Carbohydrate Loading

The term *carbohydrate loading* is used to describe everything from the pasta feed the night before a fun run to the overindulgence in foods of dubious athletic value usually associated with some celebratory event. In reality, carbohydrate loading is a research-proven fueling strategy designed to extend endurance in athletes. This article will help you understand how carbohydrate loading works, when to use it and when not to, where athletes typically go wrong, and practical strategies for how to best make it work for you. Carbohydrate loading is not new. It dates back to the late 1960s, when Scandinavian scientists found that after several days of a low-carbohydrate diet, men in their study had low muscle glycogen stores and less endurance compared to when they consumed a moderate-carbohydrate diet. And when the men consumed a high-carbohydrate diet over several days, glycogen stores in the muscle became supersaturated, and endurance times were significantly extended. The scientific term for this loading of carbohydrate fuel into muscle is glycogen *supercompensation,* and these studies led to the classic seven-day model of carbohydrate loading — it's a model you'll want to avoid. With the classic approach, athletes began their preparation seven days before a competition. The first 3-4 days were a miserable regimen of exhaustive training and few carbs. Designed to strip the muscle of glycogen stores, the depletion phase worked, but the high-fat, high-protein diet wreaked havoc on the digestive tract. And with an ever dwindling supply of carbohydrate fuel, exercise was grueling, low blood sugar was rampant, and the resulting fatigue and irritability were overwhelming. But the regimen did the job, and during the subsequent 3-4 day repletion phase, the combination of lots of carbohydrates combined with tapered training resulted in super-saturated levels of muscle glycogen. Subsequent studies have shown that this classic approach to carbohydrate loading extends endurance in distance runners. And when the sport of running caught fire in the 1970s and 1980s, carbohydrate loading became a staple of elite marathon runners, and then, through the trickle-down effect, it achieved popularity in recreational runners.

Carbohydrate loading — version 2.0

The studies that led to the classic seven-day carbohydrate loading protocol utilized non-athletes as research subjects. In the early 1980s, another researcher decided to test a variety of carbohydrate loading protocols in well-trained athletes. What his team found was that the torturous glycogen depletion phase was unnecessary. In a modified version of the classic carbohydrate loading regimen, athletes simply tapered their training for three days before a competition, while simultaneously boosting their intake of carbohydrates. The end result was the same very high storage levels of muscle glycogen without the debilitating fatigue, irritability, radical change in diet, and extreme training requirements of the classic approach's depletion phase. In a 2002 study, researchers found that supercompensation of glycogen stores can occur sooner than three days. In this study, athletes followed their normal training regimen on day one. On the morning of day two, their muscle glycogen levels were measured, and then they began consuming a high-carbohydrate diet while resting for three consecutive days. Researchers found that 24 hours after the athletes began consuming a highcarbohydrate diet, muscle glycogen levels peaked and did not increase any further with continued rest and two additional days of high-carbohydrate intake. In yet another carbohydrate loading protocol twist, trained athletes were required to sprint on a cycle ergometer for two minutes and 30 seconds, and then sprint all-out for 30 more seconds. The athletes then rested and consumed a high-carbohydrate diet that was initiated within 20 minutes of

finishing the three-minute, high-intensity exercise regimen. Using this protocol, athletes achieved supercompensated muscle glycogen storage levels, comparable to other methods, in just 24 hours. What method should you follow? Skip the classic approach. The three-day modified regimen is a much better option. Or, if you want to continue to train normally for as long as possible prior to a competition, supercompensation can be achieved if you rest for at least 24 hours while simultaneously boosting carbohydrate intake.

Does it really work — and when do you use it?
Carbohydrate loading does work. Typically, if you are exercising at a steady pace and intensity, carbohydrate loading will increase your endurance by about 20%. For example, if you typically can run 20 miles before exhaustion gets the better of you, with supercompensated glycogen stores you may be able to extend that to 24 miles. Or, if your event calls for you to cover a specific distance, such as is the case with a cycling race or a marathon, carbohydrate loading may improve your time by 2-3%. For a four-hour race, that equates to about 5-7 minutes faster. The general consensus is that carbohydrate loading should be considered for competitive endurance events that last for 90 minutes or more. This is about the length of time it takes for typical stores of muscle glycogen to begin to run low. For events shorter than this, and especially for sprinting events, glycogen depletion isn't really a fatigue factor, and so carbohydrate loading doesn't confer performance benefits.

Loading up for team sports
Soccer, basketball, hockey, and football are all examples of team sports where the exercise is often high-intensity, and the length of play in some circumstances can exceed 90 minutes. These sports can burn glycogen at a high rate, and if played long enough, can result in muscle glycogen depletion and fatigue. Therefore, performance could potentially be improved by supercompensation of muscle glycogen stores. However, the benefit will likely vary based on the position you play. For example, point guards in basketball or running backs in football are more likely to deplete muscle glycogen stores, and may benefit more from carbohydrate loading than other positions in these sports. If you play heavy minutes in your sport, you may want to experiment with carbohydrate loading to see if it makes a difference for you.

Women respond differently than men
Most of the early carbohydrate loading studies were done in males, and the assumption was that the results would apply to females. However, studies in women have produced equivocal results. For example, in one study female athletes didn't supercompensate their muscle glycogen levels when they followed a carbohydrate loading protocol, and not surprisingly, they didn't show a performance benefit. In other studies, supercompensation was achieved, but it didn't translate into a performance benefit.
The menstrual cycle seems to be a factor. Researchers have observed that glycogen storage is likely to be more efficient in the two weeks before menstruation as compared to the week during and after a woman's period. Total energy intake is another complicating factor. On average, female athletes consume fewer calories than their male counterparts. So, even though you may be boosting your carbohydrate intake compared to what you normally consume in order to carbohydrate load, because your total calorie intake is low relative to your male training buddies, you may not actually be getting enough carbohydrates to achieve supercompensation of muscle glycogen stores. You can't do much to influence the timing of your menstrual cycle before an important endurance event, but you can do something about carbohydrate intake. Carbohydrate loading days are definitely not the time to cut calories, In fact, overconsuming calories for the few days that you're carbohydrate loading may be necessary. And of course, make sure all those extra calories come from carbohydrates. For example, instead of consuming 2,000 calories, you may need to consume 2,600 calories for a few days. Those 600 bonus calories equate to 150 extra grams of carbohydrates. In practical terms, that's one cup of oatmeal with raisins, a bagel, and a sports bar. And for those concerned about gaining weight, no worries, the free pass for extra carbohydrates and calories expires after a few days.

Loading carbs means carrying more baggage
Glycogen is stored in muscle with water. That means that if you've effectively supercompensated, you'll be a bit heavier because of the extra water you're carrying. Full glycogen loading can lead to an increase in body weight of around 4 lbs (about 2 kg). But don't worry, the weight gain is temporary -- it will only

last as long as glycogen stores are supercompensated. That said, give some thought to whether an increase in body weight will put you at a disadvantage during competition.

Load now — use it later

If the time between when you complete carbohydrate loading and your competition is a few days, not to worry, your stores will remain supercompensated as long as you continue to eat a high-carbohydrate diet and you rest or engage in no more than light training. In fact, elevated storage levels can be maintained for as long as five days, although a detraining effect is likely to occur if you miss training for this long. The key point is that if a solid day or two of travel is needed to get you to your event venue, and during that time access to extra carbohydrates will be limited, you can complete your carbohydrate loading the day before travel and not lose any of the performance benefit.

The nitty-gritty

Okay, your sport is a high-intensity endurance activity that involves 90 minutes or more of continuous exercise such that heavy demands will be placed on your glycogen stores. If you fit this bill, carbohydrate loading will probably offer you a performance benefit. But you've got to get it right. Carbohydrate loading requires that you consume 3.6-5.5 g of carbohydrate per lb of body weight per day (8-12 g of carbohydrate per kg of body weight). You can either gradually taper your exercise for three days while eating this very high-carbohydrate diet, or rest for a day or two while chowing down on the carbs.

Where athletes commonly stumble is not eating enough carbohydrates. Case in point: If you weight 150 lbs (68 kg), you'll need to consume somewhere between 544-816 g of carbs each day to effectively carbohydrate load. That equates to 2,200-3,300 calories from carbohydrates alone during each day of loading. Eating this much carbohydrate requires some serious strategic planning. A boost in your carbohydrate intake may mean your digestive tract gets deluged with hard-to-digest fiber. A rapid change in the fiber content of your diet can result in symptoms like gas, diarrhea, and stomach discomfort — not what you want leading up to an important competition. To avoid these symptoms, you may need to substitute white or French bread for whole-grain breads and cereals, canned fruit in place of some fresh fruit, and more liquid or semisolid forms of carbohydrates like juices, smoothies, flavored milks, and energy gels and chews in place of the slower-to-digest solid forms of carbohydrates. Also, if piling on the carbohydrates starts to become an overwhelming struggle, take advantage of concentrated carb sources like jams, preserves, honey, hard candies, and soft drinks.

If you only have a day or two to super-maximize your glycogen stores, consume in the range of 4.5-5.5 g of carbohydrates per lb of body weight daily (10-12 g per kg of body weight), but combine that with rest rather than tapered training. Also, when time is of the essence, consume your carbs as soon as possible after your last training session, continue to consume them in small amounts frequently, and select high–glycemic index or readily digestible carbohydrates. Attention to these details may offer a bit of extra benefit. Be sure to practice your carbohydrate loading regimen before a long training session or a minor competition. This will help you become familiar and comfortable with the types and quantities of foods and beverages you'll need to successfully carbohydrate load, and will help you get a sense of the performance benefits you can expect as a result. Finally, Table 1 is an example of a one-day carbohydrate loading menu for a 150-pound (68kg) athlete striving to consume 4.5 grams of carbohydrate per pound of body weight daily (10 grams per kg of body weight), or 675 grams of carbohydrates. Use it as a guide to effectively carbohydrate load for your next endurance challenge:

Breakfast

2 cups dry breakfast cereal (48g carbs)
1 cup nonfat milk (12g carbs)
1 banana (27g carbs)
2 halves toasted English muffin with 2 tbs. strawberry jam (25 + 26g carbs)
8 oz orange juice (26g carbs)
.....164g carbs

Snack

1 sports bar (45g carbs)
1 cup of fresh fruit salad (32g carbs)
8oz sports drink (17g carbs)
.....94g carbs

Lunch

1 turkey sandwich with 2 slices sourdough bread (30g carbs)
1 cup fresh or canned fruit (32g carbs)
16oz sports drink (34g carbs)
.....96g carbs

Snack

16oz fruit smoothie (62g carbs)
5 saltine crackers (11g carbs)
.....73g carbs

Dinner

2 cups noodles with stir-fried chicken (80g carbs)
1 cup broccoli (10g carbs)
1 cup fresh fruit (32g carbs)
20oz soft drink (68g carbs)
.....190g carbs

Snack

1 sports bar (45g carbs)
8oz sports drink (17g carbs)
.....62g carbs

Total: .....679g carbs

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