Tri-ing to bridge the gap between evidence and practice: what do *we* know, and what do *they* do?

Oliver Shannon, Dr Lauren Duckworth, Dr Andy King and Dr Matthew Campbell provide an overview of current knowledge on triathlon-specific nutrition as a guide for practitioners and provide insight into the nutritional practices of world-class triathlete Tom Bishop.

Introduction

Olympic distance triathlon is a multi-discipline event, comprising sequential completion of a 1,500 m swim, 40 km cycle and 10 km run, and represents one of the strongest medal chances for Team GB at the 2016 Olympic Games in Rio de Janeiro.

Nutrition is acknowledged as key to successful Olympic distance triathlon performance, both at an elite and recreational level, given the prolonged and arduous nature of this sport. However, direct evidence regarding the efficacy of common nutritional strategies on triathlon performance is lacking, with very few intervention studies employing simulated or 'real-world' models. Consequently, practitioners are often required to make recommendations that are poorly informed, relying upon evidence derived from anecdote or research into single discipline sports (e.g. cycling or running). In this article, we provide a brief overview of current knowledge on triathlon-specific nutrition as a guide for practitioners. Where possible, evidence is presented from 'triathlon-specific' research studies. We also provide insight into the nutritional practices of an elite level triathlete, obtained via interview with world-class triathlete Tom Bishop.

Pre-competition nutrition

Several pre-competition strategies might be warranted for Olympic distance triathlon performance. These include carbohydrate ingestion, caffeine consumption and dietary nitrate supplementation.

Carbohydrate

Traditional carbohydrate loading procedures involve extreme protocols comprising carbohydrate-depleting exercise followed by super-compensation. However, supplementing with a high carbohydrate diet (~7-10 $g \cdot kg^{-1} \cdot d^{-1}$) for 1-2 days appears to be similarly beneficial for endurance performance. Athletes may expect performance improvements of 2-3% during events lasting >90 minutes, suggesting potential benefits for Olympic distance triathlon performance (typical duration 1 hr 45 plus). Ingestion of a high-carbohydrate (100-300 g or 1-4$g \cdot kg^{-1}$) meal 2-4 hours pre-exercise might help increase muscle and/or liver glycogen concentrations, and maintain blood glucose levels throughout exercise, and has been reported to improve exercise capacity, at least relative to fasted exercise. Reports suggest typical triathlon race day carbohydrate intakes of 2.1–3.0 $g \cdot kg^{-1}$ (Jeukendrup *et al.,* 2005).

Consuming a low- versus high-GI carbohydrate meal prior to exercise results in an attenuated blood glucose/insulin response, and may lead to greater fat oxidation and muscle glycogen sparing, although findings have been inconsistent.

Tom Bishop *"I tend to maintain my normal diet in the days before a race, focusing my intake on good sources of carbohydrate. I usually have a carbohydrate snack 2 hours before racing, and have a sports drink/ consume a gel in the hour pre-race. You have to be prepared to be flexible though, especially if racing abroad."*

Caffeine

Caffeine (1,3,7-trimethylxanthine) is the world's most-consumed natural pharmacologic agent, and evidence suggests widespread use by triathletes (Del Coso *et al.,* 2011). Caffeine functions as a stimulant, predominantly via antagonism of adenosine receptors. Through its effects on the central nervous system, caffeine decreases tiredness, increases alertness, improves mood and concentration, enhances reaction time and has demonstrated performance benefits when ingested in doses as low as 3 $mg \cdot kg^{-1}$/~200mg. Athletes are recommended to ingest caffeine 30-60 minutes before competition to coincide with peak plasma concentrations. Doses above 9 $g \cdot kg^{-1}$ should be avoided, given the increased risk of side effects including jitteriness, nervousness, and gastrointestinal distress. Habitual caffeine users are advised to gradually reduce intake 3-4 days before competition, to obtain the desired stimulant effects with pre-competition supplementation; the benefits of which have been reported to outweigh any withdrawal.

Above: Tom Bishop in full flight.
Courtesy of Tommy Zaferes/@TZaferes

Tom Bishop: *"I know that extra caffeine has some performance benefits, but my personal preference is to consume a strong black coffee on race morning. The caffeine helps wake me up, and gives me a buzz for the race."*

Nitrate

Dietary nitrate supplementation (>5 mmol consumed ~3 hours pre-exercise), typically via nitrate-rich beetroot juice, increases nitric oxide (NO) bioavailability, and reduces the oxygen cost of steady-state exercise. Nitrate supplementation has also been reported to enhance short duration (<30 minutes) exercise performance, in untrained and moderately-trained ($\dot{V}O_2max$ <70 $ml \cdot kg^{-1} \cdot min^{-1}$) individuals. Conversely, nitrate appears to be minimally effective during longer duration exercise tests and in highly-trained

endurance athletes, although some well-trained 'responders' have been identified in the literature (Jones, 2014). Whilst direct evidence is lacking, anecdotal reports suggest that nitrate supplementation is widespread in elite triathlon.

Tom Bishop: *"I typically drink two 70 ml beetroot shots per day, for 3-5 days before an important race. You see a lot of professional triathletes consuming beetroot prior to competition."*

During competition

Carbohydrate and fluid

There is a paucity of triathlon-specific guidelines for during competition feeding, however the optimal dose of carbohydrate remains to be established. McGawley *et al.* (2012) reported a significant 4% improvement in run time, when participants were supplemented with ~115 g of glucose+fructose during the cycle-leg of a simulated Olympic distance triathlon. In trained athletes, the demands of Olympic distance triathlon are not likely to fully deplete muscle glycogen stores although increasing exogenous carbohydrate availability will augment the high rate of exercise induced carbohydrate oxidation. Recent recommendations show that 90 g per hour can be particularly beneficial to performance than lower carbohydrate doses, and are supported by our research (King *et al.*, unpublished data), which has demonstrated the potential for this carbohydrate dose to maximise the ability to spare muscle glycogen. To achieve such high ingestion rates, it is necessary to consume carbohydrate in two forms, i.e. glucose and fructose in a 2:1 ratio in order to maximise the transport of carbohydrate across the intestinal mucosa (Jeukendrup *et al.*, 2005). The cycle leg of the triathlon arguably represents the best opportunity for consuming carbohydrate and fluid.

Hydration guidelines for endurance performance are more widely established and accepted. Athletes may be advised to avoid a 2-3% loss in body mass during prolonged exercise, although elite endurance athletes may achieve a greater decrement in body mass despite drinking to the recommended level. Further, the tactical demands of triathlon, such as pace and technical skill, may create difficulty in taking on fluids. It is therefore suggested that elite triathletes follow the practice of elite marathon runners, and drink to thirst or in the region of 0.5 $L.h^{-1}$.

Tom Bishop: *"I try to have a gel or two during the cycle leg of the race, and also ingest a carbohydrate drink whilst on the bike. I'm usually dehydrated at the end of a race, but it isn't always possible or comfortable to take on large amounts during a race."*

Recovery

The primary demands for post-triathlon recovery include restoring hydration status, replenishing muscle glycogen stores and repairing muscle damage. Several strategies have been applied to assist with post-exercise recovery, and considerable recent evidence advocates the use of natural 'functional foods' (e.g. milk and cherries). Optimal nutrition plays a particularly important recovery role when time between competitions is brief, but may be less crucial when athletes have several days/weeks for recovery.

Milk

Milk has a similar carbohydrate and protein content to many commercially available recovery beverages, and is a relatively inexpensive and readily available post-competition recovery aid. Previous investigations have reported improved recovery of exercise capacity and greater post-exercise protein synthesis following chocolate milk ingestion relative to an isocaloric carbohydrate beverage (Lunn *et al.*, 2012).

Cherries

Known to be high in antioxidant and anti-inflammatory compounds, cherries have been reported to aid recovery and reduce muscle damage. Notably, Howatson *et al.* (2010) observed faster recovery of isometric strength and reduced inflammation in marathon runners following prolonged cherry juice supplementation. The effect of cherries and other functional foods on adaptation to intense exercise is unclear, but may be warranted when rapid recovery takes precedence over physiological adaptation.

Summary

Consumption of a high carbohydrate diet in the 2-3 days before competition, and supplementation with caffeine and nitrate in the hours pre-competition, might be beneficial for triathlon performance. Moreover, 'topping up' with additional fluid and carbohydrate during competition, particularly the cycle stage, might be advantageous. Following competition, fluid ingestion, and carbohydrate and protein consumption, might be warranted to restore fluid balance, endogenous glycogen stores, and repair muscle damage. Likewise, anti-inflammatory and antioxidant foods (e.g. berries and cherries, beetroot) may help with recovery. However, current recommendations for triathletes are primarily derived from research conducted into single-discipline sports, and further triathlon-specific investigations are warranted into the type, timing and dose of potentially ergogenic nutritional strategies for Olympic distance triathlon performance. ■

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