So the equations tended to give strange values for her.

Continuing in this vein, studies are showing that one type of lean body mass (called essential lean body mass) has a different density than another type (called inessential lean body mass). Researchers now delineate different types of subcutaneous body fat, which may have different densities as well. You're probably starting to get the idea of the complexity of the situation and why assumptions about fixed unvarying densities for the different tissues can cause problems.

Now, as I noted above, with the exception of DEXA, pretty much all body composition share the above assumption and problems. However, calipers, which I discussed in Measuring Body Composition Part 2 have their own individual set of problems that I want to discuss next.

Specific Caliper Problems

Despite giving values very close to that of hydrostatic weighing, calipers have their own set of problems on top of the body density issues I discussed above.

One of these is the assumption that skin thickness is the same among individuals and always constant. While the differences tend to be small (a millimeter here or there), when you're measuring a lot of sites, and dealing with someone who is pretty lean, a one millimeter difference can throw off the estimation. Putting some values to it, a one millimeter difference over 10 sites turns out to be significant and can change the body fat estimate by about 1.5%. While this is fairly irrelevant for fatter individuals, it can become relevant when folks get lean.

The next issue I sort of dealt with in the previous article and that has to do with where body fat is carried and the number of sites measured. As I mentioned in Measuring Body Composition Part 2, equations which use fewer sites (one common one is pec, abdominal, and thigh for men) can drastically under-estimate true body fat percentage if someone carries a lot of fat in an unmeasured site (upper back is a common place for males).

Often individuals are losing body fat in unmeasured places but this won't show up with a 3 site measurement and it will look like the diet isn't working. As I noted in that article, taking more measurements can get around this but also requires a partner who knows what they are doing; as well, more sites gives them more chances to mess up. So it's always a trade-off.

Additionally, visceral fat (the stuff found in and around the gut) isn't even measured by calipers, although methods such as DEXA (or even the waist to hip ratio) can track changes there. By many methods, a loss of visceral fat will actually show up as a loss of lean body mass although it's not. Someone losing visceral fat early in a diet may think that their diet really isn't working when it actually is.

And of course, there are also the other issues endemic to caliper technique that I mentioned in Measuring Body Composition Part 2; you need a trained operator, they have to know how to pull a proper consistent skinfold, etc. One thing I didn't mention is that large skinfolds (as are often seen in the female thigh) can be damn near impossible to measure accurately.

I'd note that if the BodyMextrix 2000 turns out to be a valid and accurate method, that might get around this set of problems entirely. It won't solve the other issues inherent to the method but at least will avoid issues related to caliper technique per se.

Problems with the Caliper Equations

In addition to the issues inherent to caliper measurements I discussed above (and if you wonder why I'm spending so much time on calipers, it's because they tend to be the most commonly found and used method), there is another potentially bigger problem and that's with the equations.

Essentially, there are a whole bunch (I'd imagine hundreds at this point) of caliper equations which take the measurements themselves and convert them into body fat percentage. And the big issue here is that any single equation will only be truly valid (or even close to valid) for the group that it was originally developed in and/or for. To understand this I have to tell you how they commonly develop the equations.

First off researchers pick the group that they want to measure. This might be white college aged non-athlete female, or middle aged black women, or Hispanic high school girls or whatever. I'm just picking these examples at random, don't read anything into them.

Next the group in question will either be underwater weighted or DEXA'd and the value obtained here will be assumed to give the true body fat percentage. Then the group will be calipered at however many sites that researchers want to look at (this can range from 3 to 10). Then a computer is used to crank out an equation that will let the caliper measurements match up with the DEXA/underwater weighing value.

Now, the big issue comes in when you try to use an equation for one population in a different one. So while an equation derived for the white college-aged non-athlete females may be fairly accurate in that group, it won't be accurate at all applied to a different population. Differences in tissue density, body fat distribution, etc. all throw a wrench into things. Of course, this mainly just means getting ahold of the proper equation, assuming it exists.

One common way of getting around this is to develop generalized equations; basically they take a bunch of different estimation equations and mathematically put them together (don't ask me for details) to develop a single generalized equation that gives decent average results.

Perhaps the most common set are the Jackson-Pollock generalized equations, of which there are 3, 4 and 7 site measurements. These equations tend to show a decent correlation with 'true' body fat percentage for both men and women although the 3 and 4 site equations can still drastically underestimate if someone carries a lot of fat in a place that the calipers aren't measuring.

A couple of final issues with caliper equations. The first is that most are developed as a curve. That is, when researchers work the math, usually you end up with something that is curved rather than being a straight line. What that means in practice is that the equations tend to be fairly accurate in the middle range of body fats but can become very wrong very quickly at the extremes. So once someone gets above 40% body fat (or so) or below 10%, the equations become progressively more wrong; fatter individuals will be overestimated and leaner individuals are typically underestimated.

A final comment has to do with age which is often included in the caliper equations. Many have found to their chagrin (yes, chagrin) that a birthday suddenly shows them as being fatter, even if the actual caliper measurements haven't changed. What's going on?

The reason has to do with some of the assumptions about tissue density that are being made; it's usually assumed that bone density is being lost with age, and that muscle is being lost. Thus an identical caliper measurement (say that a three site measurement gives 45 millimeters total skinfolds) will give a different body fat estimation with increasing age. The charts that often accompany calipers will show body fat percentage as a function of age and when you move to a higher category, often the values go up.

What's the Solution?

In previous articles I've gone into some detail about different methods of measuring body composition and why I think it's important; in this article I seem to be saying that all of the methods aren't actually that accurate and have all kinds of problems.

First and foremost, that's not exactly what I'm saying. My only point with today's article is to make some of the underlying issues with the method known. Body composition measurements aren't perfect but no method of measuring much of anything is; that doesn't make them useless.

Just keep in mind that sometimes some very weird values (such as negative values in lean athletes) can come up; when values fail the reality check (e.g. someone is claiming to be 1.4% body fat based on calipers), it's time to take a step back and reconsider what's going on.

Beyond that, unless you're doing clinical work where absolute accuracy is required in your measurements, it's usually good enough that the measurements be at least consistent. That is, for any given individual, it's far more important to get consistent measurements even if those measurements aren't exactly accurate.

What does that mean? Hopefully the following example will make it clear.

Let's say that someone weighs 150 pounds, let's say that they get on two different scales and one puts them at 153 pounds and the other at 147 pounds. Neither scale is accurate because they both give values that are different than the actual value.

Now let's say this person loses 5 pounds so that they really weigh 145 pounds. Now they get on the same two scales and get the following measurements. The first scale, that originally said 147 pounds says the person weighs 142 pounds; that is it accurately measured the 5 pound loss. But the second, which originally said 153 pounds says that the person weighs 150 pounds; the second did not accurately measure the 5 pound loss.

Neither scale was accurate, but the first was at least consistent (it was off by 3 pounds each time); it reflected the changes properly. The second scale wasn't accurate or consistent (it was off by 3 pounds initially and by 5 pounds the second time around).

For measuring body fat percentage, usually it's more important to be consistent than accurate. Now, there are places where you want an accurate measurement (e.g. to determine actual lean body mass or what have you) but the reality is that you're not going to get 100% accuracy almost no matter what you do (DEXA might be the lone exception here). You can get close (calipers are usually 3-5% off of true measures) but that's about it. So the best you can get is consistent.

And most of the issues I've discussed in this article are going to be consistent for any given individual. Your bone density is unlikely to change massively over the course of a diet, neither will skin thickness for the most part. Unless you happen to have a birthday and move up in the body fat percentage chart, that's a non-issue too.

So assuming that you use the same method, measure at the same time of the day under similar conditions (e.g. don't compare carb-loaded to depleted), at the same time of the month (this is critical for females due to shifts in water balance and such over the menstrual cycle), etc. you can at least get consistently comparable measures to track changes.

You may not know the exactly accurate values (unless you can afford to get DEXA done a bunch of times) but you can measure changes. You can tell if you're losing fat, staying the same or gaining fat. Of course, as I'll detail in an upcoming article, standing in front of the mirror or taking pictures every 4 weeks would tell you as much.

Summing Up

Body composition measurements, like almost everything to do with the life sciences, has its set of problems. Assumptions about tissue density is an inherent problem in most measurements of body composition (DEXA being one of the few exceptions).

Calipers, while common, have their own set of problems and assumptions both related to the method and the equations that are used to crank out the actual body fat percentage numbers.

However, outside of clinical practice, at least consistent and comparable measures can usually be made even if complete accuracy can't be obtained. For most applications, this tends to be sufficient.

In an upcoming article, I'll give some concrete recommendations on how I think people can or should use the different methods of tracking body composition changes to make sure their training and eating programs are working the way that they want them to.

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