Exercise Physiology- Part 5

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OK, we're going to start talking about human energy expenditure. And we first want to talk about human energy expenditure at rest, what we call the basal metabolic rate.

Now keep in mind what we're going to do is we're going to base it on some equations. Is there a way of actually assessing basal metabolic rate? They do have chambers. For example, if you want to find out exactly how many calories in a slice of pizza, what they call a bomb calorimeter, where they would put it in a chamber and actually burn it to ashes and measure the heat through some pipes going through, and get a change.

They have chambers for humans, where they'll have people exercise on a stationary bike, where they measure the change in heat in the room, based on the energy that they give off. So you can do that. But it's not as convenient for most people. And there are other ways of doing it.

And we want to get an idea of how many calories people are expending, if we want to give them some ideas of weight control. If we talk about weight loss, weight control, weight gain; we need to have a basic understanding of, well, how many calories are they burning to begin with? Because when it comes to weight, the base equation is calories equal calories out, you'll stay the same weight. But you have to know how many calories are going out also.

So the basal metabolic rate is the minimum level of energy required to sustain the body's vital functions in a waking state. So if you woke up in the morning and didn't do anything, just stayed in bed, you'd have to expend a certain amount of calories. And that's the basal metabolic rate.

Now so what we'll do is we'll figure out our basal metabolic rate based on some equations. So here's how we'll do this. We're going to start with this nomogram. Now what you can see is, have this is the column for your height, your column for your weight, and we're to come up with your surface area in meters squared.

So the way you would do this, you would find your height. So for example, I find my height, I find my weight, and right across the middle I would find out what my surface area is in meters squared, because that helps determine in the equation how much energy you're expending. So has everyone done that? Come up with a number and write that number down and put it aside.

So match up your height and weight. So here's my height here. Here's my weight here. When I draw the line across, I come up. It crosses where my area is for meters squared. Everyone have that?

OK, so we'll put that number. So for me, that number is about 2.2. What you do is in here you can see your age in years. So you would just take your age and you would put a line going up.

And at a certain point you'll see that crosses one of these lines in here, whether you're male or female. And you would just go across in here.

So the male is the higher one. If you look at the lines, the male is the higher line. The female is the lower line. So you see where it intersects. And then you bring your line across here. And you can see this will tell me how many kilocalories I'm burning per hour per meter squared. Everyone have that number?

So you take your age. You go up to your line, male or female. Once you find the intersection, you come across and you'll come on the scale and you'll see how many calories you're burning per meter squared per hour. And most of my day-- remember I gave you a value before, most men in this country about 2,700 to 2,900.

But as my basal energy expenditure, so if I wanted to lose weight, not taking anything into account, I would go less than 2,000 calories a day. But what happens if you start dieting under your basal energy expenditure? The body does not read this as a diet. The body reads this as starvation and lack of food.

So when you start going into your lower calorie diet, your body will actually down-regulate your basal metabolic rate and you'll burn less. But if I go by this now, I have my 2006. And generally I'm probably burning, if I don't do anything, if I don't exercise I'm probably burning about 700 calories a day, if I'm not doing anything. So 2,700 is my basic.

If I eat more than 2,700 calories a day, I will gain weight. If I can drop it down, I will lose weight. Now if I throw in one hour of good exercise a day, let's say one hour a day I run six miles, I can add another 900 calories of burn and 3,600 calories. So if I exercise really well for an hour day, I can eat almost anything I want within reason. I don't have to diet. And I could do pretty well.

What about heavily muscled person versus someone who's not so muscled at the same meter squared? Do you have any--

They probably would not fit into this chart well, because they're going to be on the extreme levels. Same thing on an obese person. They may not fit as well also on something like this. So 3,600 calories per day.

Now if I wanted to lose weight, I'd just have to make sure if I'm burning 3,600 a day, now here's the interesting thing. Let's say I want to lose a pound a week. I want to lose a pound of fat a week. A pound a week of fat is about 3,500 calories. That's how many calories in a pound of fat. So if I want to lose it in a week, I need to lose 500 a day. I have to create a caloric imbalance of 500 a day.

That means if I'm burning 3,600 a day, I can't eat more than 3,100 a day. So that's 500. Now that's a rough estimate in there. But just think about that for a second. That means to lose weight if you're exercising, you don't have to drastically diet. In fact, most diets by themselves don't work. Most people have dieted without exercising, it hasn't worked, it has worked short term. But it doesn't seem to work long term. Long term they seem to gain it all back.

The people who successfully keep off weight have always been a combination of exercise and diet. Question?

Where did you come up with the 3,600?

The 3,600? OK, this was my basal metabolic rate. I added 700 for daily activities that don't require much. And that gave me the 2,700, which is pretty average. I added the 900 in my hour of exercise. Let's say I run six miles a day. That's where I get that information from. Those are rough estimates, yeah.

Well generally, I weigh 200 pounds. So generally you burn about a calorie per pound per mile. All right? That's why I hate those machines at the Y, because they don't give me enough credit. Actually what I'm doing is going by the Y machine, and they have me burning about 160 calories per mile, which really is pretty accurate probably. The 1 pound is a rough estimate, 1 one pound burn 1 calorie. That would be a rough estimate.

So that's where I get that number. So you can see, if I want to lose weight, I may not have to do a whole lot. Just 3,100. Any questions on that, how you can use the basal metabolic rate? It's really important.

I think people have to understand when I'm dealing with patients, because we're getting so many patients in with low back pain, they want to know why they have low back pain. They have low back pain because they don't exercise and they weigh too much. So what I'm telling them, a lot of times they didn't get hurt because of the extra weight. They did something to hurt themselves. But the extra weight is hampering the recovery and that's what you work with.

So you're working with a back injury. But then the recovery is going to be slow if they cannot get in shape. So you're trying to get them in shape. If I can break it down for them this way and say, you know what? I want you to lose 1 pound every two weeks, 1 pound every two weeks. So they have to now create a 3,500 calorie in the negative over a two-week period. So instead of 500 a day, what am I asking them to do? 250 a day.

So if I can get them, someone who is sedentary, if I can get them now to walk about 20 to 30 minutes a day. I can create this negative balance, without changing their diet drastically if I can get them to walk about 30 minutes a day.

Some of the contributing factors, physical activity, obviously. If you're physically active, you're going to burn more calories. If you're younger, you're going to burn more calories. Thermogenesis, a food-induced heat, and this was one of the reasoning behind some people saying for a diet high protein, because you actually increased your heat. The deamination of the proteins actually increase body temperature a little bit. Was it enough to actually make a significant difference?

Well, if you're going to eat four or five steaks, you probably, the deamination you're going through is probably going to be offset by the fact that you're eating so much. But that was one of the factors behind it. Climate, warmer climates not unlike our very tropical Minnesota, in warmer climates you tend to have a higher basal metabolic rate. You tend to burn calories at a little bit greater temperature in warmer climates.

However, in Minnesota you can offset that by going out there without a jacket, the shivering, you will definitely burn a lot more calories than if you were lounging in a pool in Florida. So this is a much better place to be, much better.

Pregnancy, obviously if you start carrying around two people instead of one, you're going to burn a lot more calories. So you'll see a higher rate of burn there.

Now when we talk about physical activity, there's a term called the MET. The MET is the metabolic equivalent of oxygen consumption at rest, which is approximately 3.5 milliliters per kilogram a minute. It was basically a way of trying to figure out how can we make things a little bit easier to understand.

So that let's say instead of saying my VO2 I'm working at 35 milliliters per kilogram, you say I'm doing 10 METs of work, working 10 METs. And you'll see a lot of the machines at the gyms now will come up with that that you're at 8 METs, you're at 9 METs, you're at 10 METs.

So if you look, I gave you the chart for intensity of activity in your notes. And once again, you can see average energy expenditure for people between the ages of 19 and 50 in the US male is about 2,900 calories. Female is about 2,200 calories. Part of that is because the natural fat content that women are carrying in essential body fat.

But look at METs, for example. Look at their ratings. 10 METs is considered unduly heavy. Now 10 METs is about 35 milliliters. And what did we say? 35 milliliters would not be tough for most of you to do. For a lot of the American population, it would be tough. 35 for you would not be hard to get to. You'd probably do that in a 10-minute mile, doing a 10-minute mile, which I'm guessing for a lot of you would not be tough.

Over 75% of our activity during the day is considered light intensity. So if you look at that, look at the calories. Look at the METs that we're using. In men, maybe 3 METs, that's about 10.5 milliliters oxygen per activity. That's nothing. Cardiac patients are about that. So we're using the

same energy that cardiac patients are generally using through most of the day. We have become a very sedentary society. And that's an issue that we have to deal with that we have to face that on one hand, we're saying that we need more exercise and more activity. On the other hand, we're becoming less active. Yes?

When you're talking about calories being burned, I think for that we're talking about kilocalories.

It's used interchangeably, yes. Right now we're using calories and kilocalories interchangeably, yeah. And it's often used in physiology interchangeably, even though technically there is a difference. No, no you're right. It can be confusing. It took me a while, even through the [? masters, ?] but it took me a while to say, are you sure we can use this. And I was assured that we can use that like that.

Just as a point of interest, and I don't know if I can find the papers here. Maybe I can't find it. I was interested in seeing-- and I don't know how accurate this is. But when we talk about activity, men's health came up with the latest list of fat cities and fittest cities. Minnesota did drop out. Minnesota dropped down to number 13 in fittest, in fittest, number 13.

Chicago was still number one. Chicago is number one in fattest cities. Apparently 60% or 70% of that population will be classified as obese. And I always thought the Saturday Night Live sketches were satire. Apparently they're not. Apparently that is a lot of Chicago. And they do this based on how many facilities you have for training, air quality, things like that.

LA, you see now Los Angeles, that's why you've got to be careful with all these surveys. Los Angeles is considered a fat city. Even though they do a lot of exercise, their air quality is so poor that it goes into the equation. But Minneapolis is number 13. One of the interesting side notes is per capita we have more recreational swimmers than most people have in any other type of activity or exercise. Just one of those little statistics most people are shocked at.

I think also statistically Minnesota has the highest amount of boat owners per capita. Maybe that's not a surprise. So that goes into effect. But sometimes when you look at some of the top recreational sports, if you look at it, what's number one generally? Walking is up there. Swimming is up there.

Some of them I don't agree with. I mean I think they rank billiards as number six. I'm not sure I would qualify that as a sport or recreation. Any sport where smoke is part of the environment I think should have some sort of asterisk next to it.

Let's go to the next page, using heart rate to estimate energy expenditure. Now the reason we can use heart rate to estimate energy expenditure is because it's basically a linear relationship during a majority of the aerobic range. So when we look at this to try and relate it, you may have all seen this before in the gyms when we talk about an exercise benefit zone and using your heart rate.

When you start increasing your exercise, if this is heart rate, as you start increasing the exercise, generally you have a linear relationship through here. So there are equations where we can often tend to estimate it. And that's why you can get on the machines, they put this equation in so when you put your hands on the heart rate monitor, they take that heart rate. And then they convert it into METs and give you an idea of how hard you're working. But it's all based on the linear relationship between heart rate and exercise. As you work harder, your heart rate goes up.

Now if you see, it's basically linear. What happens is when people are trained or untrained, who do you think has the heart rate that goes up quicker at the beginning of exercise, the trained person or the untrained person?

The trained person, good. And the reason why is because it's the ability to adapt to exercise quicker. A trained person will actually start sweating quicker than an untrained person, because that is an adaptation to the stress of exercise, to help disperse heat, to help work out a little bit. But their heart rate will then level off very quickly.

So if we looked at a trained person, it might look something like this. Whereas the untrained person takes longer to adapt, but will go up much quicker and much higher on the untrained person. So it wouldn't be that uncommon for your heart rate to jump up. Let's say you have a resting heart rate of 66 or 72 and you get on a treadmill and start running. It may not be that uncommon for you to jump right up to 120, but then take quite a while for you to go from 120 to 150. Whereas an untrained person doesn't jump up right away, but boy, it keeps going up based on the energy expenditure.

Now energy expenditure during physical activity, we have touched on this already. Walking approximate 1 kilocalorie per kilogram of body mass per hour, which is the 1 pound per mile. Running is the same as walking. But we also discussed that you actually burn more calories with running, because of the increase in heat. And then swimming, you generally multiply the distance by 4. So the equivalent in calories and expenditure of running a mile would be swimming a quarter mile.

But once again, that is also dependent on efficiency. If you're not a good swimmer, you're exhausted after one lap. So when we talk about this conversion factor of 4, we're assuming that the person is a decent swimmer, that there is some technique there. Otherwise, it's one length, one lap. They're out of breath. They're having a coronary.

So we went through the basal metabolic rate. We did some weight control in there.