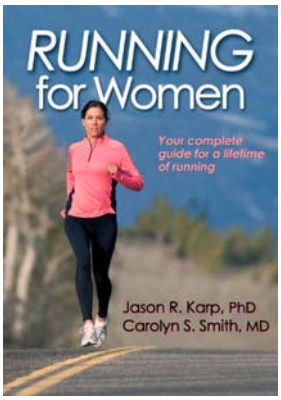
Excerpt

From *Running for Women*



A Woman's Metabolism

Metabolic Differences

Metabolism refers to all of the energy-requiring chemical reactions occurring inside your body. At any one time, trillions of reactions are going on inside of you, including the growth of new tissue, muscle contraction, and the breakdown of food for energy. The resting metabolic rate—the amount of energy needed during resting conditions—is lower in females because of their smaller body mass and muscle mass. When you run, your metabolic rate increases dramatically because of the increased demand for energy. The faster your metabolic pathways can use the available fuel to regenerate energy for muscle contraction, the faster you will be able to run any race.

While your nervous system controls your body's faster functions, like the initiation of reflexes and movement, hormones control the slower functions, like the regulation of growth and metabolism and the development of reproductive organs. Much of metabolism is under the direction of hormones, which act as conductors, initiating signals that lead to the transportation and use of fuel. And the two predominant fuels for running are carbohydrate and fat, which provide energy on a sliding scale. At slower speeds, your muscles rely more on fat and less on carbohydrate, and as you increase your running pace, the energy contribution from fat decreases while the energy contribution from carbohydrate increases.

Carbohydrate Metabolism

The hormone insulin is responsible for carbohydrate metabolism. Consuming carbohydrate elevates your blood glucose concentration and increases insulin concentration. The increase in circulating insulin, which is secreted from your pancreas, stimulates specific proteins to transport the glucose from your blood into your muscles, where it is either used for immediate energy by your cells or stored as muscle glycogen for later use. Males typically have more glycogen stored in their muscles. Longer races like the marathon are limited, in part, by the amount of stored glycogen. Therefore, the lower muscle glycogen in women's muscles can partly explain why they cannot run marathons as fast as men.

Research has shown that men also are more responsive to carbohydrate loading than women. In other words, women do not increase muscle glycogen as much as men in response to consuming more carbohydrate in their diets. However, some of this research is clouded by the fact that women consume fewer total calories than men, so the lack of glycogen storage may be due to a lower caloric or carbohydrate intake by women rather than an inherent sex difference in the ability to store glycogen. When women increase their total caloric intake as they also increase the amount of carbohydrate in their diets, they increase their muscle glycogen content by a similar amount as men. From a training perspective, while men simply need to increase the percentage of their calories coming from carbohydrate

in order to carbo load and store more glycogen, women need to also increase the total number of calories in their diets to get the same effect.

Because carbohydrate is the predominant fuel source during running and the only fuel source at speeds faster than acidosis threshold, research has focused on how the hormonal differences between men and women affect insulin and alter carbohydrate metabolism. Most research has found that women use less carbohydrate than men when exercising at similar intensities.

When you finish a workout that severely lowers your muscle glycogen content, it's important to replenish the carbohydrates so you can resynthesize more glycogen to be prepared for your next run. In fact, refueling nutrient-depleted muscles is possibly the single most important aspect of optimal recovery from training and racing. Scientists first discovered in the late 1960s that endurance performance is influenced by the amount of stored glycogen in skeletal muscles, and that intense endurance exercise decreases muscle glycogen stores. The faster you can resynthesize muscle glycogen, the faster your recovery. Research has shown that the rate of glycogen synthesis in the first few hours following a workout (the time when you are best able to store glycogen because the cells are most sensitive to insulin) is similar between the sexes. This suggests that recovery rates between males and females are similar, at least the component of recovery affected by the resynthesis of fuel.

Fat Metabolism

As a consequence of not using as much carbohydrate during exercise, women rely more on fat than men. Indeed, it has been estimated that women use about 75 percent more fat than do men while running or cycling at 65 to 70 percent V·O2max. Women get about 39 percent of their energy from fat during exercise at 65 percent V·O2max, while men get about 22 percent of their energy from fat. However, the percentage of energy derived from fat varies significantly from person to person because factors such as training status, muscle fiber type, muscle glycogen content, and mitochondrial density all play a role.

While it is difficult to tease out the exact reasons for the difference between the sexes in the metabolism of carbohydrate and fat, it appears that estrogen is at least partly responsible. Research done on rats has shown that when male rats are given estrogen, they deplete less glycogen during exercise; the concentration of fatty acids in the blood increases, suggesting a greater availability of fat for energy; and they can exercise for longer periods before becoming exhausted. Increasing the amount of fatty acids circulating in the blood favors their use by muscle during exercise, resulting in a decreased reliance on muscle glycogen and blood glucose, thus delaying glycogen depletion and hypoglycemia, or low blood sugar, and postponing fatigue.

This switch in fuel use to a greater reliance on fat at the same running speed also occurs from endurance training. Training enhances fat use by increasing the mitochondria in your muscles, allowing for more aerobic metabolism and the sparing of muscle glycogen. This shift in the energy source for muscular activity is a major advantage in delaying the onset of fatigue in running events that are limited by the availability of muscle glycogen—marathons and ultramarathons. Because humans' carbohydrate stores are limited, the difference in metabolism between the sexes may give female runners an advantage for very long endurance activities, during which there is a greater need to conserve carbohydrate and a greater use of fat because of the slower pace. In 2002 and 2003, Pam Reed showed that

science may be on to something, by winning the 135-mile (217K) Badwater Ultramarathon, beating all of the men. In shorter races, however, when there is a greater demand to generate energy quickly for muscle contraction, relying more on fat will slow the pace because energy is derived much more quickly from carbohydrate than from fat.

Protein Metabolism

The third macronutrient, protein, is often neglected in metabolism because it accounts for only 3 to 6 percent of the amount of energy expended while running. Rather, protein is used primarily for other things, such as building, maintaining, and repairing muscle, skin, and blood tissue, as well as aiding in the transportation of materials through the blood. Protein can be thought of as your body's scaffolding and cargo. However, it can be used for energy if inadequate amounts of fat and carbohydrate are available because the body's requirement for energy takes priority over tissue building. Although the amount of protein you use for energy may be small, even a small contribution to your daily run may be large if you run a lot and run often.

Exercise increases the use of amino acids from protein breakdown, and the amount of amino acids that your muscles use is inversely related to the amount of glycogen in the muscle. When glycogen is abundant, muscles rely on glycogen, but when glycogen is low, muscles begin to rely more on amino acids. Research has shown that females use less protein during exercise than do males. Because endurance-trained females use less muscle glycogen and rely more on fat than endurance-trained males, protein breakdown seems to be inhibited in females by virtue of the greater muscle glycogen.