Dear Alice,

Does altitude affect calorie-burning? That is, if I do the exact same workout twice — once in New York City and once in Colorado — will I burn more calories at the high altitude? What things DO affect how many calories you burn in a workout?

— Training at 6500

Answer

Dear Training at 6500,

During the first few days at a higher altitude with thinner air that contains less atmospheric oxygen, one's body will respond as follows:

- Breathing rate (ventilation) increases
- Blood pH decreases, becoming more acidic
- Muscle pH also decreases and becomes more acidic
- Use of carbohydrates as an energy source increases
- Use of fat as an energy source decreases

These changes lead to a slight increase in basal metabolic rate (BMR), the amount of energy needed to keep your body working correctly at rest for 24 hours. Research studying this phenomena have found between a 6 to 28 percent increase in overall BMR in women and men at high altitudes. With time, the increase in BMR lowers, but does not return completely to baseline, so metabolism is slightly elevated at higher altitudes.
With this said, it seems that someone can expend many more calories while exercising at high altitudes; however, this is not necessarily the case. There is not a huge difference in the amount of calories utilized at a higher altitude during exercise even though it may feel as though a person is working much harder. The few extra calories someone will use will be a result of increased breathing to get more oxygen into the body, which means increased work by the rib cage and other muscles involved in ventilation. So even though ventilation increases and oxygen delivery is enhanced, it doesn’t necessarily mean a person is expending more energy while exercising.

Here are some factors that do influence the number of calories a person expends in general:

- **Genetics:** Some people are born with high metabolisms (the rate at which one’s body uses calories) and others are born with low metabolisms. The main culprit of these phenomena is the thyroid gland. Some individuals produce more thyroxin (the hormone that is secreted from the thyroid) than others. Thyroxin is responsible for metabolism, so if a person's body produces a high-normal amount of thyroxin, s/he will utilize calories more quickly. If a person's body produces a low-normal amount of thyroxin, s/he will utilize calories more slowly. NOTE: if thyroxin is out of normal range in either direction, it is dangerous and needs medical attention.

- **Gender:** Typically, men have greater muscle mass than women. Since muscle requires more calories to maintain, men tend to have 10 to 15 percent faster metabolisms than women. Similarly, men have a lower body fat percentage than women.

- **Age:** Metabolic rate is higher in childhood than in adulthood. Children are growing and need more calories to fulfill their bodies’ requirements. After the age of 20 years, metabolism drops two percent per decade.

- **Brain Power:** The brain is only two percent of the body’s weight, but accounts for more than 20 percent of total calories used. Also, the length of time per day spent awake affects the amount of calories utilized. We expend more calories when we are awake than when we are asleep.

- **Fever:** For every increase of 0.5°C (32.9°F) in body temperature, BMR increases by approximately seven percent. For example, if someone has a fever of 42°C (107.6°F), s/he would have an increase in metabolic rate of 50 percent. The reason for this is that chemical reactions in the body occur more quickly at higher temperatures.

- **Medications:** Some medications, such as anti-depressants, can slow down metabolic processes and lead to weight gain.

During exercise, the following factors influence calorie expenditure:

- **Cardiovascular Exercise Intensity:** The intensity of aerobic exercise has the greatest impact on calorie usage during exercise. As exercise intensity increases, the greater the caloric expenditure during and after exercise. Intensity refers to the rate of exertion during exercise, which can be measured by VO₂ max (oxygen consumption), heart rate, or perceived exertion. Here’s an example of cardiovascular exercise intensity: running on a treadmill at 6.5 mph is more intense than running at 5.5 mph, so increasing speed can impact intensity. However, two people can be running at 5.5 mph, but if one runs on an incline, that activity would be more intense.

- **Cardiovascular Exercise Duration:** The length of time per exercise session not only
impacts the number of calories utilized during exercise, but also the number of calories to be utilized after exercise. The longer the bout of physical activity, the more calories will be expended right after it is over, a.k.a. the 'after-burn.'

- **Intermittent vs. Single Bouts of Exercise:** Several studies have concluded that intermittent aerobic exercise expends more calories overall than continuous exercise. People used more calories during two, 25-minute sessions when compared to a continuous 50-minute bout of the same exercise. This occurs for two reasons: first, the body has to work harder at rest to move from an anaerobic state, using glucose and other simple and complex carbohydrates during the first few minutes of exercise, to an aerobic state, which relies on fat as its main energy source during more sustained activity. This will happen twice in intermittent exercise bouts versus once in a continuous bout. Also, there is more 'after-burn' of calories in intermittent exercise sessions versus one continuous session.

- **Resistance Training:** The intensity of weight training also influences calories utilized. Heavier lifting (three sets, eight exercises, three to eight reps at 80 to 90 percent of 1RM) will use more calories during and right after than lighter weight lifting (four sets, eight exercises, 15 reps at 50 percent of 1RM). 1RM refers to the weight of one repetition at maximal strength. For example, if a person's 1RM of a squat is 100 pounds, then heavy lifting would be doing three sets of three to eight reps of squats at 80 to 90 lbs. Lighter weight lifting would be squatting 50 lbs for four sets of 15 reps.

- **Fitness Level:** People who are more fit expend fewer calories during and right after exercise than people who are less fit. This occurs because people who have been exercising more consistently have faster recovery time in breathing and heart rate, and repair muscle more quickly.

Overall, metabolism increases slightly at higher altitudes with some greater caloric expenditure, but this difference is insignificant, since metabolism is influenced to a larger degree by the above eleven factors.

Alice!
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Published date:
Oct 14, 2005
Last reviewed on:
May 14, 2015