CARBOHYDRATE intake during exercise – *how much is enough?*

Dr Galloway and Dr Hamilton discuss the question 'How much carbohydrate is appropriate?' to improve sport endurance performance

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Several reviews, and meta-analyses have been published evaluating carbohydrate intake recommendations to support endurance exercise performance.[1-7] These assessed carbohydrate recommendations for two elements: 1) enhancing the time to complete a work task (performance), 2) enhancing the time for which exercise can be sustained before the point of fatigue (capacity). These reviews highlight an overall moderate positive impact of carbohydrate ingestion on exercise performance/capacity in a variety of exercise situations/durations.

These recent conclusions mirror early studies which reported a positive impact of pre-exercise carbohydrate feeding on delaying fatigue during exercise.[8-10] The replication of these early observations, the extension to feeding strategies during exercise, and the consistent application to sport performance establish a consistent positive effect of carbohydrate feeding before and/or during exercise on performance.

There is no need to question whether or not carbohydrate ingestion improves endurance performance/capacity. Instead, the current questions is: how much carbohydrate is appropriate?

CURRENT RECOMMENDATIONS

A recent position statement[11] suggested the application of the scientific findings on carbohydrate feeding. For carbohydrate feeding during exercise they recommend: no requirement for carbohydrate in events <45 minutes; only small amounts of carbohydrate (including mouth rinsing with carbohydrate) in events lasting 45-75 minutes; 30-60g/h of carbohydrate in events lasting 1-2.5 hours; and up to 90g/h of carbohydrate in events lasting >2.5-3 hours.

For the shorter tasks (<75 minutes) the recommendations are justified. In short events exercise intensity is likely to be very high, and demand for high rates of ATP resynthesis in contracting muscle will lead to carbohydrate being the predominant fuel source. However, at these high intensities, the task duration is short enough to not completely deplete endogenous liver and muscle glycogen stores and therefore additional carbohydrate is unnecessary.

In longer events (1-2.5 hours) the potential for endogenous glycogen stores to become depleted is greater and the need for additional carbohydrate becomes apparent, but what evidence underpins the 30 and 60g/h recommendation?

Smith et al[12] observed that performance in a 20km cycling time-trial task conducted after a two-hour bout of exercise was improved equally by feeding carbohydrate at a rate of 15g/h, 30g/h or 60g/h. Smith et al[13] then conducted a multi-centre study in which they modelled the performance outcomes (two hour ride followed by 20km time-trial) from 51 participants who ingested a placebo drink (no carbohydrate) or three other drinks containing carbohydrate across a wide range of doses (10-120g/h). Their data suggests optimal performance was achieved with a dose of 78g/h. However, doses of 30-50g/h resulted in performance times that were only ~9 seconds slower than the modelled optimal dose of 78g/h. Thus, the difference between 30g/h and 78g/h falls within the error of the performance task measurement.

Our recent work adds to this, as performance gains over a 2.5 hour exercise task were equal with 39 and 64 g/h compared to no carbohydrate.[14] It seems that for exercise lasting approximately 2-2.5 h, 40-60 g/h is likely optimal. Case studies on elite marathoners suggest their intake is in the region of 60g/h.[15] In practice however, many sport nutritionists find that athletes can only cope with doses of up to 40-50g/h. This is possibly related to gastrointestinal problems and highlights the need for individualised feeding approaches. Some emphasis has been placed on improving intestinal transport of carbohydrate using glucose/fructose mixes[16] and training the gut to cope with higher carbohydrate ingestion rates.[17]

Guidelines for longer events (ultramarathons and ironman triathlon) suggest that carbohydrate ingestion rates should be higher still (up to 90g/h). Case studies of elite ultra-distance cyclists and runners suggest that average intake reaches around 60-70g/h but with a wide range (28-145g/h).[18-19] Research demonstrates that it is possible to oxidise exogenous carbohydrate, delivered in glucose:fructose blends, at rates as high as 90g/h[20] and observational data indicates that higher intakes are associated with better performances.[21] However, no study has yet compared 40-60g/h glucose vs 90g/h glucose:fructose blends to see what works best for longer events.

The studies examining carbohydrate dose in events lasting up to 2.5 h demonstrate little benefit to going above 40-60g/h. A balance must be struck between evidence and individual needs of the athlete. However, athletes that can manage intakes as high as 70-90g/h may find a performance advantage.

REFERENCES

1 Stellingwerff and Cox. Systematic review: Carbohydrate supplementation on exercise performance or capacity of varying durations. *Appl Physiol Nutr Metab* 39(9):998-1011. 2014

2 Temesi et al. Carbohydrate ingestion during endurance exercise improves performance in adults. *J Nutr* 141(5):890-7. 2011

3 Vandenbogaerde and Hopkins. Effects of acute carbohydrate supplementation on endurance performance: a meta-analysis. *Sports Med* 41(9):773-92. 2011

4 Newell et al. Impact of carbohydrate nutrition on exercise metabolism and performance. *Agro FOOD Industry Hi-Tech* 25(2):18-22. 2014

5 Jeukendrup. A step towards personalized sports nutrition: carbohydrate intake during exercise. *Sports Med* 44 Suppl 1:S25-33. 2014

6 Karelis et al. Carbohydrate administration and exercise performance: what are the potential mechanisms involved? *Sports Med* 40(9):747-63. 2010

7 Cermak and van Loon. The use of carbohydrates during exercise as an ergogenic aid. *Sports Med* 43(11):1139-55. 2013

8 Krogh and Lindhard. The Relative Value of Fat and Carbohydrate as Sources of Muscular Energy: With Appendices on the Correlation between Standard Metabolism and the Respiratory Quotient during Rest and Work. *Biochem J* 14(3-4):290-363. 1920

9 Christensen and Hansen. II. Arbeitsfähigkeit und Ernährung. *Acta Physiologica* 80:160-171. 1939

10 Bergstrom et al. Diet, muscle glycogen and physical performance. *Acta Physiol Scand* 71(2):140-50. 1967

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