

Nutrition for Long-Distance Triathletes: Facts and Myths

Ernährung für Langstrecken-Triathleten: Fakten und Mythen

Summary

- › **Long distance triathlon** (i.e. half- or full ironman distances) brings specific nutritional challenges and extra attention is necessary for optimal fueling when training six to eighteen hours weekly, especially among age-group athletes who juggle training, work and family life.
- › **In the first section** of this narrative review we discuss optimal body weight and energy availability, the instances where carbohydrates or fats should be preferred during training, the effects of high-fat/low-carb diets and the role of protein, micro-nutrients and ergogenic supplements in endurance sports.
- › **The second part of this paper** describes optimal nutrition and hydration strategies for racing. The specific format of the race necessitates careful planning of food and fluid intake to meet the large amounts of energy required to complete a full or half-ironman triathlon.
- › **Most of the refueling takes** place on the bicycle, which has a longer duration but also offers the opportunity to chew and drink properly while in a seated position. Gastrointestinal distress affects 14-30% of triathletes, and training the gut is of utmost importance to allow for sufficient food and fluid intake. Indeed, entering the run in a depleted nutritional state will most likely force the athlete to slow down in order to finish the race.

KEY WORDS:

Endurance Sports, Body Weight, Carbohydrates, Fats, Hydration

Zusammenfassung

- › **Der Langdistanz-Triathlon** (halbe oder ganze Ironman-Distanz) bringt besondere Ernährungsherausforderungen mit sich. Für Athleten, die über sechs bis achtzehn Stunden pro Woche trainieren, ist zusätzliche Aufmerksamkeit für die Optimierung der Nahrungsaufnahme unbedingt nötig, insbesondere in „Age-Groupers“, die Training, Arbeit und Familie balancieren müssen.
- › **Im ersten Abschnitt** dieses „Narrative Reviews“ besprechen wir für den Bereich Ausdauersport die Optimierung von Körpergewicht und Energieverfügbarkeit, wann Kohlenhydrate und wann Fette während des Trainings bevorzugt werden sollten, die Auswirkungen einer „High-fat/low-carb“-Ernährung sowie die Rolle von Protein, Mikronährstoffen und leistungsfördernden Nahrungsergänzungen.
- › **Der zweite Teil des Artikels** beschreibt optimale Ernährungs- und Hydratationsstrategien am Wettkampftag. Das spezifische Format des Triathlons erfordert eine sorgfältige Planung der Nährstoff- und Flüssigkeitszufuhr, um die großen Energiemengen zu decken, die im Rahmen eines (Halbdistanz-)Triathlons nötig sind.
- › **Der größte Teil der Nährstoffzufuhr** findet beim Radfahren statt, das nicht nur länger dauert, sondern auch die Möglichkeit bietet, im Sitzen zu kauen und zu trinken. 14-30% aller Triathleten werden von Magen-Darm-Beschwerden getroffen. Daher ist es wichtig, die Verdauung zu trainieren, um eine ausreichende Nahrungs- und Flüssigkeitsaufnahme zu erreichen. Ein Nährstoffmangel bei Anfang des Wettlaufs wird höchstwahrscheinlich den Athleten zwingen, langsamer zu laufen, um ihn zu vollenden.

SCHLÜSSELWÖRTER:

Ausdauersport, Körpergewicht, Kohlenhydrate, Fette, Hydratation

Introduction

With its increasing popularity over the last decade, and its unique format where age-group athletes can compete together with professionals, male and female, triathlon draws a heterogeneous crowd. In 2019, race times ranged from less than eight to more than 17 hours for the Ironman World Championship in Kona, and from less than four to

more than eight hours for the Ironman 70.3 World Championship in Nice.

Nutrition advice for training and racing must therefore be tailored to the abilities and goals of the athlete. In this paper, we will focus on athletes participating in long distance triathlon, (i.e. the half and full ironman distances). ➤

REVIEW

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Nutrition Strategies for Optimal Training

Extra attention is necessary when training more than six to eight hours weekly, especially with two or more training sessions the same day. Athletes can find it difficult to meet their nutritional needs as they juggle training, work and family life.

The primary goal for any endurance athlete is to meet their energy needs, which vary between 50 and 80 kcal/kg/day (29). This wide range is due to individual variations in training and energy efficiency in the three sports, therefore a pragmatic approach for age-groupers is to monitor their weight: a stable, normal weight is a good indicator, as long as the weighing is performed regularly (once a week) in similar circumstances (usually after an overnight fast). Experience shows that variations within 2 kg are not alarming and can be related to the measurement itself, or circumstances such as heavy training or racing the day before (dehydration or muscular oedema), a full bowel, alcohol consumption or carbo loading (both of which promote water retention). However, consistent (i.e. at least two weeks in a row) weight gain or loss should be taken seriously and trigger corrective measures.

Weight

Many endurance athletes strive for a low body weight, which they associate with better performance. While carrying excessive weight can indeed be an impediment, an insufficient body weight, and specifically very low body fat, puts the athlete at risk regardless of their performance level. These risks include low energy storage, reduced immunity, increased risk of injuries such as stress fractures, general fatigue and suboptimal training abilities, as well as a mental strain to control food intake. Relative energy deficiency in sport (RED-S) is the extreme manifestation of insufficient intake, but health issues can happen at any level of food restriction (26).

Nevertheless, striving for a low body fat mass has become a prevalent strategy for improving performance among triathletes, despite evidence showing limited impact on performance. In a sample of 209 participants (155 males, 54 females) competing in a half-Ironman, Gilinsky et al. found that, despite a significant difference in percent body fat between the fastest and slowest men, anthropometrics did not predict performance when other variables were taken into account (14). In women, there was no difference in percent body fat between the fastest and slowest groups. In this study, anthropometric variables had less impact on race performance than expected, similarly to a study on full-Ironman competitors (24). The differences in body fat percentages between the fastest and the slowest group were small (18.0±4.2 vs 18.9±4.5 in females and 8.9±4.2 vs 11.9±4.1 in males) and could explain these results, suggesting that, once low body fat is achieved, a further reduction would result in a limited benefit in performance, if any.

In case of overweight however, weight loss can become a priority as long as there is sufficient time to attain this goal safely. The strategies aiming for rapid weight loss followed by athletes competing in weight-regulated sports would be counterproductive in an endurance event. For a triathlete, the process of weight loss should be monitored by a sports dietician and include attention to the following:

- Timing: rapid weight loss can affect performance for several reasons, including excessive loss of fat free mass, suboptimal training sessions due to insufficient energy availability and psychological burden related to excessive control over eating (26, 27).

- Energy intake: weight loss can only be achieved if the energy intake is lower than the output, but because the latter reaches higher levels among triathletes than the general overweight population, the intake deficit should be more conservative than the usual guidelines (e.g. 500-700 kcal/day) (27).
- Protein intake: in order to avoid the excessive loss of fat free mass, it is advised to consume 1.5 to 2 g of protein/kg of body weight (27, 38).
- Training in a fasted state: this may improve body weight loss, but there is few evidence that it is more effective than a daily energy deficit. Moreover, training in a fasted state, or with low energy availability may impair training effectiveness and thus decrease exercise performance (53).

Carbohydrates and “Train Low”

Carbohydrates are the main substrate used by the muscle during efforts which intensity equates or exceeds 65% $\dot{V}O_2$ max exercise, i.e. the major proportion of the training time in triathlon (5, 40). Currently, the guidelines recommend between 6 and 10 g of carbohydrates per kg of body weight per day, according to the frequency and intensity of weekly training (47). This allows for optimal storage of glycogen in the muscles and the liver in order to perform the requested training. Practically, this means that sources of carbohydrates (mostly starches) should be present during each meal and that snacks (starches, fruits or dairy) should be used throughout the day to complete the intake (6). Proper hydration is also of importance to allow for glycogen storage.

Strategies for optimal refuelling after training are useful if several sessions take place the same day. These include the consumption of 1 to 1.2 g CHO /kg of body weight per hour at frequent intervals during 3 to 5 hours after the session (23). When carbohydrate intake is suboptimal, which can be the case due to lack of time, low appetite or the attempt at weight loss, the intake of several smaller portions (6), as well as the addition of 20 g of protein (in the form of food or supplements) can increase glycogenic synthesis (20, 23). However, the depleted state of muscular glycogen after a training session sets the condition for optimal storage, which will take place whatsoever over the next 24 hours if meals including carbohydrates are consumed (23).

Most often, the nutritional goal is to start each training session with an optimal amount of glycogen on board, but periodized nutrition is an exception to this rule. Also known as “train low” (i.e. with low glycogen stores) this modality may improve metabolic and muscular adaptation to endurance (2, 28). Many endurance athletes thus perform training sessions after an overnight fast, hoping to increase performances by changing their fuel substrate selection. Only a few studies have examined this strategy’s effect on physical performances and the results are inconclusive (53). In addition, this highly specialized procedure can backfire when it is performed carelessly, by increasing fatigue and risk of injury (2). Athletes, especially those with limited experience, should be warned against a chronically depleted state, which can lead to low energy availability and even RED-S (48), especially as the (marginal) gains might not be of great importance for most age-groupers.

Fats and High-Fat/Low-Carb Diets (HFLC)

Some triathletes disregard fats, believing they will increase their body weight, while others adopt the “high-fat/low-carb” (HFLC) in the hope to improve their performance. The fact is that the intake of sufficient essential fatty acids is necessary for proper body functioning, and that fats contribute in

a useful way to the daily energy needs of the training triathlete. Despite the lack of research, it is advised to consume no less than 20% of total energy intake (47). Athletes who limit their intake should devote special attention to the quality of fat sources as to provide liposoluble vitamins and an optimal mix of fatty acids.

Insufficient fat intake is clearly deleterious to performance. But what about high fat intake? Although public health recommendations advise to consume fat in moderation (i.e. 30 to 35% of total energy intake (12)), the high-fat/low-carb diet (ketogenic or not) has gained popularity in the world of endurance sports. The belief surrounding this practice is that, because its effect on improved fat oxidation, a diet with low carbohydrate content will help sparing the glycogen during exercise and enhance endurance as well as performance. However, numerous studies have shown that, despite an increase of mitochondrial density and fat oxidation, performance drops when exercise is performed at intensities >75% of maximal aerobic capacity – which is not rare when training for a half or even a full ironman triathlon (5). One explanation is the lower efficiency of ATP production from fats vs carbohydrates, increasing the oxygen cost of energy production (5).

Protein

To sustain nitrogen balance and muscle protein turnover, protein requirements for endurance athletes are higher than in the general population (1.2 to 1.4 g/kg/day vs 0.8 to 1 g/kg/day) (39). Larger intakes have no beneficial effect on performance, but a chronic deficit, even slight, can promote fatigue, lower cellular repair and other impairments affecting training quality and performance. With the exception of those following a vegan diet (33), endurance athletes tend to consume more than enough protein: in a study among elite cyclists (12 women and 9 men), Lecoultré & Decombaz showed that 57% consumed 1.3 to 2 g/kg and 52% more than 2 g/kg. Only two consumed 0.8 to 1 g/kg (Lecoultré & Décombaz, unpublished data, 2005). It should be highlighted however that more importantly than protein intake per se, sufficient energy intake is required in order to avoid the oxidation of amino acids. In other words, in the absence of adequate fuel (i.e. carbohydrates and fats), proteins will be wasted to meet the high-energy requirements of endurance athletes instead of used for repair and synthesis (47).

In some specific instances, research supports increased protein intake (i.e. >1.4 g/kg/day):

1. During the two first weeks of training after a break or for beginners to promote muscle synthesis and repair.
2. To optimize recovery in case of suboptimal carbohydrate intake: 20 g of protein can increase glycogen synthesis (3). This strategy is also useful when two training sessions are planned in a row.
3. For athletes with a low body weight (mostly women), as low energy intakes can impact the effectiveness of protein metabolism.

Protein/amino acids supplements can be useful in the situations described above, as well as for vegan athletes who have to ingest large volumes of food to meet their nutritional needs (33). Amino acid supplements may increase post-endurance exercise protein synthesis (23) but whether this strategy surpasses regular food intake has not been demonstrated. During the recovery phase, protein intake before sleep increases muscle protein synthesis after resistance exercise (51). However, this strategy shows inconclusive results in the context of endurance training (16, 25).

Training the Gut

More than one third of full and 14% of half ironman participants reported serious gastrointestinal distress during their race in an observational study (37). Race duration rather than the amount of consumed carbohydrates seemed to be involved, as well as a history of gastrointestinal symptoms. The consequence is usually a reduced intake of food and/or fluids during the race, which leads to an impaired performance (37). As dehydration also promotes gastrointestinal distress, training the gut is an important part of the preparation in triathlon (10). In his review on this topic, Jeukendrup proposes several methods, including training with large volumes of fluid, training immediately after a meal or simulate the race with a race nutrition plan (22). Other strategies may be found elsewhere (10, 19), but as evidence is scarce it is advised to test various strategies during training.

Micronutrients, Supplements and Ergogenic Aids

Numerous supplements in various forms are marketed towards athletes, amateur and elite alike, but valid results supporting their claims are scarce (for a review, see (4, 36)). Supplements of vitamins and minerals are only necessary when food intake is insufficient, such as vitamin B12 among vegan athletes (33). Particular attention should be given to iron and vitamin D. Iron deficiencies are common in menstruating female athletes and distance runners (through gastrointestinal blood loss due to repetitive gut micro-ischemia, heavy sweating and increased destruction of red blood cells in the feet due to the mechanical force during a foot strike). Moreover, recent data show that the inflammatory response during intensive sport triggers hepcidin (i.e. the principal regulator of iron homeostasis) bursts, causing blockage of iron metabolism (35). Oral supplementation (100 mg/day) should be considered to prevent anemia when ferritin levels reach 20 to 35 µg/L (42). Vitamin D status can be low in triathletes using sunscreen, and during the winter months for those living above a latitude of 35°N (54) and a supplementation of 1500 to 2000 IU per day might be necessary. The ergogenic effect of caffeine has been well demonstrated (4) and can be consumed as 3-6 mg/kg preceding or during an event. Micronutrients, amino acids etc. that are added into sports food and drinks have yet no demonstrated effect on endurance performance. The intake of supplements is associated with a slight risk of contamination with banned substances under anti-doping regulations, and some labels (such as WALL-Protect) ensure the conformity of the product with anti-doping rules.

Nutrition for Racing

The effort to complete a half or a full ironman triathlon requires large amounts of fuel (around 8'000 kcal for a male participant in Ironman-Kona (11)). The specific format of the race necessitates careful planning of food and fluid consumption. Indeed, most of the intake takes place on the bicycle, which has a longer duration but also offers the opportunity to chew and drink properly while in a seated position (37). During the run leg of the race, the athlete faces three challenges: the change in position from seated to standing, entering the last stage of the race with preserved energy stores, and the vertical oscillations that can affect digestive tolerance. Over this last bout there are also less opportunities for food intake as compared to the bike leg. It is of utmost importance that the athlete fuels and hydrates properly during the bike leg, because entering the run in a depleted nutritional state will most likely force the athlete to slow down in order to finish the race. >

Carbohydrates or Fats?

During prolonged exercise, it is widely accepted that ATP production typically relies on the oxidation of both carbohydrates and fats, with lower intensities and longer durations increasing the proportion of fat oxidized (40). In this context, it has been hypothesized that fat intake during exercise might increase performance and spare endogenous glycogen stores during an endurance race. As of today, there is no evidence that a high fat feeding strategy in a race context might improve performance. On the other hand, a systematic review showed improved performance when carbohydrates vs placebo were provided during exercise in 50 out of 61 studies (45). Not one single study showed a detrimental effect of carbohydrate intake on performance. However, a high intake of carbohydrates (especially in the form of hyperosmolar solutions) are among the main causes of gastrointestinal distress in long distance sports (48) and an adequate compromise between fuel and tolerance has to be found.

Pre-Race and Race Feeding Strategies

Starting a long-distance event with elevated muscle glycogen levels is known to improve performance (17). Consuming 10 to 12 g carbohydrates/kg during two days prior to the race can double glycogen stores as long as exercise is kept minimal (7, 13). These studies have included men exclusively, but there is evidence that women are able to store muscle glycogen as effectively (46). To reach these high levels, intake should be split in small and frequent portions of familiar, low-fat and low-fiber food items. The storage of each gram of glycogen requires three grams of water, so sufficient hydration is warranted, and the athletes should be aware that their weight gain is a sign of efficient carbo-loading.

Even after thorough carbo-loading, glycogen stores are limited and it has been numerously suggested to provide up to 60 g of carbohydrates per hour in the form of glucose or glucose polymers molecules such as maltodextrin (47) or even up to 90 g/hour of multiple transportable carbohydrate blends (i.e. glucose-fructose blends) (21, 41, 50). These recommendations are also valid for women (49, 52). Moreover, timing of glucose intake appears to be important, as muscle glycogen stores may be spared when ingesting carbohydrate from the very beginning of exercise

Practically, this means that the athlete should calculate the amount of carbohydrates per portion of their usual sports foods and drinks, and prepare the right amount to carry with them either on the bike or during the run.

Are Proteins of Any Use during a Long-Distance Triathlon?

Protein oxidation may probably occur during a race such as a half or full ironman triathlon. To date, since there is no strong evidence that competing in an ultra-endurance event depletes the body protein stores, nor that protein ingestion during exercise improves performance. Protein/amino acid intake during the race are thus not suggested, as the potential ergogenic effect of protein in isocarbohydrate drinks may be only due to the extra-calories (fuel) rather than to a unique benefit of protein (43).

Hydration: Walking a Tightrope

Guidelines regarding hydration during endurance exercise have evolved greatly over the past decades, with restrictive regulations up to 1970 (31), followed by recommendations to “consume the maximal amount of fluids that can be tolerated” in the 1990s (9), and a more customized approach from 2007 onwards (1). These personalized recommendations can be viewed as a result of several dramatic cases of fluid overload and

hyponatremia in long-lasting events (18, 34). Exercise associated hyponatremia can occur either because of excessive fluid intake (mostly among slower participants, and those who gain weight during the race), or inadequate sodium replacement among people with high sodium containing sweat losses (44). Another reason to strive for the prevention of hyponatremia is to optimize carbohydrates' absorption, as glucose molecules are mainly transported by sodium-glucose cotransporters (SGLT-1) (while fructose is passively absorbed by the GLUT5 transporters). Thus, the presence of sodium in drinks and foods optimizes the absorption of carbohydrates. Since most of the commercially available drinks and foods contain sodium, it is not essential to further add sodium to the race diet for most athletes.

On the other hand, dehydration has deleterious consequences as well, from poor performance to severe heat stroke, especially when exercising in a hot environment where fluid losses can triple compared to normal weather (32). Indeed, even athletes who tolerate hydric losses up to 2% of their weight without risk will suffer impaired performance when dehydration occurs in a hot environment (15).

In order to limit the risk of over- as well as dehydration, athletes should strive to replace around 98% of their sweat losses (29). This is a difficult task during a triathlon, where sweat losses are hard to gauge. It is advised that individuals assess their usual sweat losses by weighing before and after training sessions mimicking race conditions, taking into account the amount of fluids consumed as well as urine evacuation. The replacement of sodium losses should be considered only for the “heavy and salty sweaters”. Indeed, sodium concentration in the sweat varies greatly among individuals, from 20 and 80 mmol/liter, and the food consumed during a long-duration event contains good amounts of sodium.

Practically, drinking according to thirst can be sufficient when the event takes place in an environment up to 21°C. In a hot climate, a 2% dehydration significantly impairs performance (8). Whereas fluid losses may be difficult to compensate for in high level athletes due to elevated sweat rates, slower athletes are at risk of overhydration and hyponatremia. Also, one has to bear in mind that fluid absorption is not instantaneous, especially as the presence of food delays gastric emptying. It seems that 200 ml/ 20 minutes is more efficient than smaller, more frequent amounts (30), but the optimal sequence remains very individual. As it is the case for carbohydrates, fluid intake should be trained and tested prior to race day for tolerance and to prevent hyper- or hypo-hydration during the race.

Conclusion

Long distance triathletes devote a large amount of time and money to be able to participate in half and full ironman events. They should also pay specific attention to their nutrition and hydration, during training as well as racing, in order to perform to their best potential. ■

Conflict of Interest

The authors have no conflict of interest.

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