

Low-Carb/Ketogenic Diets and Exercise Performance

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Low-carb and [ketogenic](#) diets are extremely popular.

These diets have been around for a long time, and share similarities with [paleolithic diets](#) (1).

Research has shown that lower-carb diets can [help you lose weight](#) and improve various health markers (2).

However, the evidence on muscle growth, strength and performance is mixed (3, 4, 5).

This article takes a detailed look at low-carb/ketogenic diets and physical performance.

What are Low-Carb and Ketogenic Diets?

The guidelines for a [low-carb diet](#) vary between studies and authorities. In research, low-carb is usually classified as less than 30% of calories from [carbs](#) (6, 7).

Most average low-carb diets consist of 50–150 grams of carbs per day, a fairly high amount of [protein](#) and a moderate-to-high fat intake.

Yet for some athletes, “low-carb” can still mean over 200 grams of carbs per day.

In contrast, a well-formulated ketogenic diet is more restrictive, usually consisting of only 30–50 grams of carbs per day, combined with a very high fat intake (8).

This extremely low carb intake helps you achieve [ketosis](#), a process where [ketones](#) and fat become the main sources of energy for the body and brain (9).

There are several versions of the ketogenic diet, including:

- **Standard ketogenic diet:** This is an extremely low-carb, moderate-protein, high-fat diet. It typically contains 75% fat, 20% protein and 5% carbs (8).
- **Cyclical ketogenic diet:** This diet involves periods of higher-carb refeeds, such as 5 ketogenic days followed by 2 high-carb days.



- **Targeted ketogenic diet:** This diet allows you to add carbs, usually around periods of intense exercise or workouts.

The pie charts below show the typical nutrient breakdown of a low-fat Western diet, a low-carb diet and a typical ketogenic diet:



In most low-carb and ketogenic diets, people restrict food sources like [grains](#), [rice](#), beans, [potatoes](#), sweets, [cereals](#) and [some fruits](#).

An alternative approach is [carb cycling](#), where high-carb periods or refeeds are included regularly in a low-carb or ketogenic diet.

Bottom Line: A low-carb diet usually consists of a higher protein intake with less than 30% of calories from carbs. Ketogenic diets are very high in fat, moderate in protein and contain almost no carbs.

Low-Carb Diets and Fat Adaptation

During a low-carb or ketogenic diet, the body becomes more efficient at using fat as fuel, a process known as fat adaptation. The drastic reduction in carbs causes a rise in ketones, which are produced in the liver from fatty acids (10).

Ketones can provide energy in the absence of carbs, during a prolonged [fast](#), during long exercise periods or for people with uncontrolled type 1 diabetes (11, 12, 13).

Even the brain can be partly fueled by ketones (14).

The remaining energy is provided by [gluconeogenesis](#), a process where the body breaks down fats and proteins, converting them into carbs ([glucose](#)) (14).

Ketogenic diets and ketones have many beneficial properties. They are even being used to [treat diabetes](#), neurological diseases, cancer and risk factors for heart and respiratory diseases (2, 15, 16).

The fat adaptation on a ketogenic diet can be very powerful. One recent study in ultra-endurance athletes found that a ketogenic group burned up to **2.3 times more fat** in a 3-hour exercise session (17).

Yet although low-carb and ketogenic diets provide [many health benefits](#), there is an ongoing

debate about how these diets affect exercise performance (18, 19).

Bottom Line: In the absence of carbs, your body burns fat for energy. This mainly occurs by increased fat oxidation and the production of ketones.

Low-Carb Diets and Muscle Glycogen



Dietary carbs are broken down into glucose, which turns into blood sugar and provides the main fuel for moderate and high-intensity exercise (20).

For several decades, research has repeatedly shown that eating carbs can help with exercise performance, especially endurance exercise (21).

Unfortunately, the human body can only store enough carbs ([glycogen](#)) for around 2 hours of exercise. After this time, fatigue, tiredness and decreased endurance performance may occur. This is known as “[hitting the wall](#)” or “[bonking](#)” (22, 23, 24).

To counter this, most endurance athletes now consume a [high-carb](#) diet, “carb up” the day before a race and consume carb supplements or food during exercise.

However, low-carb diets don’t contain a lot of carbs, and therefore don’t help optimize the reserves of stored glycogen in the muscles.

Bottom Line: Stored carbs provide an efficient energy source for exercise lasting up to 2 hours. After this time, energy output and endurance performance usually decrease.

Low-Carb Diets and Endurance Performance

Research has been done on the use of fat as fuel in sports performance (25).

During exercise, fat provides more energy at lower intensities and carbs provide more energy at higher intensities.

This is known as the “crossover effect,” which is illustrated below (26):

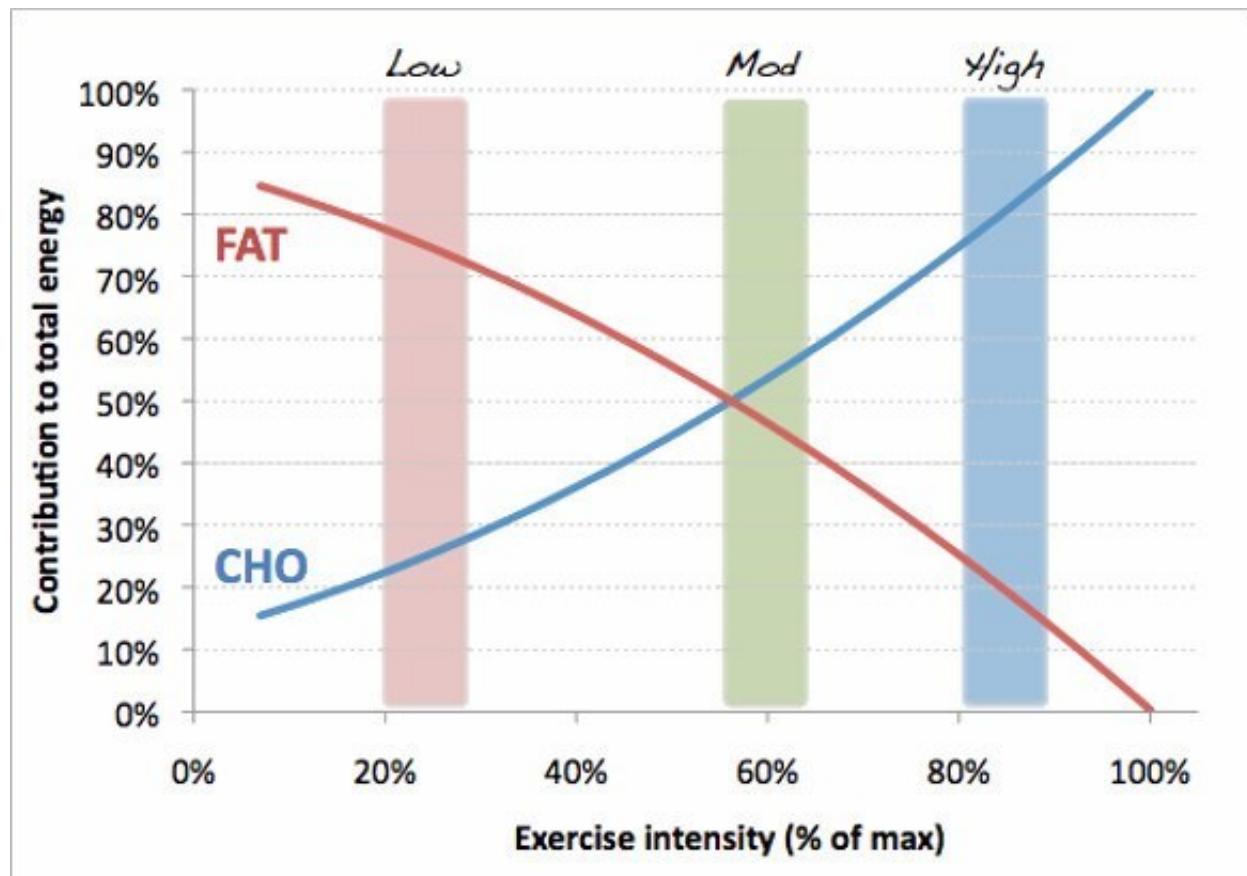


Image source: [The Science of Sport](#).

Recently, researchers wanted to see if a low-carb diet could alter this effect (18, 19).

Their study found that ketogenic athletes burned mostly fat at up to 70% of max intensity, vs only 55% in the high-carb athletes. In fact, the ketogenic athletes in this study burned the most fat ever recorded in a research setting (17).

Yet despite these positive findings, fat may be unable to produce energy fast enough to meet the demands of the muscles of elite athletes (27, 28, 29).

Therefore, more research is needed in an athletic population before any firm recommendations can be made.

Nevertheless, studies have found that low-carb diets can help prevent tiredness during prolonged exercise. They may also help you lose fat and improve health, without compromising low-to-moderate intensity exercise performance (4, 30, 31).

Furthermore, these diets can teach your body to burn more fat, which may help you preserve

muscle glycogen during exercise (17).

Bottom Line: A low-carb diet is likely to be just fine for most people exercising at low-to-moderate intensities. However, more research is needed for high-level athletes.

How Carbs Affect Muscle Growth

As of now, no research has shown that low-carb or ketogenic diets are better for high-intensity, strength or power-based sports.

This is because carbs aid muscle growth and high-intensity exercise performance in several ways:

- **Promote recovery:** Carbs may help with recovery after exercise (32).
- **Produce insulin:** Carbs also produce [insulin](#), which helps with nutrient delivery and absorption (33).
- **Provide fuel:** Carbs play an important role in the [anaerobic](#) and ATP [energy systems](#), which are the primary fuel sources for high-intensity exercise (34).
- **Reduce muscle breakdown:** Carbs and insulin help reduce muscle breakdown, which may improve net protein balance (35, 36).
- **Improve neural drive:** Carbs also improve neural drive, resistance to fatigue and mental focus during exercise (37).



However, this doesn't mean your diet must be very high in carbs, like a typical Western diet. A moderate-carb or carb cycling diet may work well for most sports.

In fact, a moderate-carb, higher-protein diet seems to be optimal for muscle growth and body composition for people who are lean and active (38).

Bottom Line: Carbs play an important role in muscle growth and high-intensity exercise performance. There is no research showing low-carb diets to be superior for this.

Studies on Low-Carb Diets for Athletes

Several studies have looked into the effects of low-carb diets on high-intensity endurance exercise.

However, they have provided mixed results.

One study found no difference between the ketogenic and high-carb groups for high-intensity sprints.

Yet the ketogenic group did get less tired during low-intensity biking, which is probably because the body used more fat for fuel (39).

Other studies have shown that people on low-carb diets can spare muscle glycogen and use



more fat as fuel, which could be beneficial for ultra-endurance sports (18).

Nevertheless, these findings have less relevance for athletes performing high-intensity exercise or workouts of less than 2 hours.

The research is also mixed in obese populations, with some studies showing benefits in lower-intensity aerobic exercise, while others show a negative effect (31, 40).

Some studies have found that individual response may vary as well. For example, one study found that some athletes achieved better endurance performance, while others experienced drastic decreases (41).

At the present time, the research does not show that a low-carb or ketogenic diet can improve high-intensity sports performance, compared to a higher-carb diet.

Yet for lower-intensity exercise, a low-carb diet can match a conventional high-carb diet and even help you use more fat as fuel (31).

Bottom Line: Low-carb and ketogenic diets do not seem to benefit high-intensity exercise performance. However, these diets seem to match high-carb diets when it comes to lower-intensity exercise.

Are There Any Additional Benefits For Athletes?



One beneficial aspect of a low-carb or ketogenic diet is that it teaches the body to burn fat as fuel (42).

For endurance athletes, research has shown that this can help preserve glycogen stores and keep you from “hitting the wall” during endurance exercises (18, 42).

This helps you rely less on carbs during a race, which could be important for athletes who struggle to digest and consume carbs during exercise. It may also be beneficial during ultra-endurance events where access to food is limited (18).

Additionally, several studies have shown that low-carb and ketogenic diets can help people lose weight and improve overall health (43, 44).

Fat loss can also improve your fat to muscle ratio, which is extremely important for exercise performance, especially in weight-dependent sports (45, 46).

Exercising with low glycogen stores has also become a popular training technique, known as “train low, compete high” (47).

This can improve fat utilization, mitochondria function and enzyme activity, which have a beneficial role in health and exercise performance (47).

For this reason, following a low-carb diet for a short period of time — such as during an “off season” — may aid long-term performance and health.

Bottom Line: Low-carb diets may be useful for some types of endurance exercise. They can also be used strategically to improve body composition and health.

Take Home Message

Low-carb or ketogenic diets can be a good choice for healthy people who are mostly exercising and lifting to stay healthy.

However, there is currently no solid evidence that they improve performance over higher-carb diets in athletes.

That being said, the research is still in its infancy, and some early results suggest that they can be a good choice for low-intensity exercise or ultra-endurance exercise.

At the end of the day, carb intake should be tailored to you as an individual.