



Carbohydrate Loading and Exercise Performance

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Background

When I played school rugby towards the end of the 1980's my Dad used to feed me a 500 g T-bone steak about 90 minutes before every game. Recently I read an article published in the Journal of Nutrition stating that, 100 years ago, beef (protein) was the most important component of an athlete's diet.⁵ While there could be some debate as to whether I was considered a "true" athlete in the 1980's, it seems that the Journal of Nutrition has got it wrong, as in my household, beef was the recommended sports supplement of choice up until the end of 1989, only 18 years ago. It wasn't until I started studying Sport and Exercise Science in the early 1990's that I learnt about carbohydrate (CHO) supplementation for improving performance. Carbohydrate supplementation is now big business and the hype around it has ensured that every "serious" sports person, from the weekend warrior, to the Olympic athlete, consumes vast quantities of CHO every day. This article will attempt to provide some guidelines regarding CHO supplementation, some of the latest "scientific evidence" regarding the effect that it has on performance as well as information that individuals should consider before they start a CHO supplementation regimen.

Why is carbohydrate supplementation important?

The depletion of individual's body CHO stores is a major cause of fatigue during exercise.¹ The primary goal of CHO supplementation is to optimise the level of CHO in the muscle and liver.¹ This

ensures that athletes have sufficient glycogen (CHO stores) which can be broken down or metabolised to help produce energy for muscle contraction. The availability of an adequate supply of CHO in working muscles and in the bloodstream is central to an individual's ability to sustain an intensive training load as well as to perform well in competition.¹ For these reasons, athletes are advised to consume CHO before exercise, ensure adequate CHO intake during exercise, and replenish CHO stores as soon as possible after exercise.⁵

Pre-event fuelling (carbohydrate loading)

Carbohydrate loading refers to a strategy that aims to maximise muscle glycogen stores prior to exercise that would otherwise deplete glycogen levels.¹ This has been shown to be a very important practice for sports events such as marathons that last longer than 90 minutes.¹ The "classical" CHO loading model takes place over 7 days prior to an event. This involves a 3-4 day glycogen/CHO "depletion" phase of hard training and low CHO intake, finishing with a 3-4 day "loading" phase of high CHO eating and an exercise taper (reduction of the amount of exercise performed). Recently, a "modified" CHO strategy has become popular amongst athletes. This strategy requires that an individual tapers their exercise and increases CHO intake over 3 days leading up to an event. This has been shown to be a more practical strategy for individuals as the fatigue and com-

plexity of extreme dieting and training are avoided.¹

Carbohydrate loading and endurance event performance

CHO loading does not increase overall running speed but helps maintain race pace during the last part of the run.⁶ Specifically, CHO loading will postpone fatigue and extend the duration of exercise by approximately 20%, and improve performance over a set distance by 2-3%.⁴ The strategy therefore provides substantial improvements in most simple endurance events such as marathons, prolonged cycling and triathlon races. Importantly, shorter events, under 60 minutes' duration, do not show significant performance benefits from CHO loading.⁴

The decision to carbohydrate load

There are various factors for and against CHO loading that need to be considered before a decision to CHO load is taken. The athlete should have a good comprehension of the rationale for loading, the requirements, side effects and practical difficulties associated with achieving an exercise taper and high CHO intake.¹

1) Physiological requirements of the sport

Firstly, the physiological requirements of the athlete's event should be considered.¹ If the exercise is a high-intensity endurance activity and involves more than 60-90 minutes of continuous exercise, then CHO loading is necessary. If the activity is high-intensity but for a short duration (lasting less than 60 minutes), then normal

glycogen stores will be adequate to fuel the event and CHO loading is not necessary.¹

2) Weight gain

It is important that athletes know that CHO loading is often associated with a body mass gain of approximately 2 kg. Activities that involve high-intensity work over a short duration, such as sprint and field events, will be adversely affected by the weight gain.¹ For endurance athletes it has been suggested that the athletes should be advised that the benefits of significantly increasing their CHO stores outweigh the possible disadvantage of the extra weight gain.¹

3) Daily dietary carbohydrate intake

If an athlete's daily CHO intake provides less than 7-8 g CHO/Kg body mass (BM)/day, which has been shown to be associated with reduced glycogen stores, then CHO loading should be considered. In order to maximise the glycogen stores, the following CHO loading regimen is recommended: 3 days of a CHO intake between 8 and 12 g/kg BM/day. With this regimen 70-85% of the daily energy intake will be from CHO.¹ If training or competition schedules do not allow a 3-day CHO preparation, research has shown that athletes are able to increase their muscle CHO stores with 36-48 hours of rest and a carbohydrate intake of 10-12 g/kg/day.¹

4) Medical considerations and potential adverse effects

It is important that there are no medical reasons that might contraindicate a very high CHO diet for a 3 day period. Specifically, if an athlete presents with medical problems such as diabetes or other endocrine disorders (e.g. hyperlipidaemia) or gastrointestinal problems, it is important that advice is

given to the individual to work closely with their dietitian and physician when preparing for competition.¹

It has also been found that some athletes find it difficult to tolerate the higher fibre content of a high CHO diet, particularly if wholegrain and wholemeal breads and cereals and large quantities of fruit are consumed. In order to avoid gastrointestinal symptoms such as flatulence, diarrhoea and gut discomfort, it has been suggested that the individual should rather consume low fibre alternatives such as white bread, plain cereals, tinned and peeled fruit and liquid forms of CHO.¹

5) Type of carbohydrate

In most of the early studies on the effect of CHO loading on exercise performance, glucose was the primary CHO used for supplementation. However, the type of CHO does not appear to be critical, and glucose, sucrose and oligosaccharides have all been shown to be effective in improving endurance capacity.⁷ Importantly, it has been stated that fructose taken in high concentrations should be avoided due to an increased risk of gastrointestinal upsets.¹ Research has suggested theoretical advantages in the use of CHO other than glucose. Specifically, it has been shown that the substitution of glucose polymers for glucose allows for an increased CHO content without an increased osmolality, thereby improving absorption of CHO into the body.¹ However, the available evidence suggests that the use of glucose polymers rather than free glucose does not alter the effect on exercise performance.³ In addition, some research has also suggested that long-chain glucose polymer solutions are more readily used by exercising muscles compared to glucose or fructose solutions.⁸ However, the prevailing evidence has indicated that this is not the case.¹ On the contrary, a mixture of glucose and fructose in equal amounts seems to have the advantage,

causing increased CHO breakdown for energy.¹

Conclusion

Despite the fact that CHO loading is a very well known term and is used regularly in discussions by individuals preparing for endurance events, research has shown that it is difficult for individuals to master this strategy, even its simplified form.¹ Specifically, research has demonstrated that individuals may not have the knowledge to plan an exercise taper and also fail to reach the daily CHO intake targets of 8-12 g per kg BM needed to maximise CHO storage.² For this reason it is important that individuals practice their CHO loading regimen long before their important events, to ensure that they are able to tolerate and achieve the requirements of a CHO loading regimen. sapa

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