ORIGINAL ARTICLE

Participation and Performance Trends in Triple Iron Ultra-triathlon – a Cross-sectional and Longitudinal Data Analysis

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Received: *Jan 21, 2012*
Accepted: *May 25, 2012*

Key Words: Swimming; Bicycling; Running; Ultra-endurance; Athletic Performance

Abstract

Purpose: **The aims of the present study were to investigate (*i*) the changes in participation and performance and (*ii*) the gender difference in Triple Iron ultra-triathlon (11.4 km swimming, 540 km cycling and 126.6 km running) across years from 1988 to 2011.**

Methods: **For the cross-sectional data analysis, the association between with overall race times and split times was investigated using simple linear regression analyses and analysis of variance. For the longitudinal data analysis, the changes in race times for the five men and women with the highest number of participations were analysed using simple linear regression analyses.**

Results: **During the studied period, the number of finishers were 824 (71.4%) for men and 80 (78.4%) for women. Participation increased for men (r^2=0.27, P<0.01) while it remained stable for women (8%). Total race times were 2,146 ± 127.3 min for men and 2,615 ± 327.2 min for women (P<0.001). Total race time decreased for men (r^2=0.17; P=0.043), while it increased for women (r^2=0.49; P=0.001) across years. The gender difference in overall race time for winners increased from 10% in 1992 to 42% in 2011 (r^2=0.63; P<0.001). The longitudinal analysis of the five women and five men with the highest number of participations showed that performance decreased in one female (r^2=0.45; P=0.01). The four other women as well as all five men showed no change in overall race times across years.**

Conclusions: **Participation increased and performance improved for male Triple Iron ultra-triathletes while participation remained unchanged and performance decreased for females between 1988 and 2011. The reasons for the increase of the gap between female and male Triple Iron ultra-triathletes need further investigations.**

Asian Journal of Sports Medicine, Volume 3 (Number 3), September 2012, Pages: 145-152

INTRODUCTION

Triathlon is a multi-sports discipline consisting of swimming, cycling and running [1]. Different distances do exist such as the Olympic distance triathlon (1.5 km swimming, 40 km cycling, and 10 km running) [2], the Ironman distance triathlon (3.8 km swimming, 180 km cycling and 42 km running) [3,4], and distances longer than the Ironman triathlon such as the Double Iron ultra-triathlon (7.6 km swimming, 360 km cycling, and 84.4 km running) [5], the Triple Iron ultra-triathlon (11.4 km swimming, 540 km cycling, and 126.6 km running) [6-10], and the Deca Iron ultra-triathlon (38 km swimming, 1,800 km cycling and 422 km running) [11,12].

In recent years, an increase in participation in both endurance and ultra-endurance races such as ultra-marathons [13-16] and ultra-triathlons [11,17,18] has been described. An increase in female participation in recent years has been reported for marathons [19] and ultra-marathons [14]. Although female ultra-marathoners improved their performance [14], a gender gap remained [20]. It was assumed that women may outrun males with increasing length of an endurance performance [21,22],

however, a gender gap still exists in ultra-endurance performances [3,4,20]. Women were ~20% slower in 161-km ultra-marathons [16] and ~22% slower in a 100-km ultra-marathon [20] compared to men.

To date, no study investigated participation and performance trends in longer triathlon distances such as the Triple Iron ultra-triathlon. The first ever Triple Iron ultra-triathlon was held in Le Fontanil, France, in 1988, where 11 male competitors entered [11]. The first women took part in 1989 in a Triple Iron ultra-triathlon. The aims of the present study were to investigate the changes in (*i*) participation and performance and (*ii*) gender difference in Triple Iron ultra-triathlon across years from 1988 to 2011. We hypothesized (*i*) an increase in participation and performance for both women and men across years and (*ii*) a decline in the gender difference in performance with women becoming faster across years.

METHODS AND SUBJECTS

The study was approved by the Institutional Review Board of St. Gallen, Switzerland, with waiver of the requirement for informed consent given that the study involved the analysis of publicly available data. The data set for this study was obtained from the race directors and the International Ultra-Triathlon Association (www.iutasport.com). All participants who started in a Triple Iron ultra-triathlon worldwide between 1988 and 2011 were analysed regarding the aspects of participation and performance related to gender.

In this cross-sectional data analysis, data were available from 1,256 athletes (102 women and 1,154 men) and 1,024 finishers (824 men and 80 women). For the analysis of the top performances, the fastest swimming, cycling and running and overall race times were determined and analysed for each year and both genders. The gender difference was calculated using the formula ([performance of women] – [performance of men]) / [performance of men] x 100. To test whether the inclusion of the same athlete in different years had an impact on the analysis, we determined the five women and men with the highest number of participations within the 24-year period. From these ten athletes, the change in overall race time was analysed longitudinally across years. In case an athlete participated more than once within one year, only the best performance (*e.g.* fastest overall race time) was included in the analysis.

Statistical analysis:

In order to increase the reliability of the data analysis, each set of data was tested for normal distribution as well as for homogeneity of variances prior to statistical analysis. Normal distribution was tested using a D'Agostino and Pearson omnibus normality test and homogeneity of variances was tested using a Levene's test in case of two groups and with a Bartlett's test in case of more than two groups. To compare two groups with normal distribution and equal variances, the Student's *t*-test was used. To compare two groups with not normal distribution but equal variances, the Mann-Whitney test was applied. In case of not equal variances, an unpaired test with Welch's correction was used. To compare more than two groups with normal distribution, a one-way analysis of variance (ANOVA) with Tukey-Kramer post hoc test was applied. In case of not normal distribution, the Kruskal-Wallis test with Dunn's post hoctest was used. To find significant changes in the development of a variable across years, simple linear regression was used. Statistical analyses were performed using IBM SPSS Statistics (Version 19, IBM SPSS, IL, USA) and GraphPad Prism (Version 5, GraphPad Software, CA, USA). Significance was accepted at $p<0.05$ (two-sided for *t*-tests). Data in the text are given as mean ± standard deviation (SD).

RESULTS

Participation and performance trends:

Between 1988 and 2011, 53 races were held. Among the 1,256 starters, 102 athletes were women (8.1 %) and 1,154 were men (91.9 %). On average, 52.5±22.4 athletes with 48.4±20.4 men and 4.0±3.2 women competed annually in these races. Per race, 21±12 men and 2±1 women started where 15±9 men and 2±1 women finished (Table 1).

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Table 1: Number of starters, finishers and non-finishers

Year	Race	Starter		Finisher		Non-Finisher	
		Men	Women	Men	Women	Men	Women
1988	Le Fontanil (FRA)	11	-	7	-	4	-
1989	Le Fontanil (FRA)	8	1	6	1	2	-
1990	Le Fontanil (FRA)	28	-	21	-	7	-
1991	Le Fontanil (FRA)	28	1	13	-	-	1
1992	Le Fontanil (FRA)	28	1	16	1	12	-
	Lensahn (GER)	9	2	6	1	3	1
1993	Le Fontanil (FRA)	28	1	20	1	8	-
	Lensahn (GER)	17	1	15	1	2	-
1994	Le Fontanil (FRA)	37	4	-	2	15	2
	Lensahn (GER)	24	2	18	2	6	-
1995	Le Fontanil (FRA)	43	3	19	2	24	1
	Lensahn (GER)	24	1	21	1	3	-
1996	Le Fontanil (FRA)	29	4	18	3	11	1
	Neulengbach (AUT)	10	-	7	-	3	-
	Lensahn (GER)	18	2	16	2	2	-
1997	Le Fontanil (FRA)	40	8	23	3	17	5
	Neulengbach (AUT)	7	1	3	1	4	-
	Lensahn (GER)	20	2	17	2	3	-
1998	Le Fontanil (FRA)	26	4	17	4	9	-
	Neulengbach (AUT)	20	3	12	2	8	1
	Lensahn (GER)	21	4	17	4	4	-
1999	Neulengbach (AUT)	20	3	12	2	8	1
	Lensahn (GER)	13	2	11	2	2	-
2000	Le Fontanil (FRA)	21	4	16	3	5	1
	Neulengbach (AUT)	10	1	6	1	4	-
	Lensahn (GER)	30	6	22	5	8	1
	Virginia (USA)	7	-	6	-	1	-
2001	Le Fontanil (FRA)	22	4	15	3	7	1
	Lensahn (GER)	33	1	27	1	6	-
	Virginia (USA)	4	-	2	-	2	-
2002	Lensahn (GER)	24	1	20	1	4	-
	Virginia (USA)	5	1	3	-	2	1
2003	Lensahn (GER)	38	4	35	3	3	1
	Virginia (USA)	6	2	5	1	1	1
2004	Lensahn (GER)	26	2	23	2	3	-
	Virginia (USA)	6	2	6	2	-	-
2005	Lensahn (GER)	28	2	19	2	9	-
	Virginia (USA)	8	3	4	2	4	1
2006	Moosburg (AUT)	29	3	20	3	9	-
	Lensahn (GER)	25	1	20	1	4	-
	Virginia (USA)	8	1	5	1	3	-
2007	Moosburg (AUT)	6	-	5	-	1	-
	Lensahn (GER)	43	2	32	1	11	1
	Virginia (USA)	18	1	14	1	4	-
2008	Lensahn (GER)	41	2	36	1	5	1
	Virginia (USA)	11	1	10	1	1	-
2009	Lensahn (GER)	41	-	33	-	8	-
	Virginia (USA)	13	1	7	1	6	-
2010	Lensahn (GER)	45	3	38	3	7	-
	Virginia (USA)	4	1	3	1	1	-
	Lichfield (GBR)	22	1	17	1	5	-
2011	The New Forrest (GBR)	11	-	11	-	-	-
	Virginia (USA)	15	-	13	-	2	-
	Lensahn (GER)	45	2	36	2	9	-
Sum	-	1,154	102	824	80	292	22
Mean±SD	-	21(12)	2(1)	15(9)	2(1)	6(4)	1(1)

Table 2: Number of multiple participations for women and men

Number of participations	Overall	Women	Men
1x	300	12	288
2x	75	6	69
3x	47	1	46
4x	25	-	25
5x	25	2	23
6x	13	1	12
7x	8	-	8
8x	4	2	2
9x	5	-	5
10x	7	-	7
11x	1	-	1
12x	2	-	2
14x	1	-	1
15x	2	-	2
24x	1	-	1
25x	1	1	-
27x	1	-	1

For all starters, 288 men (35%) and 12 women (15%) finished at least one Triple Iron ultra-triathlon (Table 2).

Overall (r^2=0.27, P<0.01) and male participation (r^2=0.31, P<0.01) increased across years. The number of women remained unchanged at 8% (P>0.05). In men 824 athletes (71.4%) were able to finish; in women, 80 athletes (78.4%) finished (Table 1).

Gender difference across years:

Men finished a Triple Iron ultra-triathlon within 2,146±127.3 min, significantly faster than women with 2,615±327.2 min (P<0.001) (Fig. 1).

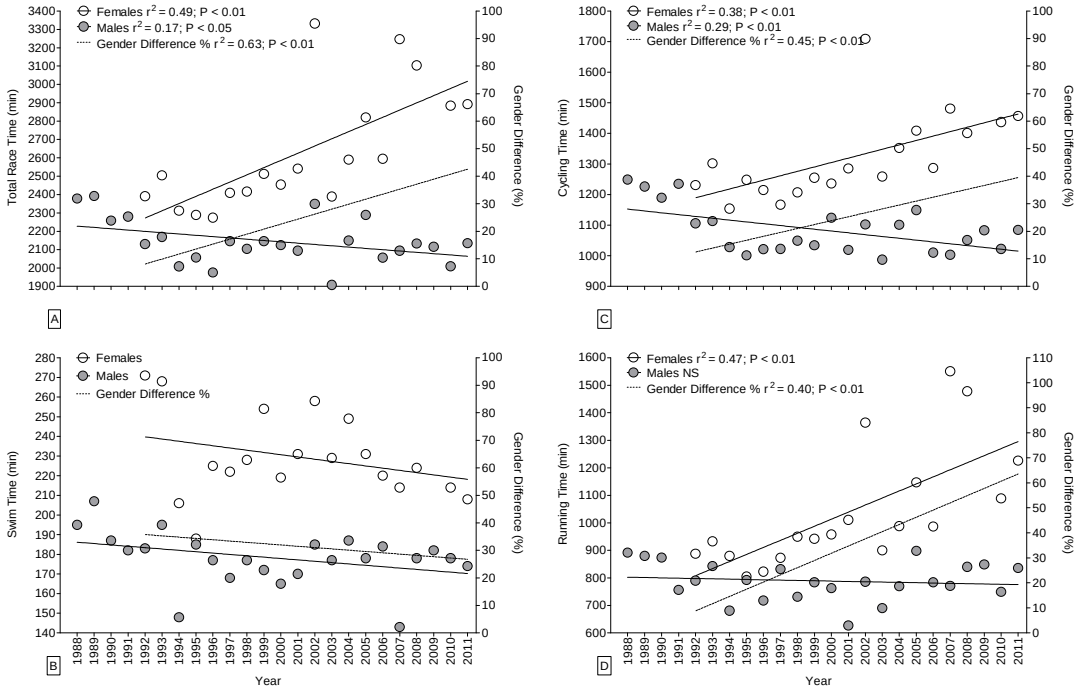

Fig. 1: Performance and gender difference of the top performance for women and men for overall race time (Panel A), swimming (Panel B), cycling (Panel C) and running (Panel D)

Men improved their performance (r^2=0.17; P<0.05), whereas females became slower (r^2=0.49; P<0.01) across years. The gender difference in performance increased from 10% in 1992 to 42% in 2011 (r^2=0.63; P<0.01). In swimming, neither top men nor top women improved (P>0.05). The gender difference decreased from 35% in 1992 to 28% in 2011 (P<0.05). Top men achieved swimming times of 178.4±13.9 min and top women of 230.6±21.8 min (P>0.05). In cycling, top men achieved split times of 1,084±80.1 min and were significantly faster than top women with 1313±135.3 min (P<0.001). Top men became faster in cycling, whereas top women became slower across years. The gender difference increased from 12% in 1992 to 40% in 2011 (P<0.05). Top men completed the run within 787±70.4 min and were faster than top women with 1032±218.4 min (P<0.001). For running, top men showed no change in performance across years whereas top women became slower. The gender difference increased from 10% in 1992 to 64% in 2011 (P<0.05). The longitudinal analysis of the five women and five men with the highest number of participations (Figure 2) showed that performance decreased in one female (r^2=0.45; P=0.01) (Panel C). The four other women as well as all five men showed no change in overall race time across the years.

DISCUSSION

We intended to investigate the changes in participation and performance and the gender difference in Triple Iron ultra-triathlon across the years from 1988 to 2011. Considering the study design, this cross-sectional study was limited because we were unable to take into consideration aspects of age [4,20] , training [23-25], previous experience [9,24,26], nutrition [27,28] anthropometry [10,23,29], fluid metabolism [6], race intensity [30], motivation [31] and equipment [32]. Another limiting factor for an ultra-endurance performance is the weather [13,33-35].

Female participation remained unchanged at 8% whereas male participation increased across years. A low female participation rate has been previously observed in ultra-triathlons [11,17]. In other ultra-endurance distances such as 100-km ultra-marathons, female participation was higher at ~13% [20]. In 161-km ultra-marathoners, female participation increased from 10-12% in 1986-1988 to 20-22% in 2001 [14]. A reason for the low female participation in Triple Iron ultra-triathlons could be the effort athletes have to invest in training. When male 100-km ultra-marathoners were compared to male Triple Iron ultra-triathletes, triathletes invested ~19.3 hours per week in training, runners only ~7.2 hours [23]. Motivation to train for an ultra-endurance performance might differ between the genders. Psychological issues such as personality, motivation, and goal orientation have been investigated in endurance athletes [36-38]. For women, the motivation to exercise is the desire to lose body fat, to increase physical fitness, and to gain social affiliation [36-38]. Women participating in competition at a recreational level report the aspects of achievement, of personal accomplishment and of empowerment as their motivation [39,40]. Regarding an ultra-endurance performance, the longer events rely on long-term preparation, sufficient nutrition, accommodation of environmental stressors, and psychological toughness [41]. For female ultra-marathoners, the strongest sources of motivation were health and personal achievement [31]. Female ultra-marathoners were more task-orientated than ego-orientated and set goals for their events [31].

The overall race times for women increased across years, leading to an increase in the gender difference from 10% in 2000 to 40% in 2011. The reasons for the decrease in women's performance might be in their split times [7,42]. The split time for women in swimming improved non-significantly across years. This finding is not surprising, since studies on triathletes showed that the gender difference in swimming was generally smaller than the gender difference in cycling and in running [3,4,43]. Swimming, however, is not relevant for overall race time in a Triple Iron ultra-triathlon [7,42]. The running performance, as well as the cycling performance in women decreased. We assume that the limiting factor is the lower skeletal muscle mass in women [29]. Also, the aspect of motivation to train hard should be considered [31,40]. Levy reported for women that psychological motives were strong motivators [40]. Men, on the other side, rather search for competition and try to reach high rankings. Training for ultra-endurance athletes relies heavily on the athlete's tolerance to repetitive strain. Successful ultra-endurance performance is characterized by the ability to sustain a higher absolute speed for a given distance than other competitors [41].

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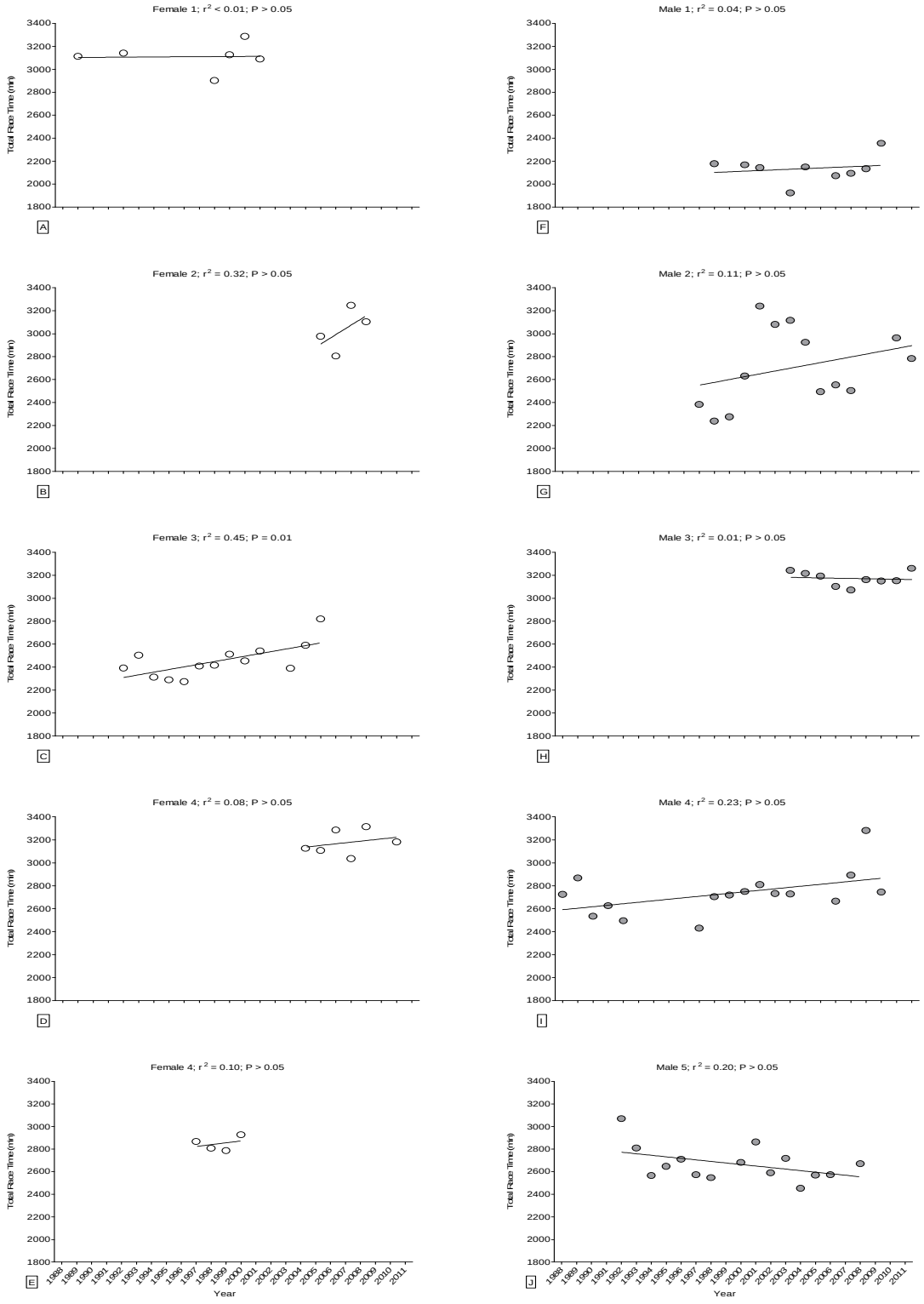

Fig. 2: Longitudinal-analysis of the five women (Panel A-E) and the five men (Panel F-J) with the highest number of participations in a Triple Iron ultra-triathlon

In recent years, an increase in female participation has been reported for ultra-marathons [14]. Although female ultra-marathoners improved their performance [14], a gender gap remained [20]. The gender difference was ~17% for top runners and ~22% for top ten runners in a 100-km ultra-marathon [20]. For 161-km ultra-marathoners, the gender difference was ~20% [16]. Also in triathlon, an increase in participation has been reported for ultra-endurance distances [11]. Although it was assumed that women may outrun men with increasing length of an endurance performance [21,22], a gender gap exists in endurance performance. In triathlon, the gender difference seems to increase with increasing length for a performance. In an off-road triathlon, the gender difference was ~19.2% [43]. In an Ironman triathlon, the gender difference was ~12.6% [3,4]. For triathlon distances longer than the Ironman, the gender difference was ~19.3% in a Double Iron ultra-triathlon, ~19.2% in a Triple Iron ultra-triathlon, and ~29.7% in a Deca Iron ultra-triathlon [11]. However, the gender difference seemed to decrease across years in triathlon [45]. Another factor for the decrease in performance in women could be that the motivation in achieving best times has lost importance [31]. This may be due to the influence of social factors. Possibly, female athletes might rank the social interaction in the race and during training as a more important reason for taking part in the Triple Iron ultra-triathlon.

It would be interesting in future studies to perform a longitudinal observation and to compare the age-related decline from cross sectional and longitudinal data. A short analysis of the present data showed that four ultra-triathletes finished the Triple Iron ultra-triathlon at least eight times between 1992 and 2010. For these four ultra-triathletes, their total performances did not significantly change across the ages. These findings suggest that some exceptional ultra-triathletes are able to perform at the same level of performance during an 8-(subject A) to 16-year (subject D) period.

CONCLUSION

We found an increase in overall participation in these Triple Iron ultra-triathlons where male participation increased across years and female participation remained unchanged at 8%. Men improved their performance, while women's race times increased. The gender difference for winners increased from 10% in 1992 to 42% in 2011. Men improved their cycling performance whereas women's performance decreased in both cycling and running. The reasons for the increase of the gap between female and male Triple Iron ultra-triathletes need further investigations.

ACKNOWLEDGMENTS

The authors thank all race directors for providing us their race results.

Conflict of interests: None

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