



REVIEW

Maximising performance in triathlon: Applied physiological and nutritional aspects of elite and non-elite competitions

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Summary Triathlon is a sport consisting of sequential swimming, cycling and running. The main diversity within the sport of triathlon resides in the varying event distances, which creates specific technical, physiological and nutritional considerations for athlete and practitioner alike. The purpose of this article is to review physiological as well as nutritional aspects of triathlon and to make recommendations on ways to enhance performance. Aside from progressive conditioning and training, areas that have shown potential to improve triathlon performance include drafting when possible during both the swim and cycle phase, wearing a wetsuit, and selecting a lower cadence (60–80 rpm) in the final stages of the cycle phase. Adoption of a more even racing pace during cycling may optimise cycling performance and induce a “metabolic reserve” necessary for elevated running performance in longer distance triathlon events. In contrast, drafting in swimming and cycling may result a better tactical approach to increase overall performance in elite Olympic distance triathlons. Daily energy intake should be modified to reflect daily training demands to assist triathletes in achieving body weight and body composition targets. Carbohydrate loading strategies and within exercise carbohydrate intake should reflect the specific requirements of the triathlon event contested. Development of an individualised fluid plan based on previous fluid balance observations may assist to avoid both dehydration and hyponatremia during prolonged triathlon racing.

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Introduction

Triathlons are held over a variety of distances, the four most common being the Sprint (750 m swim, 20 km bike, 5 km run), Olympic (1.5 km swim, 40 km bike, 10 km run), half-Ironman (1.9 km swim, 90 km bike, 21.1 km run) and Ironman (3.8 km swim, 180 km bike, 42.2 km marathon run) distance triathlons. More recently, 'Grand Prix' style events have been conducted where athletes complete multiple swim-bike-run or different combinations of shorter distances in swimming, cycling and running in a continuous or discontinuous fashion. Hence the diversity of event duration and specific characteristics in triathlon results in a variety of physiological constraints and nutritional requirements. The physiological and technical attributes of successful triathletes over varying distances have been reviewed elsewhere.^{1–4} The purpose of the present review is to examine the scientific literature relevant to short and long-distance triathlon and to provide contemporary recommendations for maximising triathlon performance. The article will identify key elements for performance improvement in Sprint, Olympic distance and long-distance (half-Ironman and Ironman) triathlon.

Swimming performance

Swimming performance tends to be of greater importance in cycle draft-legal Sprint and Olympic distance triathlon events compared with half-Ironman and Ironman events where drafting during the cycle phase is not legal.⁵ This is due to the fact that the energy required in cycling when drafting is reduced by about 30%.^{6,7} Thus, slow swimming performance at the elite level can be detrimental to overall triathlon performance irrespective of cycling and running ability. While the variation in swimming performance of

elite triathletes is generally small compared to that of recreational athletes, longitudinal observations of swimming performance in the top 20 elite triathletes in the world compared to that of the remaining field indicate that swimming performance is especially crucial in Olympic distance events (Vleck et al., unpublished). Swimming performance can however be influenced by the wearing of a wetsuit, as well as drafting during the swim.

Wetsuits and performance in swimming

Aside from any thermoregulatory effects, the most significant motivation for using a wetsuit is to improve performance velocity.⁸ This is due largely to the positive buoyancy and hydrostatic lift effects that a wetsuit makes during swimming^{8–11}; with performance improvements upwards of 5%.^{8,9} However this effect diminishes as ability level in swimming increases⁹ making performance benefits greater for lower ability swimmers. Wearing a wetsuit may also conserve energy^{8,9} and has been shown to be associated with an improvement in subsequent cycling performance.¹² These effects may influence a triathlete's tactical approach and might influence race selection in wetsuit versus non-wetsuit events. While wearing a wetsuit has been shown to impact the stroke kinetics of a swimmer,^{10,13} the influence of training with a wetsuit on subsequent swimming performance is not known. Furthermore, little is currently known regarding changes in swimming efficiency and stroke characteristics with alterations in swim distance. It is possible that wearing a wetsuit may be more beneficial in events of longer duration where the velocity is slower, and resulting body position and buoyancy are lower. That aside, it is likely that triathletes will benefit from training in a wetsuit, especially at swimming speeds that approximate race pace.

Drafting in swimming

A number of studies have examined the effects of swimming on cycling performance.^{12,14–17} These studies demonstrate that overall cycling performance may be hindered by short-duration high-intensity swimming,^{16,17} but may have less influence with longer duration lower-intensity swimming.¹⁵ Drafting during the swim stage of the triathlon will occur irrespective of swim distance or fitness level. Drafting during swimming, by swimming behind or slightly to the side of a leading swimmer (common to mass-start triathlons), is a tactic that has been shown to decrease passive swimming drag,¹⁸ resulting in either an ability to swim faster,^{18–22} conserve energy and/or improve subsequent cycling performance.^{23,24} Drafting during swimming also results in a lower metabolic response, as evidenced by a reduction in blood lactate concentration, oxygen uptake ($\dot{V}O_2$) (reflecting improved economy) and rating of perceived exertion when swimming at the same absolute velocity.^{18–20} Drafting behind a lead swimmer improves swimming economy through modification of stroke parameters such as stroke rate and distance per stroke.^{18,19,22} By drafting, triathletes may induce a 'metabolic reserve' when exercising at the same relative velocity in a drafting position.^{18,19} Some studies demonstrate that drafting in swimming results in an improvement in pedalling technique and efficiency during cycling.²³ This is probably the result of the energy saved during swimming when in a sheltered position. However whether drafting is of benefit in terms of improving absolute performance level in the subsequent cycle stage or for the remainder of the race is not entirely known. A recent study has demonstrated that the average power during a 30 min time trial is improved after swimming in a drafting position compared with swimming in isolation.²⁴ The change in swimming performance when drafting is known to be ~5% and is higher in leaner athletes.¹⁸ This improvement is significant in the context of elite sprint or Olympic distance triathlon, as it may result in an athlete exiting the water more proximal to a group of athletes prior to the cycle stage. This has obvious tactical implications that should be emphasised in race preparation and training.

During the swimming stage of a triathlon, athletes are able to change position and draft beside or behind another swimmer. At the same time, kicking frequency may vary from one swimmer to the next, and this may affect the turbulence encountered by a drafting swimmer. Only a few studies have examined these parameters and their effects

on performance. In one study it was shown that there was no advantage to drafting behind an athlete with a two-beat rather than a six-beat kick, even if passive drag is lower behind the two-beat kick swimmer.²¹ Recently however, the effects of different drafting positions on swimming performance have been compared.²² These authors examined the influence of drafting distance (0, 50, 100 and 150 cm behind a lead swimmer) and from the side (40 cm laterally). It was shown that drafting 0–50 cm behind resulted in the largest performance benefit, although all strategies improved swimming performance. However studies concerning the effects of drafting on swimming performance were conducted in a swimming pool and behind only one drafted swimmer, which may be different to an open water situation. While it may be beneficial for a triathlete to practice drafting in training to optimise race performance, it may not be necessary in competition to swim as close as possible behind another swimmer to optimally improve swimming performance.

Factors influencing running after cycling in triathlon

The relative importance of running in triathlon is emphasised by the large variability in running performances compared with swimming and cycling, particularly in events with draft-legal cycle stages.^{5,25} This may be related to its position as the final stage of the triathlon. As such, running performance in triathlon can be further complicated by the contribution of an athlete's preceding effort in the swimming and cycling stages of the event.

Previous research has shown that a slow rise in the metabolic cost of exercise occurs when performing prolonged constant high-intensity exercise.^{26,27} More specifically, the energy cost of running (C_r) at the end of a triathlon in both well-trained and recreational triathletes is significantly higher compared to the running component of a triathlon in isolation.^{28–32} However, conflicting results have been reported in studies that have examined this.^{33,34} Millet and co-workers³³ compared C_r following cycling in international-elite versus regional-national level triathletes and found a greater detrimental change in C_r following cycling in the regional-national level group.³³ In another study from the same laboratory, both junior and senior international-elite triathletes showed no difference in their C_r following a high-intensity cycling bout.³⁴ Therefore, it appears that high-intensity cycling can have a detrimental effect on subsequent running performance; however, the effects may be dependent on the level of athlete, with

greater effects on recreational athletes and minimal effects on international-elite athletes. In a practical sense, this means that elite triathletes may be able to maintain a higher relative intensity during the cycling stage of a triathlon with minimal affects on their overall performance compared to recreational athletes. Of additional importance is whether elite triathletes have a basic ability to perform running efficiently after cycling or whether training comprising cycle-run repetitions can improve this skill. In one study it was shown that multiple high-intensity cycle-run repetitions improved cycle-to-run transitions compared to normal cycle and run training in isolation.³⁵ Apart from this study, little is known regarding the effect of specific training on cycle-to-run performance in well-trained triathletes.

Drafting during the cycle stage of an elite triathlon presents a unique opportunity for athletes to reduce relative intensity during this phase of the event. In cycling, the energy expenditure and forward motion are linked to the effects of gravity, rolling resistance and frontal (air) resistance. Frontal resistance and consequently energy expenditure are reduced by drafting behind another cyclist or group of cyclists; the extent to which this occurs being influenced by the physical characteristics of the athlete and the biomechanical characteristics of the bicycle. Drafting during the cycle stage of a simulated triathlon has been shown to result in a significant metabolic savings, which influences subsequent running performance.^{6,7} Hausswirth et al.⁶ have shown that $\dot{V}O_2$, pulmonary ventilation ($\dot{V}_E$), heart rate (HR) and blood lactate concentration were lower during 20 km of cycling in a drafting position compared to cycling alone, and subsequent running performance was improved by 4%.⁶ In a follow-up study, Hausswirth et al. showed that the metabolic cost of alternating the lead with another cyclist compared with cycling alone was similar,⁷ and that athletes who were able to draft continuously during the cycle phase showed running improvements of 4% compared with cycling alone or alternating with one other cyclist.⁷ Furthermore, cycling behind a pack of eight cyclists has been shown to result in a larger decrease in the energy cost of cycling compared to drafting behind one, two or four cyclists.³⁶ An interesting aspect of these studies is that increases in physiological stress ($\dot{V}O_2$, $\dot{V}_E$ and HR) can be maintained by subjects during the running stage following cycling in a sheltered position. Therefore it is possible that triathletes are able to maintain a higher metabolic rate due to the energy savings accrued from drafting during the cycling stage, suggesting that the metabolic

cost (i.e., intensity) of triathlon cycling is directly related to subsequent self-paced running performance.

Given the fact that cycling intensity influences running performance and that pedalling frequency and exercise intensity vary considerably in elite Olympic distance triathlons, there are two related and important questions: (1) can cycling cadence have an impact on subsequent running performance and (2) what are the effects of steady-state compared to variable-intensity cycling strategies on subsequent running performance?

Cadence selection has been shown to influence metabolic responses and performance during a variety of cycle-run performances.^{37–40} However previous research has shown conflicting results for the effect of cadence selection on the maximisation of running performance. The relationship between a range of cadences (50–110 rpm) and $\dot{V}O_2$ in well-trained triathletes during a 30 min cycling bout was assessed by Brisswalter et al.⁴¹ While the most energetically optimal cadence was initially 70 rpm (during 3rd–6th min), optimal cadence tended to rise with increases in exercise duration and $\dot{V}O_2$ drift and was 86 rpm towards the latter end of the test (during 25th–28th min).⁴¹ Vercruyssen et al.³⁹ found that a low cadence (73 rpm) reduced $\dot{V}O_2$ compared to a selection of higher cadences (80–90 rpm) and the benefits of adopting a low cadence have been shown even when adopting this strategy late in the cycling stage.³⁹ Running time to fatigue at 85% of maximal velocity was significantly increased by adopting a slow cadence (74 rpm) for the final 10 min of a 30 min cycling bout compared to continuing with a freely chosen cadence (94 rpm) or using a high cadence (109 rpm) for the final 10 min.⁴⁰

Bernard et al.³⁷ reported a significantly higher $\dot{V}O_2$ during running after cycling at 60 rpm and the mean 3000 m run time was 4.3 and 12.0 s faster in the 60 rpm condition compared to 80 and 100 rpm conditions, respectively. However these differences were not significant. There is only one study that has reported benefits from high cadence conditions. Gottschall and Palmer³⁸ reported an improvement in 2-mile running performance following 30 min of high-intensity cycling with a cadence of 109 rpm compared to 90 and 71 rpm conditions. However, the results from this study should be read with caution as cycling efforts were matched for HR, rather than power output. Previous studies have reported HR values 10 bpm higher during cycling at 110 rpm compared to the same power output at 80 rpm.⁴¹ It is possible therefore that the high cadence group did not produce the same amount of external work. Another point to consider in this study is that 2-mile

running performance was conducted at the same HR as the control running condition, rather than as a maximal running trial. Overall, there seems to be good support for triathletes to utilise a lower (60–80 rpm) cadence for at least the final stages of the cycling stage in order to maximise running performance. That aside, there is great variation in cadence (high or low) and work intensity during the cycle stage of an elite draft-legal event,⁴ and for optimal performance, these variations should be replicated in training to mimic competition conditions.

The introduction of draft-legal cycling into elite Olympic distance triathlon has made for highly variable cycling stages compared with non-drafting events. The effects of steady-state cycling versus stochastic cycling was first investigated by Palmer et al.,⁴² who assessed 20 km cycling time trial performance following 150 min of constant (58% of peak power output; PPO) or variable ($58 \pm 12.2\%$ of PPO) cycling. While HR was not different between the 150 min or 20 km time trial segments of both trials, time to complete the 20 km time trial was significantly faster, and mean power output was significantly higher in the constant load condition. In a second, more in-depth study by the same research group,⁴³ average physiological variables ($\dot{V}O_2$, HR, ratings of perceived exertion, and energy expenditure) were again similar following 140 min of steady state (58% of PPO) or variable riding ($58 \pm 13\%$ of PPO). While no significant difference was found in 20 km cycling time trial performance, average performance times were 80 s faster in the steady state group.⁴³ While the variable-intensity group appeared to utilise a greater proportion of anaerobic energy and conserve a larger portion of their aerobic system, this appeared to have only a small affect on time trial performance.⁴³

A more recent study has assessed the effects of a variable intensity (alternating every 5 min from 20% above or below 90% of lactate threshold) or a steady state (90% of lactate threshold) 30 min cycling bout on subsequent treadmill run time-to-exhaustion (85% of maximal aerobic velocity).⁴⁴ During cycling, no significant differences were detected in average values of $\dot{V}O_2$, respiratory exchange ratio, or HR between the controlled or variable conditions. However, run time-to-exhaustion was significantly improved in the variable condition.⁴⁴ The authors concluded that the low-intensity nature of the final portion of the cycle stage was responsible for the conflicting results. In the other two studies investigating the effects of variable-intensity cycling, athletes finished the initial cycling phase with a high-intensity segment.^{42,43} Hence it is recommended that the final section of the cycle stage

be performed at a lower intensity to optimise running performance; however this is unlikely to occur in practice, as athletes typically jostle for position upon nearing the cycle-to-run transition.

There is little research conducted in the laboratory that has examined pacing strategy in cycling to maximise run or overall triathlon performance. One study suggests that at least in a sprint event, the cycle stage (20 km) should be performed as maximally as possible to optimise overall triathlon performance.⁴⁵ More research is required in this area to investigate manipulation of exercise intensity at different stages of the cycle phase and how this may impact on cycling and cycle-run performance.

Overall it appears that drafting, cycling cadence and the variable nature of the cycling stage of an elite Olympic distance triathlon are all factors that can influence running performance after cycling. Triathletes may be able to improve running performance by whenever possible: (1) drafting behind as many athletes as is practical (in draft-legal events); (2) adopting a cycling cadence of between 70 and 80 rpm; and (3) concentrating on reducing effort during the final minutes of the cycling stage to prepare for the run.

Special considerations for the Ironman triathlon

While a multitude of considerations particular to the Ironman triathlon have been identified,^{3,46} the focus of this section will be the issue surrounding exercise intensity and pacing. The Ironman triathlon is completed in times approximating 8 h for the elite professional, to 17 h for less-trained individuals. Hence the physiological demands and nutritional requirements will be especially different compared to the shorter triathlons. Field-based research has shown that well-trained triathletes perform the cycle phase of the Ironman triathlon at 80–83% of maximum HR^{47,48} and 55% of PPO,⁴⁹ with laboratory simulations suggesting a metabolic intensity of around 55% of $\dot{V}O_{2peak}$.^{50,51} Ironman triathlons are also generally performed with a positive pacing strategy, whereby exercise intensity (and speed) is highest at the beginning of the event and lowest near the finishing stages.⁴⁹ For example, 6–7% reductions in HR have been reported during both the cycle and run phases in field-based Ironman triathlons.^{48,50,51} This observation suggests that performance might be bettered through the adoption of a more even pacing strategy. Indeed, Laursen et al.⁴⁷ showed that HR during the cycle and run phases (148 ± 9 and

143 ± 13 bpm) approximated that of HR corresponding to the first ventilatory threshold (VT₁) (146 ± 12 and 148 ± 15 bpm; $r = 0.66$ – 0.76). Moreover, differences between average HR during the cycle phase and HR corresponding to VT₁ were related to marathon run time ($r = 0.61$; $P < 0.01$) and overall Ironman triathlon time ($r = 0.45$; $P < 0.05$).⁴⁷ This finding suggests that triathletes exercising below VT₁ during the cycle phase of this study tended to have faster marathon run times and faster overall Ironman triathlon times. While these findings might not be transferable to the elite Ironman triathlete, they do suggest that it may be beneficial for recreational Ironman triathletes to lower exercise intensity below their VT₁HR during the cycle phase in order to maximise marathon run performance, a stage which has consistently been shown to be the most important factor dictating overall Ironman triathlon performance time.^{47,50} Exercise intensity below VT₁ may spare stored carbohydrate (CHO) and reduce disruption of intramuscular ion gradients, enabling maintenance of exercise intensity during the latter stages of prolonged ultra-endurance racing.³ Indeed, HR is generally seen to fall after 90–120 min of marathon running in an Ironman,⁴⁷ a fatigue-related observation likely due to the combined effects of depleted muscle glycogen stores, eccentric-induced muscle damage, dehydration, and a multitude of other fatigue-related ailments associated with ultraendurance exercise.³

Nutrition and hydration strategies for triathlon

Nutritional strategies and considerations for training

Elite and age-group level triathletes are faced with a range of obstacles in meeting daily nutrient and fluid requirements as a direct result of daily training commitments. Residual fatigue from training, reduced appetite following intense training sessions, inadequate planning and lack of access to appropriate foods and fluids make it difficult for time-poor triathletes to meet added energy, nutrient and fluid demands associated with heavy training.^{52,53} For many triathletes, this situation is further complicated by the added pressure of organising access to appropriate food and fluids around work (study) and/or family commitments.⁵⁴

Triathletes routinely undertake ~20 h per week of training and regularly train more than once a day in order to optimise performance across

three individual sport disciplines.⁵⁵ In order to assist triathletes in meeting daily energy and nutrient requirements to match daily training needs, specific nutrition education should be undertaken to ensure triathletes are skilled at manipulating daily energy and nutrient demands to reflect daily training loads.⁵³ Further benefit may be gained by including a fortified, energy and nutrient dense meal supplement during periods of heavy training.⁵²

The importance of managing body weight and body composition for a triathlete is influenced by the level at which the athlete competes and the specific triathlon distance raced. Landers et al.²⁵ found slower total race times and run times were related to increasing levels of adiposity in elite level Olympic distance triathletes. Thus, dietary advice aimed at enhancing daily training performance and facilitating recovery between training sessions should be modified accordingly. A varied diet, focused on nutrient-rich foods and fluids that is adjusted in response to daily training loads may assist triathletes in avoiding extreme dietary behaviours such as severe energy restriction, reduced variety of foods and use of strict dietary rules.⁵⁶

Most triathletes express a keen interest in the benefits of optimising their dietary intakes to enhance exercise performance,⁵⁷ with many knowledgeable about nutrition.⁵⁸ Accompanying this interest and knowledge, is a heightened awareness and use of dietary supplements and nutritional ergogenic aids.⁵⁸ Triathlon magazines are littered with advertisements promoting supplements for health and enhanced exercise performance. Although some dietary supplements and nutritional ergogenic aids have a legitimate use to support exercise performance, triathletes should be educated about the risks involved in taking supplements.

Nutritional strategies and considerations for competition

The importance of nutrition strategies that can be employed in preparation for, immediately prior to, during or after a triathlon competition will be influenced by the duration of the event, training status and training age of the athlete, and the environmental conditions in which the triathlon event is held. It is well established that CHO-loading improves exercise performance in single modality endurance exercise such as running and cycling.^{59,60} For athletes undertaking ultraendurance triathlon events, the challenge in the final days leading into an event is to

achieve recommended daily CHO intakes of 10–12 g of CHO kg BM⁻¹. Due to their habitually low energy intakes, female competitors in ultraendurance triathlon events may need to increase both their usual energy and CHO intake leading into an event in order to CHO-load effectively.⁶¹

Unlike other athletes competing in events lasting approximately 2 h (such as marathoners), elite Olympic distance triathletes rarely undertake a formalised CHO-loading plan prior to competition (Cox, unpublished observations). With a reduced training load leading into an event, maintaining regular food intake may be sufficient to increase muscle glycogen stores for athletes competing in high-intensity multiple modality events such as the Olympic distance triathlon.

Historically, guidelines for CHO ingestion during endurance sports have been based on studies investigating maximal rates of exogenous CHO oxidation. Jeukendrup and Jentjens⁶² recommend athletes consume 1.0–1.1 g min⁻¹ or 60–70 g h⁻¹, however more recent research has shown that oxidation of exogenous CHO can be as high as 1.5 g min⁻¹ of CHO.⁶³ These maximal CHO oxidation rates are reflective of studies investigating nutritional intake practices of triathletes competing in Ironman triathlon events.⁶⁴ Kimber et al.⁶⁴ assessed food and fluid intakes of 18 triathletes competing in the 1997 New Zealand Ironman triathlon. Hourly CHO intake was higher during the cycle (1.5 ± 0.6 and 1.2 ± 0.3 g kg⁻¹ h⁻¹) compared to the run (0.6 ± 0.2 g kg⁻¹ h⁻¹, $P < 0.001$ and 0.8 ± 0.3 g kg⁻¹ h⁻¹, $P < 0.05$) for males and females, respectively. Interestingly, a positive relationship was observed for total CHO intake and cycle CHO intake with finishing time for female triathletes, whereas run CHO intake relative to body weight and time showed a negative relationship with finishing time for males.

In sprint distance and Olympic distance triathlon events, where there is limited opportunity for ingestion of CHO and an increased possibility for GI distress during the race in response to CHO gel, food and fluid intake, it is worth considering whether lower amounts of exogenous CHO will enhance exercise performance. Studies more recently have demonstrated that high-intensity endurance exercise performance is improved with small amounts of CHO (~ 10 g h⁻¹)⁶⁵; with 1 h cycling performance studies reporting improved exercise performance by rinsing the mouth with a CHO containing fluid.⁶⁶

A high incidence of gastrointestinal complaints have been reported in triathletes during train-

ing and competition, particularly during the run leg of a triathlon.^{58,63,67} Eating close to the start of exercise, consuming high-fibre foods in the pre-race meal, consuming higher intakes of protein and fat on race day and ingesting beverages of high osmolality during the race increase the likelihood of developing a gastrointestinal complaint during exercise.⁶⁷ Triathletes, particularly those competing in longer triathlon events such as Ironman triathlons, are faced with the dilemma of ingesting food and fluids during the run to support optimal performance in the latter part of the race despite the risk of gastrointestinal disturbances.

Fluid intake guidelines for athletes competing in triathlon should reflect the unique circumstances and specific challenges athletes face in each of the triathlon events. The recent guidelines for the consumption of fluid during exercise state that “the goal of drinking during exercise is to prevent excessive dehydration (>2% body weight loss) and excessive changes in electrolyte balance from compromising performance and health”.⁶⁸ Failure to follow these guidelines may lead to voluntary dehydration, rises in core temperature, and the potential for the development of a life-threatening heat injury.⁶⁹

Interestingly, in Ironman triathlon events where the intensity of exercise is lower and there is ample opportunity for fluid intake, drinking to levels that balance body mass losses may increase the risk of developing hyponatremic encephalopathy.⁷⁰ The incidence of hyponatremia appears to be more common in women, and in longer competition events where competitors have greater opportunity to drink to excess.⁷⁰

To avoid the deleterious effects of drinking too much or too little during exercise, triathletes should develop an individualised fluid intake plan for competition based on previous fluid balance observations in training. Developing an individualised fluid intake plan provides the added benefit of allowing an athlete to plan their CHO intake, particularly if they plan on consuming CHO containing beverages throughout a race. When assessing fluid balance (based on changes in body mass) in ultraendurance events such as Ironman, an allowance should be made for metabolic fuel losses.⁷¹ The timing of fluid consumed may be an important consideration for triathletes competing in Olympic distance triathlon events as a recent study demonstrated that athletes had faster run times when fluid was consumed early during the cycle leg of a simulated triathlon event.⁷²

Summary

In summary, outside of any individualised and race specific conditioning, there are particular areas within the triathlon where athletes can make choices that will affect their overall performance. Areas we have identified include drafting whenever possible during both the swim and cycle phase, wearing a wetsuit during wetsuit-legal races, and selecting a low cadence (60–80 rpm) in the final stages of the cycle phase. Adoption of a more even racing pace during cycling lowers exercise intensity and may spare a “metabolic reserve” for improved subsequent run performance in triathlons. Daily energy intake should be modified to reflect daily training demands to assist triathletes in achieving body weight and body composition targets. Carbohydrate loading strategies and within exercise carbohydrate intake should reflect the specific requirements of the triathlon event contested. Finally, development of an individualised fluid plan based on previous fluid balance observations may assist to avoid both dehydration and hyponatremia during prolonged triathlon racing.

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