CHAPTER 15

Fuelling an Ironman World Champion

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Vignette

The Hawaii Ironman World Championship is not only challenging because of the sheer distances involved (3.8km swim, 180km bike and 42 km run) but also because of the environmental challenges with temperatures around 35°C, a humidity that is approaching 80% and fierce headwinds on the bike.
The triathlete in this case report is: female, 30 years of age, 57 kg and 176 cm. The athlete had turned professional in 2007 and qualified for the Ironman World Championships by winning Ironman Korea. Performance in Ironman distance triathlon is dependent on many factors but nutrition plays a crucial role (1). Often nutrition is called the 4th discipline of triathlon and many athletes who do not perform well attribute this to nutritional problems. Two inter-linked problems in endurance sports are gastro-intestinal distress (2) and running out of energy. This makes nutrition during such an event a fine 'balancing act' between consuming enough energy but making sure that absorption is adequate and no gastro-intestinal distress develops.

For the Hawaii Ironman event the most important nutritional issues identified included

1) Avoiding major gastro-intestinal (GI) distress,
2) Providing energy throughout the event and in a way that does not exacerbate GI distress in those susceptible to it, and
3) Maintaining fluid balance.

Managing GI distress

The athlete had a history of gastro-intestinal problems. These problems typically occurred later in the race and were predominantly lower GI tract problems. After analysing food intake in the days before it was noted that ingestion of fibre, as well as dairy products, was relatively high. Previous research has demonstrated that fibre intake is linked to an increased incidence of gastro-intestinal problems. The fibre intake of the pre-race meal (breakfast) as well as that in the days leading up to the race was reduced to a minimum. Similarly, dairy product intake was reduced to very low levels for 2 days.

Gastro-intestinal distress may also occur when more carbohydrate is ingested than can be emptied from the stomach and/or absorbed. Therefore the next strategy was to provide an energy source during exercise that is readily absorbed and oxidised resulting in minimal residual volume in the stomach and intestine. This will be discussed in the next section.

Over time the breakfast for this athlete has 'evolved' and so that ingested before her last few races has consisted of a bowl of cream of rice cereal made with water with a tablespoon of sunflower butter and a tablespoon of honey, half a banana and percolated coffee with lactose free milk. The energy content and composition of the meals is comparable.

Table 1: Intake ~3 hours before the race

Time	Food	Energy	Carbs	Fat	Protein	Fibre
4:00 AM	Large mug of tea with milk, 3 English muffins, 1 Banana, 2 slices of white bread with jam and cheese (cheddar), 1 slice of white bread with honey and cheese water	1364 kcal	221 g	34 g	56 g	7g

Fuel stores and fuelling during the race

In order to start the race with optimal muscle glycogen stores the athlete consumed a high carbohydrate diet providing her with nearly 9 g/kg/day of carbohydrate (585g/day) (Table 2). The day before the race carbohydrate constituted 65% of her energy intake and fat intake was relatively low at 25%. Studies have demonstrated that well trained athletes will optimise their glycogen stores on such a carbohydrate intake even when they are in training (3). The athlete exercised for approximately 2 hours the day before the race but at a low intensity.

Liver glycogen must also have been high after the relatively large carbohydrate intake 3 hours before the race (221g; Table 1). So the athlete followed recommendations and so should have been able to start the race with optimal glycogen stores in both liver and muscle (4).

Table 2: Energy and macronutrient intake the day before the race

Intake day before	Energy	Carbs	Protein	Fat	Fibre
	3672 kcal	585 g	151 g	99 g	25 g

At 6:45AM the pro men and women started their race in Kona. The athlete had been sipping water till the start of the race but did not take anything else in the hour before. She took one gel (25 g carbohydrate, no caffeine) in the first transition (T1) before mounting the bike for a five-hour ride in the lava fields of the Big Island. Her fuel for the ride was waiting for her on the bike: two 750ml bottles of a highly concentrated carbohydrate solution (20 scoops of a carbohydrate-protein drink; vanilla flavour). At regular intervals (at least every 10 min) the athlete consumed a mouthful of this solution and washed it down with a sip of water from her water bottle attached to her handlebars. At every feed station she took a water bottle and used this to fill her handlebar mounted water bottle and also splashed water on her face and neck and to aid cooling. At the halfway point when she had moved into the top 10, Chrissie took a non-caffeinated gel and after 150 km when she had taken over the lead she had one more gel; this time the gel was caffeinated. Most of the energy during her ride, however, came from the bottles she had prepared before the race (see table 3).

With a 2 min lead she entered T2 where she consumed another caffeinated gel before starting the second fastest marathon of all times. During the marathon she would use the feed stations to grab sponges and ice to keep cool and water to wash down a gel. Her strategy was to have a gel every 25 min just before the feed station and wash this down with water. During the run she managed to take 7 gels (the first one of these coming out of transition). In the last hour she also sipped small amounts of non-carbonated cola drink at feed stations.

Overall her carbohydrate intake was calculated to be about 775 grams of carbohydrate during the bike and run. Over the entire race her average intake was 86 g/h, which is very close to the recommended 90 g/h (5). The carbohydrate source that was used is maltodextrin and fructose and because the combination of these carbohydrates results in a fast absorption it is possible to maintain such high intakes (6) without accumulation of the carbohydrate in the gut and consequent gastro-intestinal problems. Indeed the athlete experienced minimal problems during the race. These carbohydrate combinations have also been shown to result in higher exogenous carbohydrate oxidation rates (5, 7-9), better fluid delivery (10) and improved performance (11) compared with a "traditional" sports drink containing predominantly one type of carbohydrate.

It is worth noting that the athlete did not take additional salt tablets but relied on the extra sodium provided in the gels and some sodium present in her concentrated carbohydrate solutions.
In races to follow the protein was removed from the carbohydrate solution she consumed during the race and the athlete did not use protein in her drinks anymore. This is in line with the lack of convincing evidence for a benefit of added protein (12).

Table 3: Intake during the Ironman World Championship 2007 in Hawaii

Discipline	Time	Food	Energy	Carbs
Swim	0:58 h	-	-	-
T1	2:21 m	1 Gel	100 kcal	25 g
Bike	5:06 h	CHO	2000 kcal	500 g
		2 Gels	200 kcal	50 g
T2	2:03 m	1 Gel	100 kcal	25 g
Run	2:59 h	6 Gels	600 kcal	150 g
		Cola	100 kcal	~25 g
Overall	**9:08**		**3100 kcal**	**775 g**

Recently we wrote a letter to the editor (13) to indicate that one of the characteristics of a successful elite endurance athlete is a very high capacity to absorb carbohydrate. Clearly this athlete is a good example of this, being able to compete at very high intensity and still ingest and tolerate large amounts of carbohydrate. Genetics play an important role in this but the gut is extremely adaptable and trainable (7) and hence practice is recommended during training to establish optimal ingestion protocols for the individual.

Fluid intake

Fluid intake is always more difficult to measure and in this particular case we did not attempt to quantify fluid intake more accurately in this race but the important point to stress is that we uncoupled carbohydrate from fluid intake. The recommended carbohydrate intake is relatively fixed and independent of the environmental conditions. The fluid intake recommendations are not only highly individual but also dependent on the conditions. A fluid intake in a group of 52 Ironman triathletes at the 2009 Ironman World Championships was just under 800 ml/h (unpublished data) but there was a lot of variation (range: 425 ml/h -1520 ml/h). Body weight was not measured before and after the race so the fluid losses for the athlete cannot be estimated.

World Champion

The strategy employed was clearly successful as the athlete went on to win the race and was crowned World Champion. In years to follow she would repeat this in many other Ironman races every time making small improvements to the nutrition strategy, thereby reducing gastro-intestinal distress and improving the energy and fluid delivery. The drinks the athlete uses are now different (partly for sponsorship reasons), but the composition remains very similar.

Acknowledgement

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Commentary *Mathew G. Wilson.* Qatar

Over the past couple of decades, prolonged endurance events (>8hrs) such as ultra-distance running and Ironman triathlon have become a global phenomenon. Whilst the Hawaii Ironman is considered the most iconic triathlon in the world, the Ironman brand currently has 26 official Ironman distance events, and 52 'half'-distance events. Needless to say, ultra-endurance events have become a commercial extravaganza that leave many athletes feeling bewildered in areas such as selecting the appropriate cycling equipment, balancing swim-bike-run training and of course, sports nutrition. It is correct to state that nutrition is the 4th discipline of triathlon, but from professional experience, it is the 4th most neglected discipline. There are 3 key elements to Prof Jeukendrup's case study to which I would like to draw the reader's attention:

1) The utilisation of food diaries in identifying a nutritional problem, in turn providing a racing solution,
2) The correct mathematical calculation of carbohydrate (CHO) required and
3) Creating a nutritional race strategy based upon current scientific evidence not commercial branding.

The most important nutritional objective during an Ironman is to avoid GI distress. To avoid this, three variables must be taken into account;

1) The need to identify potential sources of GI distress through simple food diary analysis. In this particular case, high fibre and dairy intake was ascertained as a possible hindrance, allowing food modification to occur, helping to create a better racing platform,
2) If an athlete does not adapt their highly trainable digestive system to cope with a large volume of high energy (yet often sickly!) products under duress, the consequences aren't particularly pleasant,
3) Athletes will only know what nutritional products their gut through practice tolerates, and so experimentation should never be left till race day.

This case study also demonstrates well the calculation of the required number of grams of CHO required per hour based upon the estimated race time and tolerance to CHO concentration vs. gut absorption rates. By opting to use two pre-prepared bottles of CHO on the bike with only supplemental water to preserve fluid balance, this is an excellent example of effective race management to sustain energy for the run portion of the triathlon, with a trusted energy product ensuring the correct CHO dose per hour. It is interesting to note that the athlete drank water before the race and avoided CHO. Limited evidence exists for the impact of CHO ingestion prior to exercise causing a rebound hypoglycaemia (1) but arguably one in five individuals suffer with this so for those affected timing will be even more crucial. Finally, the athlete did not use additional protein supplementation. The effective use of protein during exercise is still under debate, with some studies showing little to no performance improvements over CHO alone(2, 3). Indeed, the difficulties triathletes face with keeping abreast of the scientific evidence is not helped by commercial companies advertising the apparent benefits of a particular endurance supplement. Athletes should seek qualified guidance when confused (4).

In conclusion, exercising continuously for periods between 8 and 14 hours is not uncommon in Ironman. Prof Jeukendrup eloquently demonstrates the need to identify potential sources of GI distress and mathematically personalise sports nutrition, allowing the athlete to optimise their performance.

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