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Original Article

Pacing in Deca and Double Deca Iron Ultra-Triathlon

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It has been shown that Deca Iron ultra-triathletes (*i.e.* performing one Ironman triathlon per day for 10 days) progressively slowed down whereas daily performance in a Triple Deca Iron ultra-triathlon (*i.e.* performing 30 Ironman triathlons within 30 days) remained unchanged. We investigated pacing in the first Double Deca Iron ultra-triathlon (*i.e.* 20 Ironman triathlons within 20 days) held in history and hypothesized that athletes in Double Deca Iron ultra-triathlon would pace evenly (*i.e.* no decrease in daily performance over time) while athletes in Deca Iron ultra-triathlon would pace positively (*i.e.* become slower over time). Day 1 was the fastest in both the Deca and the Double Deca Iron ultra-triathlon. In the Deca Iron ultra-triathlon, Day 7 was the slowest and Day 5 was the slowest in the Double Deca Iron ultra-triathlon. In the Deca Iron ultra-triathlon, swimming and cycling splits were faster compared to the Double Deca Iron ultra-triathlon whereas in the Double Deca Iron ultra-triathlon, the running splits were faster than in the Deca Iron ultra-triathlon. In summary, in both the Deca and the Double Deca Iron ultra-triathlon, athletes paced evenly. In contrast to earlier findings in Deca and Triple Deca Iron ultra-triathlon, the last day was not the slowest day. This was most probably due to environmental conditions. The findings of this study may be important for exercise physiologists, coaches, athletes and enthusiasts of this sport.

Key Words: cycling, performance, running, swimming, ultra-endurance

Introduction

Pacing has an effect on performance in endurance sports (1, 5) and pacing during an endurance race is important for a successful race outcome (4). There are different pacing strategies in endurance performance. Abbiss and Laursen (1) postulated six different pacing strategies such as negative pacing (*i.e.* increase in speed over time), positive pacing (*i.e.* decrease in speed over time), all-out pacing (*i.e.* maximal speed possible), even pacing (*i.e.* same speed over time), parabolic-shaped pacing (*i.e.* positive and negative pacing in different segments of the race) and variable pacing (*i.e.* pacing with multiple fluctuations).

Little is known for pacing in long-distance triathlons such as the Ironman distance triathlon (*i.e.* 3.8 km swimming, 180 km cycling and 42.195 km running). Elite female and male Ironman triathletes adopt a positive pacing strategy in both the running and the cycling split with no sex difference in which women used the same pacing strategy as men (2). Also for longer race distances such as a multi-stage Ironman triathlon covering ten times the Ironman distance within ten days (*i.e.* a Deca Iron ultra-triathlon), performance progressively declined over days (6, 8, 11).

However, also longer triathlon races than a single Ironman triathlon and 10 Ironman triathlons within 10 days have already been held. In 2013, for the first time in history, a triathlon race covering 30 Ironman triathlons within 30 days (*i.e.* a Triple Deca Iron ultra-triathlon) was held. At the same time, also a Deca Iron ultra-triathlon was held. While the performance in the Deca Iron ultra-triathlon decreased over time (*i.e.* positive pacing), the daily performance in the Triple Deca Iron ultra-triathlon remained unchanged across days (*i.e.* even pacing) (11).

In the same year, a triathlete completed for the first time in history in a self-paced world record attempt the total distance of 33 Ironman triathlons

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Table 1. Air temperature with daily maximum and daily minimum during the Deca Iron ultra-triathlon. Data were from www.meteoswiss.admin.ch.

Day	Maximum Temperature (°C)	Minimum Temperature (°C)
1	22.1	12.5
2	26.2	13.5
3	27.7	18.2
4	28.4	16.9
5	30.6	19.4
6	30.1	18.3
7	29.3	20.4
8	23.4	17.4
9	24.5	16.3
10	25.0	15.0

within 33 consecutive days. Interestingly, he also showed minor variations over time (*i.e.* even pacing) in both split times and overall race times (10).

In 2016, again for the first time in history, a race covering 20 Ironman triathlons within 20 days (*i.e.* a Double Deca Iron ultra-triathlon) and a Deca Iron ultra-triathlon were held. Based upon previous findings for 30 Ironman triathlons within 30 days (Triple Deca Iron ultra-triathlon), we hypothesized that athletes in a Double Deca Iron ultra-triathlon would pace evenly (*i.e.* no decrease in daily performance over time) while athletes in a Deca Iron ultra-triathlon would pace positively (*i.e.* become slower over time)

Materials and Methods

Ethics Approval

All procedures used in the study were approved by the Institutional Review Board of Kanton St. Gallen, Switzerland, with a waiver of the requirement for informed consent of the participants given the fact that the study involved the analysis of publicly available data.

Methodology

Data were obtained from the race website www.swissultra.ch. A total of 12 athletes (2 women, 10 men) started in the Deca Iron ultra-triathlon and 8 athletes (2 women and 6 men) in the Double Deca Iron ultra-triathlon. The age of the athletes were provided by the race director and the weather data (*i.e.* daily highest and daily lowest temperatures) were provided by www.meteoswiss.admin.ch. Table 1 presents the temperatures for the Deca Iron ultra-triathlon and Table 2 for the Double Deca Iron ultra-triathlon.

Statistical Analysis

After assessing normality and homogeneity of data through the Shapiro-Wilk and Levene's test respectively, data were presented as means and standard deviation (±). Repeated measures analyses of variance (ANOVA) and Bonferroni *post-hoc* test examined differences in race time among days separated for Deca and Double Deca Iron ultra-triathlon. In addition, a repeated measures ANOVA examined differences in race time among days together for Deca Iron ultra-triathlon and the ten first days of Double Deca Iron ultra-triathlon. Furthermore, to differences in overall race time among days, we studied also differences in pacing, *i.e.* relative performance in swimming, cycling and running splits. Swimming, cycling and running split times were calculated as percentage of the overall race time using the formulas 100 × swimming time/race time, 100 × cycling time/race time and 100 × running time/race time, respectively. In the analysis of pacing, the days of Double Deca Iron ultra-triathlon were adjusted to match the days of Deca Iron ultra-triathlon, *e.g.* average values of Day 1 and Day 2 of Double Deca Iron ultra-triathlon were calculated and were assigned to Day 1 of Deca Iron ultra-triathlon. The magnitude of differences in the ANOVAs was evaluated using eta squared (η^2). Pearson's correlation coefficient r examined the relationship of average daily race time with age and temperature. Alpha level was set at 0.05. All the procedures were carried out using the Statistical Package for the Social Sciences (SPSS 20.0)

Results

In the Deca Iron ultra-triathlon, 8 men finished (80% of men finished) but no woman finished. In the Double Deca Iron ultra-triathlon, 2 men (33% finished) but no women reached the finish line. No differences

Table 2. Air temperature with daily maximum and daily minimum during the Double Deca Iron ultra-triathlon. Data were from www.meteoswiss.admin.ch.

Day	Maximum Temperature (°C)	Minimum Temperature (°C)
1	27.2	17.7
2	26.0	18.1
3	26.7	17.5
4	26.7	17.5
5	24.1	16.2
6	24.1	16.2
7	24.6	15.3
8	23.8	15.8
9	22.9	18.9
10	20.0	13.2
11	22.1	12.5
12	26.2	13.5
13	27.7	18.2
14	28.4	16.9
15	30.6	19.4
16	30.1	18.3
17	29.3	20.4
18	23.4	17.4
19	24.5	16.3
20	25.0	15.0

Table 3. Pace and split time performance of Deca and Double Deca Iron ultra-triathlon. Data expressed as mean and ± standard deviation

		Deca Iron ultra-triathlon	Double Deca Iron ultra-triathlon
Swimming	minutes/100m	2.2 ± 0.2	2.4 ± 0.4
	seconds	4981 ± 524	5454 ± 1020
Cycling	km/h	27.0 ± 2.9	25.5 ± 0.7
	seconds	24261 ± 2477	25491 ± 707
Running	minutes/km	7.3 ± 1.5	7.2 ± 0.6
	seconds	18509 ± 3678	18255 ± 1632

were identified between Deca and Double Deca Iron ultra-triathlon in absolute split performance (Table 3). A repeated measures ANOVA showed differences in race time in Deca Iron ultra-triathlon among days (P = 0.026, η^2 = 0.381) (Figure 1). However, the *post-hoc* analysis did not show which days differed. The Day 1 was the fastest and the Day 7 the slowest, but not significantly (P > 0.05). A trend was observed, where race time got slower every day till Day 7 and then, this trend was inversed. In Double Deca Iron ultra-triathlon, there was no difference in race time among days (P = 0.449, η^2 = 0.229) (Figure 2). Similarly to Deca Iron ultra-triathlon, Day 1 was the fastest in Double Deca Iron ultra-triathlon and Day 5 was the slowest.

Analysing together Deca Iron ultra-triathlon and the 10 first days of Double Deca Iron ultra-triathlon, a main effect of day on race time was observed (P = 0.010, η^2 = 0.302), where the Day 1 was the fastest and Day 6 the slowest. *Post-hoc* analysis showed that Day 1 was fastest than Days 2, 4, 5 and 6 (P < 0.05).

With regards to the relative contribution (%) of each split (*i.e.* swimming, cycling and running) to

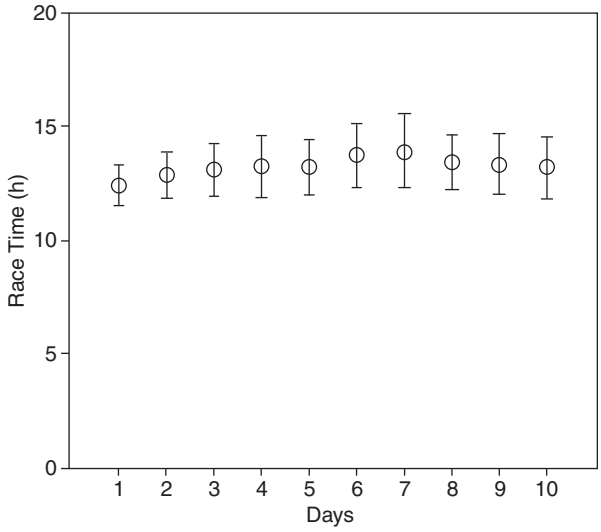

Fig. 1. Day-by-day race time in Deca Iron ultra-triathlon.

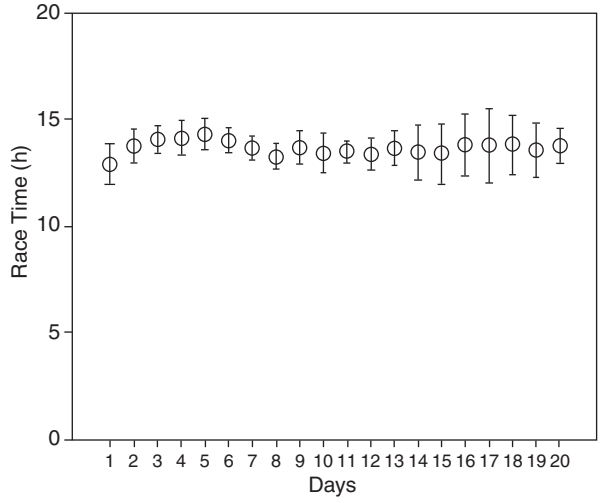

Fig. 2. Day-by-day race time in Double Deca Iron ultra-triathlon.

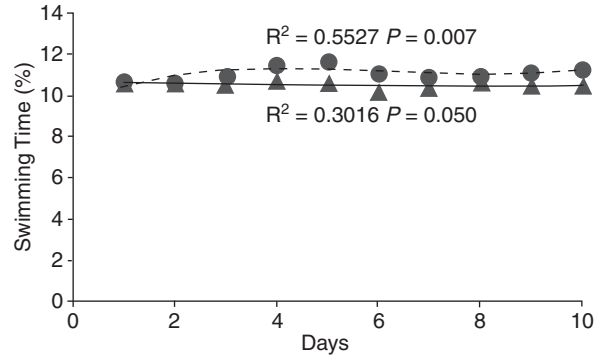

Fig. 3. Day-by-day split times in swimming (%) in Deca Iron ultra-triathlon (▲) and Double Deca Iron ultra-triathlon (●).

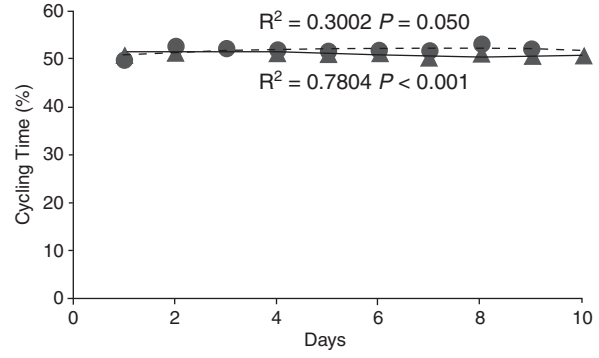

Fig. 4. Day-by-day split times in cycling (%) in Deca Iron ultra-triathlon (▲) and Double Deca Iron ultra-triathlon (●).

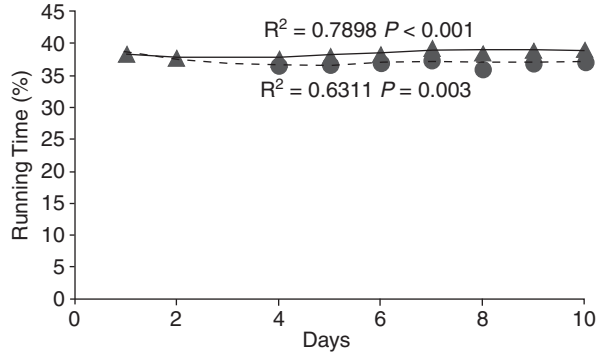

Fig. 5. Day-by-day split times in running (%) in Deca Iron ultra-triathlon (▲) and Double Deca Iron ultra-triathlon (●).

overall race time, no difference was observed among days. A repeated measures ANOVA did not show any difference, however with effects sizes considered large in all stages in swimming ($P = 0.067$; $\eta^2 = 0.955$), cycling ($P = 0.531$, $\eta^2 = 0.765$) and running ($P = 0.684$, $\eta^2 = 0.688$) split performances. A trend was observed that athletes in Deca Iron ultra-triathlon were faster than athletes in Double Deca Iron ultra-triathlon in swimming, where both versions showed small variation by days (Figure 3). In cycling, athletes in Deca Iron ultra-triathlon were faster, too, and became faster across days (Figure 4). On the contrary, athletes in Double Deca Iron ultra-triathlon were faster in running (Figure 5).

The relationship between average daily race time and age did not follow similar patterns in Deca and Double Deca (Figure 6). An almost perfect correlation was observed between race time and age in Double Deca (r = -0.96, $P = 0.040$), *i.e.* the older the finisher the faster the race time, but not in Deca (r = 0.62, $P = 0.056$).

Minimum temperature was largely correlated with average daily race time (Figure 4) in Deca Iron ultra-triathlon (r = 0.82, $P = 0.003$), but not with Double Deca Iron ultra-triathlon (r = 0.17, $P = 0.830$); *i.e.* the higher the minimum temperature the slower the race time. In contrast, daily maximum temperature was related to performance (Figure 8). No correlation

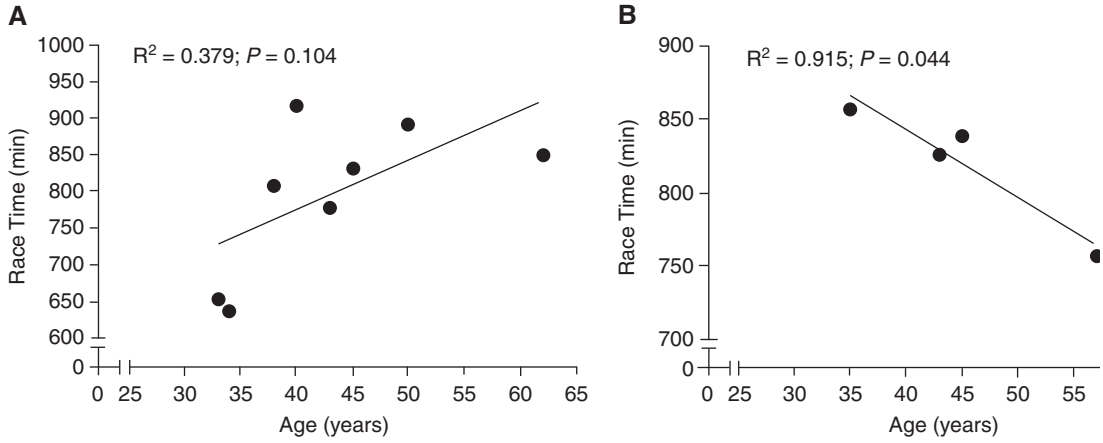

Fig. 6. Average daily overall race time and age in Deca (A) and Double Deca (B) Iron ultra-triathlon.

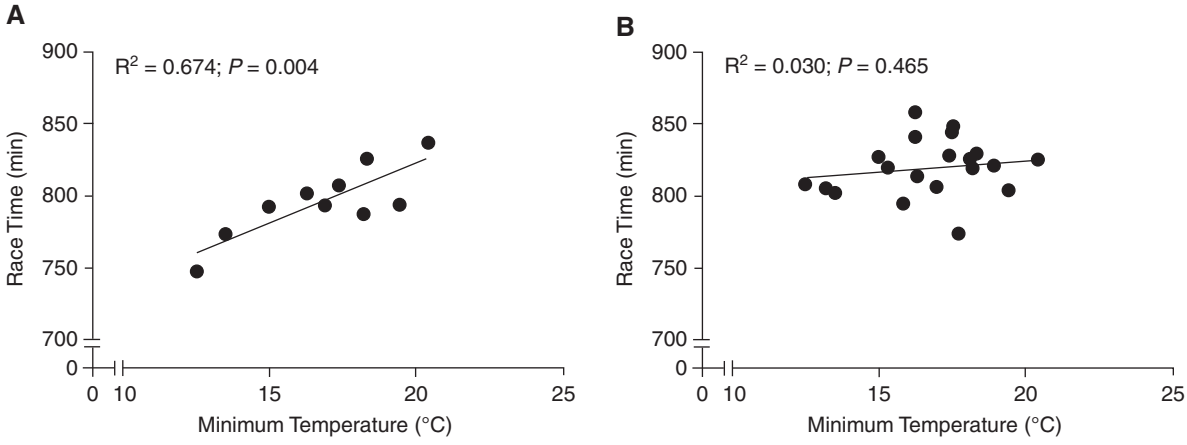

Fig. 7. Average daily overall race time and minimum daily temperature in Deca (A) and Double Deca (B) Iron ultra-triathlon.

was observed between maximum temperature and race time for Deca Iron ultra-triathlon (r = 0.57, *P* = 0.083) and Double Deca Iron ultra-triathlon (r = -0.03, *P* = 0.970).

Discussion

The main findings of the present study were that (i) in both Deca and Double Deca Iron ultra-triathlon, the fastest race time was observed in day 1, (ii) in both versions, the last days were not the slowest, and (iii) split performance in Deca Iron ultra-triathlon was faster in swimming and cycling, whereas split performance in Double Deca Iron ultra-triathlon was similar to Deca Iron ultra-triathlon in running.

The Fastest Day was Day 1

A first important finding was that Day 1 was the fastest in both Deca and Double Deca Iron ultra-triathlon and confirms recent findings for Deca Iron ultra-triathlon (6). This elevated intensity on Day 1 may be the main cause for the highest decrease in body mass and body fat previously observed in Day 1 in a Deca Iron ultra-triathlon (7). In the following days, only minor changes in body composition occurred (7).

The Last Day Was Not the Slowest Day

A further important finding in both versions was that the last days were not the slowest. In Deca Iron ultra-triathlon, Day 7 was the slowest and in Double Deca Iron ultra-triathlon, Day 5 was the slowest. Recent studies showed that performance in Deca Iron ultra-triathlon progressively decreased over days (6, 8).

The finding that the slowest day was after ~5-7 days in a multi-stage ultra-triathlon is most likely due to the progressive energy deficit which accumulates during the days that may lead to metabolic adaptation. Some studies reported a metabolic adaptation do caloric restriction on bioenergetics and in turn, on exercise performance (13-15, 18).

The attenuated day-by-day performance decrease that resulted in the last days not being the

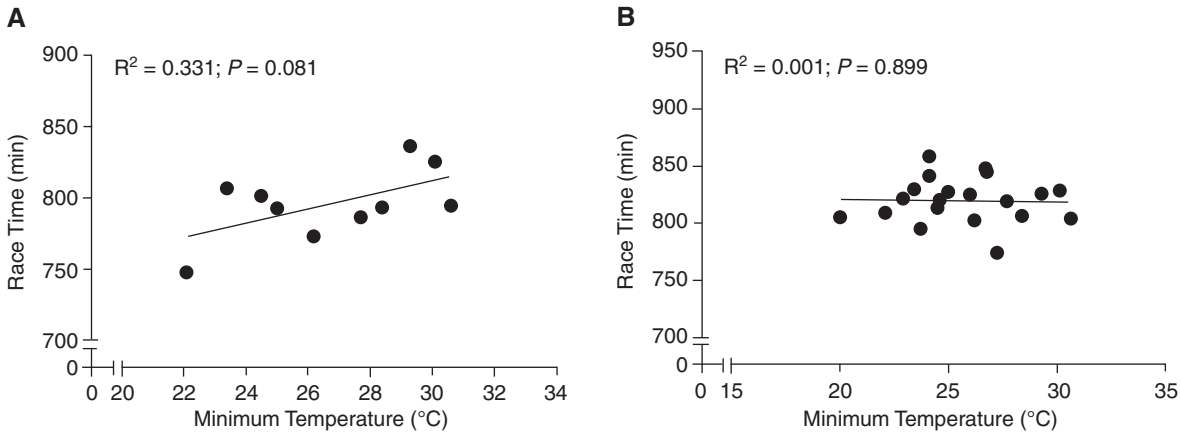

Fig. 8. Average daily overall race time and maximum daily temperature in Deca (A) and Double Deca (B) Iron ultra-triathlon.

slowest, is possibly a reflection of, after the first race days, athletes begin to adapt by increasing insulin sensitivity (14), accelerating the restoration of muscle glycogen stores (18) and optimizing energy expenditure by augmented lipid mobilization (15). Similarly as reported in a case study with one triathlete in a Deca Iron ultra-triathlon, the energy deficit was 3149 kcal on Day 1 and 1900 kcal on Day 2. On Day 3 (+110 kcal) and Day 4 (+1700) the balance was positive to become negative again on Day 5 (-1670 kcal) (9).

In the 'Transeurope Footrace 2009', a 64-stage 4,486 km ultramarathon, athletes lost both adipose tissue and lean tissue (skeletal muscle mass). Visceral adipose tissue showed the fastest and highest decrease compared to somatic adipose soft tissue and lean tissue compartments during the race. Visceral adipose tissue seemed to be the most sensitive morphometric parameter regarding the risk of non-finishing a transcontinental footrace and showed a direct relationship to pre- race performance (19).

Differences in Split Performances between Deca and Double Deca

In Deca Iron ultra-triathlon, swimming and cycling splits had a smaller contribution (%) to overall race time than Double Deca Iron ultra-triathlon, which can be visually identified in the average pacing for both races and splits. On the other hand, Double Deca Iron ultra-triathlon had a greater contribution (%) of running splits to overall race time, but an even pacing in comparison to Deca Iron ultra-triathlon.

The even pace between Deca and Double Deca Iron ultra-triathlon is a quite curious result, taking in account that the running split is the most physically demanding (3, 16), is to be expected a slowest run in the longer races (*i.e.* Double Deca Iron ultra-triathlon). Nonetheless, these disparate findings might be due to the different number of successful finishers in the Deca Iron ultra-triathlon (80% of male starters) compared to the Double Deca Iron ultra-triathlon (50% of all starters).

The Aspect of Age

We found a significant correlation in the Double Deca between race time and age where the older the finisher the faster the race time. Although this finding seems uncommon, a recent study investigating ultra-marathoners competing in races of different durations showed that the age of the best ultra-marathon performance increased with increasing race duration. The aspect of experience is the most likely explanation since these ultra-marathoners improved race performance with increasing number of finishes (12).

The Aspect of Weather

We found that minimum temperature was largely correlated with average daily race time where the higher the minimum temperature the slower the race time. It is well known that ambient temperature affects endurance performance (20). In 161-km ultra-marathoners, extreme heat impaired all runners' ability where faster runners were at a greater disadvantage compared to slower competitors (17).

Limitations and Strengths

While the present study brings important contributions, it is not without limitations. The fact that we not have access to the nutritional data can be characterized as a possible limitation. In addition, the small sample size may also characterize a limitation. However, only a very limited number of athletes start and finish in such races. Thus, we suggest that the findings of this study should be interpreted with some caution. Although up to the present time this race was performed only once and the sample of the present study represent

100% of the population investigated. The main contribution of the present study is in its originality, to the extent that, to the best of our knowledge, there are no reports in the literature of studies that have investigated the variation of performance in races of Deca and Double Deca triathlon. Thus, this knowledge is unique and can have a great application within Deca and Double Deca Triathlon.

Conclusions

In summary, in both the Deca and the Double Deca Iron ultra-triathlon, athletes paced evenly. In contrast to earlier findings in Deca and Triple Deca Iron ultra-triathlon, the last day was not the slowest day. This was most probably due to favourable environmental conditions. The findings of this study may be important for exercise physiologists, coaches, athletes and enthusiasts of this sport for future races.

Conflict of Intrest

The authors have no conflicts of interest to report.

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