the CrossFit JOURNAL ARTICLES

Good Hormones, Bad Hormones

The Energy Balance Equation

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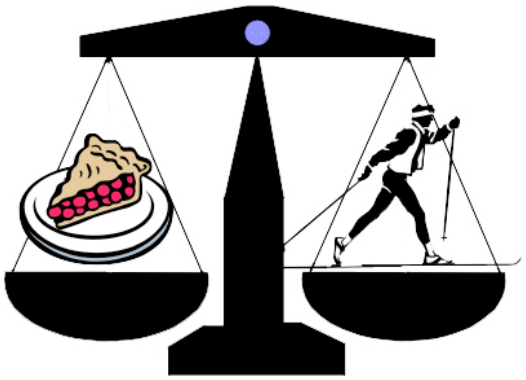
This month I want to discuss the energy balance equation in relation to diet and CrossFit training. Part of my motivation for this comes from an interview with Gary Taubes in which he makes the rather shocking statement that there is little, if any, evidence that exercise is useful in weight control.



In fact, though, a healthy body composition is the result of proper nutrition and exercise. Body composition is the result of being fit; it is not in itself a component of fitness. (I discussed this in more detail in my article "Body Composition: Not the Holy Grail" in the *CrossFit Journal* in January 2007). Performance measures are better indicators of health and fitness. (Whether measured in terms of workout or competition times and results; blood lipid profiles; or ECG, liver function, and glucose tolerance tests; among others.) That being said, weight control is important to many, and the principles of proper eating and exercise that produce healthy body composition are at root the same ones that produce elite performance. Taken together, these are key factors that determine where you are on the sickness-wellness-fitness continuum.

In his book *Good Calories, Bad Calories* (which is, I believe, quite simply one of the most important books ever written in the field of nutrition and weight control), Taubes argues that common nutritional guidelines such as the USDA food pyramid and Canada's Food Guide are inappropriate for optimal health and weight control. Many researchers have promoted numerous health benefits for low-fat, high-carbohydrate diets despite a disturbing lack of evidence to support their view. In 1960 the American Heart Association jumped on board and decided low-fat diets are a healthy option. Without studies and without evidence, they started to promote these diets. The result is that, four decades later, the majority of the North American public believe the purported benefits of this diet are absolute fact.

The energy balance equation

When it comes to weight control, many "authorities" in the field have used the first law of thermodynamics (conservation of energy) and the energy balance equation (EBE) to promote low-fat diets. The EBE is quite simple and states:

Change in Energy Stores = Energy Intake – Energy Expenditure

This equation must be correct in the simplest sense due to the laws of physics. However, despite the apparent simplicity of the equation, the interplay between these

variables is complex. Nevertheless, most weight loss programs have simply (and wrongly) treated energy intake and energy expenditure as two independent variables. Therefore the simple, but incorrect, message for individuals who want to lose weight has been to focus on decreasing caloric intake, increasing energy expenditure, or a combination of the two. This might appear to be reasonable, and, since a gram of fat is nine calories, and protein and carbohydrate are approximately four calories per gram, this approach would seem to support the notion that a low-fat diet is best for weight loss. This notion persists despite a mountain of evidence that lowfat diets do not work very well, if at all, for most individuals. (For more on this see Lon Kilgore's article "Physics, Physiology, and Food" in the June 2007 *CrossFit Journal*.)

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A further simple interpretation of the EBE is that the overweight and obese in our society must be eating too much and not exercising enough. While this may be true for some, a number of studies have shown that at least some overweight individuals eat the same number of calories, or fewer, than lean individuals.

Understanding why this happens is not exactly rocket science, and it is not a violation of the laws of conservation of energy. The fact is that the food we eat elicits hormonal responses that determine how energy is stored in the body (i.e., in the form of body fat). Basically, energy intake is not independent of energy expenditure, and the type of calories you eat does affect your energy output. Energy intake and energy expenditure are dependent variables. Sugar, high-fructose corn syrup and easily digestible carbohydrates drive an insulin response and insulin drives fat storage. Dietary fat—or even calorie quantity—is not the main culprit at all.

That storage or release of fat from our adipose tissue (fat cells) is hormonally driven is quite obvious. A typically lean woman will start to gain fat if she becomes pregnant. Why? The hormonal response to being pregnant stimulates fat accumulation to try to ensure ample energy supplies for both mother and fetus. The fat storage will usually be in the buttocks, thighs and breasts and the stored fat will be mobilized (moved out of the cells) when energy is needed during the pregnancy and lactation. After she has given birth, assuming good nutrition, she will return to a normal amount of adipose tissue for her whether or not she eats more or less calories.

So what is cause and what is effect in the energy balance equation? Do you necessarily store energy just because you ate more? The key point Taubes makes is that, for most, it is poor eating habits that cause the hormonal response that forces the body to store excess calories as fat. But these poor intake is not simply too many calories; it is high-glycemic and total carbohydrate intake. Numerous studies have shown that restricting overall carbohydrates and eating only low-glycemic index carbohydrates is the most effective diet for weight control and good health. Sumo wrestlers eat a lot of food to gain weight (body fat), and their diet is extremely low-fat (typically with only about 16 percent of total energy intake from fat). In the late 1970s, 30 percent of the U.S. population was classified as obese or overweight and the high-carbohydrate, low-fat diet "cure" that has been prescribed since then has resulted in 65 percent of the U.S. population being classified as obese or overweight by the early 1990s.

Studies have shown that individuals on low-calorie weight loss diets better tolerate high-fat, high-protein, low-carbohydrate diets. Despite low overall calorie intake, they do not report feeling hungry all the time and their metabolism does not slow down in an attempt to maintain fat stores. These kinds of diets were commonly prescribed up until World War II, and diets such as Atkins would not have been considered "fad diets" in the nineteenth and first half of the twentieth century.

So the evidence is clear that you cannot simply state that "a calorie is a calorie" when looking at the energy intake variable in the EBE. All calories are not equal, and the quality of those calories (i.e., type of nutrient and overall nutrient balance) is much more important. Restricting calorie intake but continuing to eat much of it in the form of high-glycemic foods will make your body fight to maintain its fat stores and will lower your metabolism. There is simply no well-researched evidence that contradicts this information.

Energy out

So what role does exercise play in weight control? Before getting into this in more detail, I acknowledge that Taubes's book is not, and does not claim to be, about exercise. When he states that exercise does not lead to weight loss, he is simply looking at the major epidemiological and clinical trial evidence. Most of the evidence he looked at was from exercise interventions with overweight or obese sedentary subjects. The kinds

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of exercise done in these studies would not have been the types that elicit beneficial hormone responses, and if the diet was also driving hormonal triggers for fat accumulation, it is no wonder they didn't work.

In the radio interview, Taubes said, "I assume exercise is good for a lot of things because a lot of good scientists say so." This from a man who spent five years meticulously reviewing the epidemiological and clinical trial evidence regarding diet and weight control. That he can make such a statement clearly indicates that he didn't even begin to look seriously at the health benefits of exercise. This is not a criticism of an excellent book and his unsubstantiated discussion on exercise should not discourage you from reading it. But the book is simply not about the health benefits of exercise (and its author not qualified to make on-air assertions about the role of exercise in weight control). Half the book reviews the hormonal and metabolic effects of diet; the other half is about how these affect weight control.

In a parallel manner, a fuller understanding of the relationship between exercise and weight control lies in understanding the body's hormonal response to exercise. As stated, most of the epidemiological and clinical trials that Taubes looked at would have had the subjects doing exercise like 20 to 60 minutes of steady-state low-power activities such as walking, jogging, cycling, etc. These modes of exercise are less than ideal in improving aerobic conditioning (VO_2 max), and they are utterly ineffective at stimulating significant production of testosterone, human growth hormone, and the other "good" hormones involved in optimal health and body composition.

If Taubes has shown that the "a calorie is a calorie" logic is flawed with regard to energy intake, then CrossFit, and anaerobic/power athletes the world over, have shown that that logic is just as flawed on the energy expenditure side of the equation as well.

In my *CFJ* article on body composition (January 2007) I discussed one study that showed a group of subjects doing bike interval work (series of sprints) lost more body fat than another group doing steady-state cycling. The researchers controlled the work rates so that the total external work done (measured as calories expended) per session was the same for both groups. The sprint interval group did the same amount of external work and yet lost more body fat, which correlates with the notion that high power outputs elicit different (read: better) hormonal responses than low-power steady-state ones.

Try this little experiment. Complete 50 step-ups onto a 24-inch plyo box, as fast as you can. Go hard and try to get a good time. Later (or the next day to negate effects of fatigue), try to perform 50 two-footed jumps onto the same box in the same time. Which felt harder? Which fatigued you more? If you pushed hard on the step-ups, you likely were not able to complete the box jumps in the same time. Then, try it again another time with 100 step-ups versus 100 box jumps. The difference in times will likely be even more pronounced, with the step-ups being done in considerably less time. But what is my point? Assuming you didn't jump higher than you needed to and had to drop down onto the box, the amount of external work done is the same for the step-up and box jump, since you raise your body weight the same distance. If you were to complete the 50 steps and 50 jumps in the same amount of time, the average power (work/time) would also be the same. However, the peak power involved in each activity is quite different. This is because the step-up is a gradual application of force; I raise my leg, place it on the box, and push up in a controlled manner until I am standing erect, whereas the jump is a shortduration explosive effort that raises the entire body at once onto the box, in a shorter time. I have calculated that a 180-pound athlete would produce an average power of roughly 1,500 watts (about 1000 foot-pounds of force per second) during a stepup onto a 24-inch box. The peak power in the step-up motion is unlikely to be more than 2,500 watts (and probably less). In contrast, the peak power of a jump onto the box would be 5,400 watts (around two to three times the peak power output of the step-up).

CrossFit often scales workouts or makes exercise substitutes based on this knowledge. Why is one muscle up worth four pullups and four dips? You would actually do more work during four pull-ups and four dips, but the power required to drive yourself up and though the transition in the muscle up is much larger. (Not to mention the additional demands of flexibility, coordination, accuracy, agility, and balance.) At CrossFit Vancouver, where I work out, the trainers count two step-ups equal to one box-jump for the same reasons.

Clearly, if you are doing the same amount of work in two comparable but different exercises and yet find one type of exercise more fatiguing, and if you do the same amount of work and yet lose more body fat with one

type of exercise, then something else is going on other than a simple calculation of calories expended. One factor is that we are measuring external work (how far you move your body and in what timeframe). However, the actual total energy (internal and external) cost of acceleration (overcoming inertia) is very high. If you drive a car and accelerate toward every stop sign, brake, and then accelerate away again at a high rate, your fuel consumption will be high. The car weighs the same, and if you drive 20 miles at a steady pace or do it in a series of accelerations and decelerations (braking), you have still done the same amount of total external work, but one uses significantly more fuel. In athletic performance as well, acceleration requires a huge effort and use of resources (energy). And overcoming inertia (accelerating, lifting, resisting, changing direction, etc.) is a key factor in athletic performance. Olympic lifts and maximal sprints use an incredibly high number of muscle fibers in the explosive effort to produce high accelerations. The hormonal response to such activities is profound. Although squats and deadlifts are "slow" lifts, the sheer weight being lifted also means they are very taxing lifts that will stimulate positive hormonal responses. To say that a 500-pound deadlift is a low-power lift is meaningful only in comparison to something like a maximal clean and jerk. Compared with distance running, heavy deadlifts require massive power as well as total work.

The hormonal response to high-power activities includes testosterone and human growth hormone, but many others are involved. The intense work also causes more cellular damage (on the cellular level, exercise is a stressor—a debilitating process that forces the body to rebuild tissue and strengthen), and there are important hormones involved in this rebuilding process. And, your metabolism will stay elevated for much longer after a high power activity due to the action of adrenal gland hormones (such as epinephrine and norepinephrine). This factor is often overlooked in terms of the energy expended due to an exercise session.

I am not saying that quantity of exercise is not a factor at all (just as, the quantity of calories eaten is still relevant). The problem is that many people working in these fields (exercise and nutrition) tend to see quantity as the only factor. But the high intensity levels, across all metabolic pathways, using large percentages of body musculature, are key factors to the efficacy of CrossFit programming with respect to body composition and weight control. The adaptation and hormonal response to performing only long, slow, low-powered aerobic work is clearly inadequate for driving a healthy hormonal response and a truly healthy body composition (one that includes adequate musculature in all regions of the body, good bone and connective tissue density, and healthy body fat levels).

In summary, Taubes has highlighted a crucial flaw in the way doctors and many researchers view the energy balance equation and its application to weight loss. By regarding energy in and energy out as independent variables, they have ignored the majority of research on both humans and animal models that shows the importance quality over quantity—the vital importance of the type of calories consumed.

Similarly, many who prescribe exercise for weight loss and health improvement fail to understand the importance of how the energy is expended. The focus is almost always just on quantity. But, in reality—as Taubes shows for calories consumed—the quality of the exercise performed is at least as important as the quantity of calories expended.

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