Research Article

The Role of Nationality on the Pacing of Ironman Triathletes

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Abstract

The aim of the present study was to examine the role of nationality on the pacing of Ironman triathlon (3.8 km swimming, 180 km cycling, and 42.195 km running). Data from 302,535 athletes (women, n = 61,087; men, n = 241,448) competing between 2002 and 2015 in 253 different Ironman triathlon races were analyzed. We examined split times (i.e. swimming, cycling, and running) and transition time, expressed as percentage of the overall race time. Participants were classified into performance groups according to their overall race time: 9 - 10 hours, 10 - 11 hours, 11 - 12 hours, 12 - 13 hours, 13 - 14 hours, 14 - 15 hours, 15 - 16 hours, > 16 hours. Compared to men, women spent relatively less time in swimming (P < 0.001, d = -0.07), running (P < 0.001, d = -0.14) and transition time (P < 0.001, d = -0.11), and more time in cycling (P < 0.001, d = 0.21). Germans were the fastest in both women and men (P < 0.001); Australians, Austrians and Brazilians were also among the four fastest nationalities in both sexes; (b) in women, athletes from New Zealand spent relatively the least time and athletes from Brazil the most on swimming, whereas in men, Australians spent relatively the least time and Austrians the most (P < 0.001); (c) Austrians spent relatively the least time in cycling and British the most in women, whereas Austrians spent relatively the least time and Spanish the most in men (P < 0.001); (d) British spent relatively the least time in running and Australians in women, and Spanish spent relatively the least time and Australians the most in men (P < 0.001); and (e) Australians spent relatively the least time in transition and British the most in women, whereas Australians spent relatively the least time and Irish the most in men (P < 0.001). Therefore, nationality should be considered in optimizing pacing strategy in Ironman triathlon.

Keywords: Swimming, Cycling, Running, Transition Time, Ultra-Endurance

1. Background

Ironman triathlon (i.e. 3.8 km swimming, 180 km cycling, and 42.195 km running) is a sport of high popularity as recent findings have documented an increase of the number of races hold annually and of athletes participating in them (1). Somatotype, physiological capacity, technical proficiency and pacing strategy have been identified as factors influencing performance in triathlon (2). Pacing refers to the changes in speed across a race, i.e. the effort managed across an exercise bout in relation to a specific goal and in the knowledge of the likely demands of the task (3). Moreover, recent studies have suggested that performance in endurance sports might vary by nationality (4, 5) and this trend has been observed in triathlon 'Ironman Hawaii', too (1). However, the relationship between nationality and pacing in Ironman triathlon has not been examined, yet.

Six pacing strategies have been reported (6): negative pacing (i.e. increase in speed over time), positive pacing (i.e. continuous slowing 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). It should be highlighted that pacing in the present study referred to the contribution of swimming, cycling and running to the overall race performance. It has been shown that cycling and running presented similar percentage contributions (~ 40%) for the Ironman distance in an analysis of elite triathletes (7).

Although the abovementioned studies have enhanced our understanding of pacing in Ironman triathlon, no information about the variation of pacing by nationality existed. Such information would be of great practical importance for coaches and fitness trainers working with triathletes, as they could optimize the pacing strategy of their athletes. It has been shown that performance in the 'Ironman Hawaii' varied by nationality with the fastest

women originating from the USA, UK and Switzerland and the fastest men from USA, Germany and Australia ([1](#)). It has been also found that pacing in the 'Ultraman Hawaii' varied by performance level ([8](#)).

Based on the abovementioned studies, we might assume that nationality might influence pacing through its relationship with performance. Therefore, the aim of the present study was to examine the effect of nationality on pacing of Ironman triathletes. Particularly, we investigated whether athletes pace, from one discipline to another, differently compared to athletes of other nationality, and whether transition time varies by nationality. We hypothesized that athletes of the fastest nationalities for overall race time would also be among the fastest in the split disciplines swimming, cycling and running.

2. Methods

2.1. Ethics Approval

This study was approved by the Institutional Review Board of Kanton St. Gallen, Switzerland, with a waiver of the requirement for informed consent of the participants as the study involved the analysis of publicly available data.

2.2. Data Sampling and Data Analysis

All data were obtained from the official website of Ironman triathlon races (http://eu.ironman.com/events/triathlon-races). Split and overall race times of successful female and male professional athletes and age group finishers of all Ironman races were collected. The races were held worldwide between 2002 and 2015. All race times were documented by the official Ironman triathlon website, since full data were only available starting in the year 2002. Before 2002, athletes were not classified in age groups.

Due to missing data or missing age group assignment the data of twelve races could not be gathered. Data from 351,475 athletes competing in 253 different races were considered in the present analysis. Athletes with transition time faster than 1:02 min:sec (n = 4,766), whose values were impossible ([9](#)), were excluded from further analysis. Athletes with transition time slower by three standard deviations (SD) than the mean transition time, i.e. > 35:18 min:sec (n = 3,359), were excluded as outliers. One case, whose age group was not reported, was also excluded resulting in a sample of 343,345 athletes. Only nationalities with at least 10 athletes in each performance group were considered, thus we considered 304,272 athletes. The fastest performance group (i.e. those with race time < 8 hours, n = 1,737) was not included in this analysis due to relatively small number of athletes (< 0.6%) resulting in a final sample of 302,535 (women, n = 61,087; men, n = 241,448).

2.3. Statistical Analysis

All statistical analyses were performed using the statistical software IBM SPSS v.20.0 (SPSS, Chicago, IL, USA). Descriptive statistics (mean and standard deviation of the mean) were used for all data. Sex differences in performance were examined by t-test and the effect size of these differences were evaluated by Cohen's d as $d \leq 0.2$, trivial; $0.2 < d \leq 0.6$, small; $0.6 < d \leq 1.2$, moderate; $1.2 < d \leq 2.0$, large; and $d > 2.0$, very large ([10](#)). Chi-square (χ^2) examined the nationality*performance group association and the magnitude of this association was evaluated using Cramer's φ ($\varphi < 0.10$, trivial; $0.10 \leq \varphi < 0.30$, small; $0.30 \leq \varphi < 0.50$, medium; $\varphi \geq 0.50$, large). A one-way analysis of variance (ANOVA) examined differences in race time among nationalities within each sex. The participants were classified into nine performance groups according to their overall race time: 9 - 10 hours, 10 - 11 hours, 11 - 12 hours, 12 - 13 hours, 13 - 14 hours, 14 - 15 hours, 15 - 16 hours, > 16 hours. Split times in swimming, cycling and running, and time of transition were expressed as percentage of the overall race time. In addition, we used a two-way ANOVA with post-hoc Bonferroni test to examine differences in pacing among performance groups and nationalities. The effect size (ES) was examined by eta square (η^2), classified as trivial ($\eta^2 < 0.01$), small ($0.01 \leq \eta^2 < 0.06$), medium ($0.06 \leq \eta^2 < 0.14$) and large ($\eta^2 \geq 0.14$) ([11](#)). Statistical significance was set at alpha = 0.05.

3. Results

3.1. Sex Difference

A small sex difference was observed in the overall race time with men being faster than women ([Table 1](#)). Men were also faster in all split times; however, the magnitude of this difference ranged from trivial (transition time) and small (running and swimming) to moderate (cycling). Women spent relatively more time in cycling, and less time in swimming, running and transition.

3.2. Race Time

A moderate main effect of nationality on race time was observed in women (P < 0.001, $\eta^2 = 0.060$) and men (P < 0.001, $\eta^2 = 0.095$). Germans were the fastest and US-Americans the slowest in women, whereas Germans were the fastest and Singaporeans the slowest in men ([Figure 1](#)). A nationality*performance group association was shown in women ($\chi^2 = 4177.38$, P < 0.001, $\varphi = 0.262$) and men ($\chi^2 = 25378.41$, P < 0.001, $\varphi = 0.324$), i.e. the distribution of nationality by performance group varied ([Figure 2](#)). Most Germans (27.7%) were in the 11 - 12 hours performance, whereas most US-Americans (20.3%) were in the 13 - 14 hours group

Table 1. Sex Differences in Overall Race Time, Swimming, Cycling, Running and Transition Time in Absolute and Relative (Percentage of the Overall Race Time) Values[a]

Variables	Women (N = 61,087)	Men (N = 241,448)	Cohen's d
Overall race time			
h:min:sec	13:24:35 (1:45:01)	12:34:04 (1:45:48)	0.48
Swimming			
h:min:sec	1:21:01 (0:14:18)	1:16:36 (0:13:37)	0.34
%	10.09 (1.34)	10.19 (1.36)	–0.07
Cycling			
h:min:sec	6:44:28 (0:46:56)	6:14:07 (0:46:27)	0.65
%	50.45 (2.83)	49.82 (3.06)	0.21
Running			
h:min:sec	5:04:15 (0:54:28)	4:48:53 (0:56:24)	0.28
%	37.65 (3.01)	38.11 (3.37)	–0.14
Transition time			
h:min:sec	0:14:51 (0:06:05)	0:14:29 (0:06:15)	0.04
%	1.80 (0.61)	1.87 (0.65)	–0.11

[a]Data are presented as means with standard deviations in brackets. All comparisons between sexes showed differences at P < 0.001.

in women. On the other hand, most Germans (30.0%) were in the 10 - 11 hours performance group and most Singaporeans (21.8%) in the 14 - 15 hours in men. To sum up, Germans were the fastest in both women and men; Australians, Austrians and Brazilians were also among the four fastest nationalities in both sexes; and the magnitude of the effect of nationality on performance group was larger in men than in women.

3.3. Swimming Time

A trivial main effect of nationality on swimming time (%) was observed in women (P < 0.001, $\eta^2 = 0.008$), in which athletes from New Zealand spent relatively the least time (9.65%) and athletes from Brazil the most (10.56%) (Figure 3). Also, there was a nationality × performance group interaction on swimming time in women (P < 0.001, $\eta^2 = 0.002$), in which the differences among nationalities increased in the slowest performance groups. In men, there was a small main effect of nationality on swimming time (%) (P < 0.001, $\eta^2 = 0.011$), in which athletes from Australia spent relatively the least time (9.67%) and athletes from Austria the most (10.81%). Also, a nationality × performance group interaction on swimming time was shown in men (P < 0.001, $\eta^2 = 0.004$), in which the differences among nationalities increased in the slowest performance groups. It should be highlighted that the magnitude of the

effect of nationality on swimming time (%) was similar in both sexes.

3.4. Cycling Time

In cycling time (%), a small main effect of nationality (P < 0.001, $\eta^2 = 0.015$) was shown for women, where athletes from Austria spent relatively the least time (50.25%) and athletes from Great Britain the most (52.40%). Also, there was a nationality × performance group interaction on cycling time in women (P < 0.001, $\eta^2 = 0.004$), in which the differences among nationalities increased in the slowest performance groups. A small main effect of nationality on cycling time (%) in men (P < 0.001, $\eta^2 = 0.045$) was found, in which athletes from Austria spent relatively the least time (48.60%) and athletes from Spain the most (51.81%). Also, there was a nationality × performance group interaction on cycling time in men (P < 0.001, $\eta^2 = 0.013$), in which the differences among nationalities increased in the slowest performance groups. To sum up, the magnitude of the effect of nationality on cycling time was larger in men than in women.
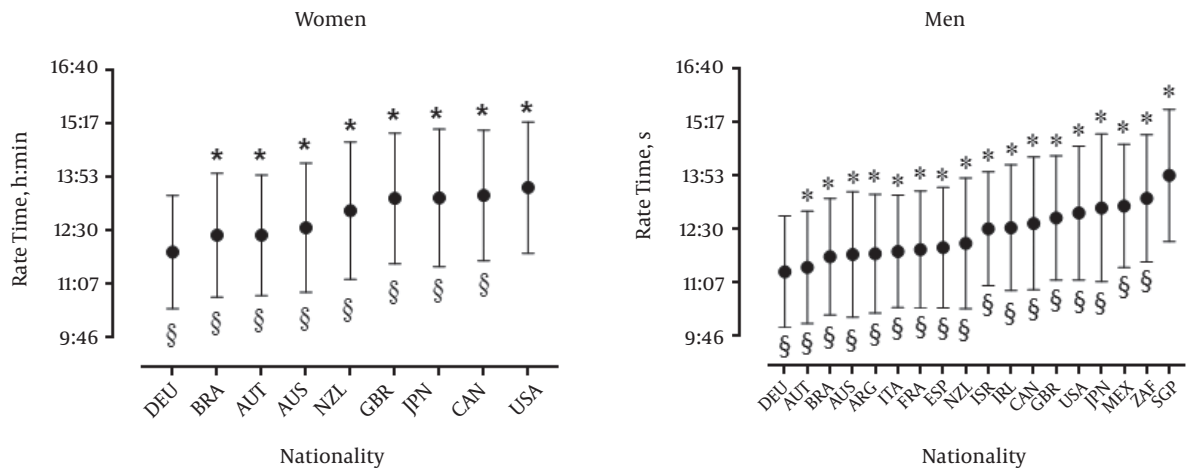
3.5. Running Time

A small main effect of nationality on running time (%) was observed in women (P < 0.001, $\eta^2 = 0.011$), in which athletes from Great Britain spent relatively the least time (35.97%) and athletes from Australia the most (37.99%). Also, there was a trivial nationality × performance group interaction on running in women (P < 0.001, $\eta^2 = 0.004$), in which the differences among nationalities increased in the slowest performance groups. Also, a small main effect of nationality on running time (%) was found in men (P < 0.001, $\eta^2 = 0.036$), in which athletes from Spain spent relatively the least time (36.41%) and athletes from Australia the most (39.58%). There was a small nationality × performance group interaction on running time was shown in men (P < 0.001, $\eta^2 = 0.010$), in which the differences among nationalities increased in the slowest performance groups. It should be emphasized that the magnitude of the effect of nationality was larger in men than in women.
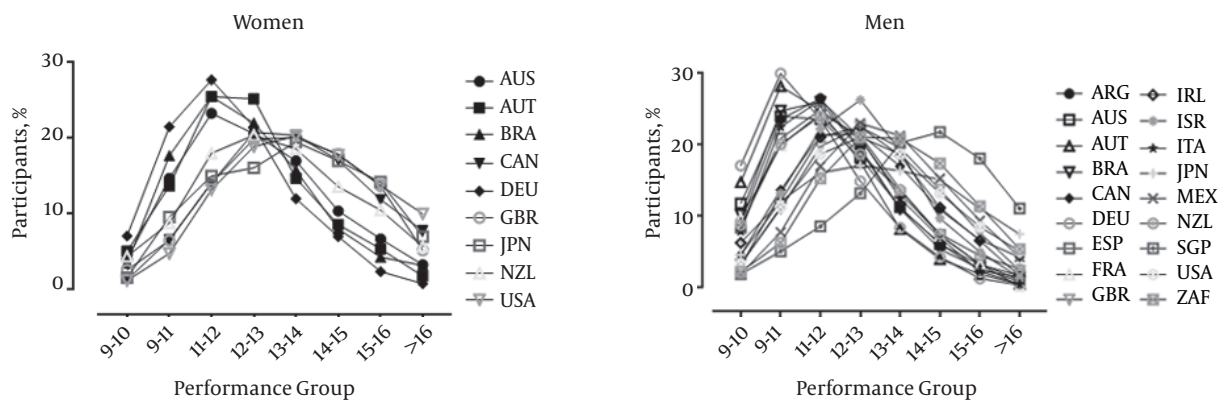
3.6. Transition Time

With regards to transition time (%), a small main effect of nationality (P < 0.001, $\eta^2 = 0.014$) was observed for women, in which athletes from Australia spent relatively the least time (1.45%) and athletes from Great Britain the most (1.78%). Also, there was a trivial nationality × performance group interaction on transition time in women (P < 0.001, $\eta^2 = 0.005$), in which the differences among nationalities increased in the slowest performance groups. A small main effect of nationality on transition time (%) in

Figure 1. Race Time by Nationality in Women and Men

Figure 2. Distribution (%) of Participants of Each Nationality by Performance Group in Women and Men

men ($P < 0.001$, $\eta^2 = 0.022$) was shown, in which athletes from Australia spent relatively the least time (1.59%) and athletes from Ireland the most (2.08%). There was a trivial nationality × performance group interaction on transition time in men ($P < 0.001$, $\eta^2 = 0.008$), in which the differences among nationalities increased in the slowest performance groups.

4. Discussion

The aim of the present study was to examine the effect of nationality on pacing of Ironman triathletes. We were especially interested whether athletes pace, from one

discipline to another, differently compared to other athletes depending on their nationality, and whether transition time varies by nationality, i.e. athletes of different nationalities differ for transition time. The main findings of the present study were that (a) Germans were the fastest in both women and men; Australians, Austrians and Brazilians were also among the four fastest nationalities in both sexes; (b) in women, athletes from New Zealand spent relatively the least time and athletes from Brazil the most on swimming, whereas in men, Australians spent relatively the least time and Austrians the most; (c) Austrians spent relatively the least time in cycling and British the most in women, whereas Austrians spent relatively the least time

Figure 3. Relative Times of Swimming, Cycling, Running and Transition Expressed As Percentage of the Total Race Time by Nationality in Women and Men
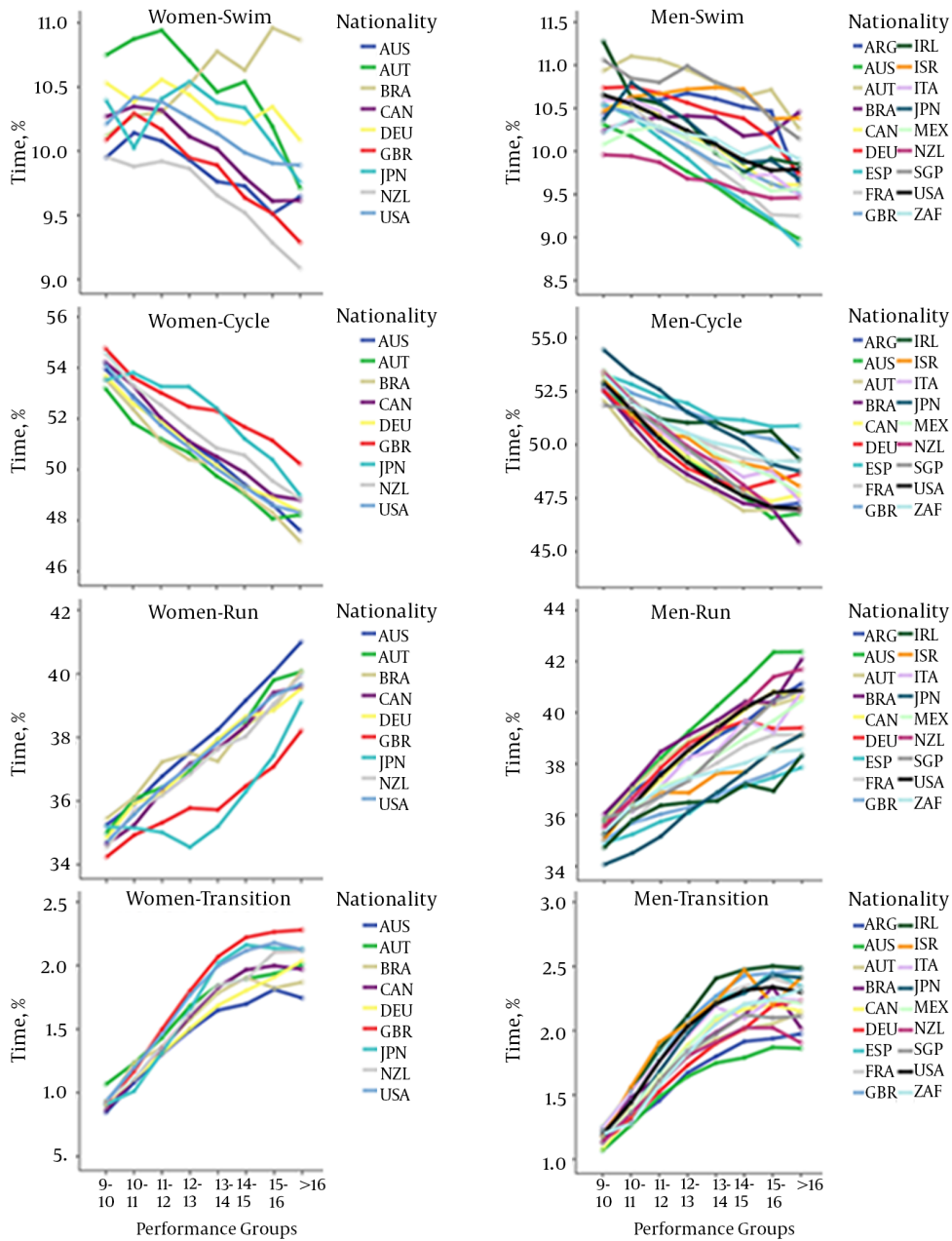
DEU, Germany; AUT, Austria; BRA, Brazil; AUS, Australia; ARG, Argentine; ITA, Italy; FRA, France; ESP, Spain; NZL, New Zealand; ISR, Israel; IRL, Ireland; CAN, Canada; GBR, United Kingdom; USA, United States of America; JPN, Japan; ZAF, South Africa; SGP, Singapore.

and Spanish the most in men; (d) British spent relatively the least time in running and Australians in women, and Spanish spent relatively the least time and Australians the most in men; and (e) Australians spent relatively the least time in transition and British the most in women, whereas Australians spent relatively the least time and Irish the most in men.

The largest variation by nationality concerned the slowest performance groups, whereas relatively small variation by nationality was observed in the fast performance

Table 2. Distribution of Participants of Each Nationality by Performance Group in Women

Variables	Performance Groups, h								
	9 - 10	10 - 11	11 - 12	12 - 13	13 - 14	14 - 15	15 - 16	> 16	Total
AUS	161	597	951	841	694	425	272	134	4,075
AUT	44	117	218	216	126	74	46	15	856
BRA	20	100	144	124	89	45	24	18	564
CAN	96	500	1,060	1,561	1,538	1,284	898	585	7,522
DEU	156	470	604	469	262	153	53	17	2,184
GBR	65	165	359	507	512	457	350	132	2,547
JPN	12	72	113	121	147	128	107	53	753
NZL	80	161	329	373	340	248	192	105	1,828
USA	501	1,974	5,364	7,697	8,288	7,237	5,638	4,059	40,758
Total	1,135	4,156	9,142	11,909	11,996	10,051	7,580	5,118	61,087

Table 3. Distribution of Participants of Each Nationality by Performance Group in Men

Variables	Performance Groups, h								
	9 - 10	10 - 11	11 - 12	12 - 13	13 - 14	14 - 15	15 - 16	> 16	Total
ARG	196	499	561	413	235	132	50	31	2,117
AUS	2,192	4,436	4,370	3,375	2,095	1,133	590	319	18,510
AUT	1,065	2,033	1,783	1,270	589	290	134	39	7,203
BRA	584	1,426	1,494	1,103	631	310	154	50	5,752
CAN	811	2,436	3,813	3,828	3,019	1,941	1,184	757	17,789
DEU	2,220	3,901	3,068	1,940	1,091	557	172	48	12,997
ESP	514	1,280	1,529	1,273	811	455	204	67	6,133
FRA	1,008	2,071	2,539	2,214	1,440	761	347	26	10,406
GBR	604	2,006	3,570	4,052	3,542	2,467	1,381	425	18,047
IRL	124	239	416	442	365	221	130	31	1,968
ISR	26	115	194	229	167	85	44	12	872
ITA	281	796	930	744	443	246	81	17	3,538
JPN	195	510	677	716	688	634	465	314	4,199
MEX	94	382	830	1,127	1,043	746	461	208	4,891
NZL	486	1,109	1,321	1,028	756	411	248	145	5,504
SGP	21	57	96	148	227	244	202	124	1,119
USA	3,906	13,166	21,843	24,651	21,805	15,342	9,956	5,994	116,663
ZAF	84	234	574	789	780	651	425	203	3740
Total	14,411	36,696	49,608	49,342	39,727	26,626	16,228	8,810	241,448

groups. This observation implied that the fast athletes of all nationalities consisted in a relatively homogenous group, i.e. they adopted similar training and nutrition practices resulting in relatively small differences in pacing, which was close to the 'optimal' percentage contribution 10%, 54%, 35%, and 1% for swimming, cycling, running and transition, respectively.

It is well known that 'Ironman Hawaii' (1) and the qualifier races (12) have been dominated by women and men from USA in participation and performance. However, recent studies investigated only overall performance in Ironman triathlon regarding nationality and not the influence of the split disciplines on overall race time. For example, it has been found that split and overall race times were slower in 'Ironman Hawaii' compared to its qualifiers (12). The American dominance in participation and performance in Ironman triathlon races is most likely due to geographical reasons as it has been reported for longer triathlon distances such as Double Iron ultra-triathlon (9, 13) and Triple Iron ultra-triathlon (14). Similarly, it has been found for 'Ironman Switzerland' as a qualifier for 'Ironman Hawaii' that most finishers originating from Switzerland and Swiss triathletes were the fastest (15). Also in another multi-sports disciplines such as duathlon (i.e. running, cycling and running), athletes from Switzerland were the most numerous and the most successful in the powerman world championship 'Powerman Zofingen' (12).

An important and unexpected finding was the German

athletes were the fastest overall in these Ironman races. Regarding 'Ironman Hawaii' as the world championship in ironman triathlon, the dominance of the nationalities has changed in recent decades. Back in the beginning, Ironman was dominated by US-American athletes where US-American men won the first 17 versions of Kona. In 1994, it changed after the victory of Greg Welch from Australia. Since then, Australians held many of the men's top spots during the mid-2000s to early 2010. However, in 2016, the top Australian was Tim Van Berkel in 19th place.

The current trend in 'Ironman Hawaii' trend seems to be distinctly European. For the men's pro race, 14 of the top 20 men were European; six of the top 10 women were European. It is difficult to explain the exact reason why the German triathletes are so strong. It could be due to their huge support at home with events like Challenge Roth, Ironman Frankfurt or the highly competitive German sprint series, the Bundesliga. Another possibility could be that experienced Ironman Hawaii winners share their experience with the younger athletes. It could also be that the German s' history in long course racing is so strong and so established that young German athletes see long-course racing as a place where they can shine (www.triathlete.com/2016/10/ironman/behind-germanys-kona-podium-domination-294851).

4.1. Limitations, Strength aAnd Practical Applications

A main limitation of the present study was that the fastest triathletes (< 8 hours) were excluded from the analysis due to their relatively small number; thus, the findings should generalize with caution to professional triathletes. Furthermore, the findings should not apply to other triathlon distances as it has been shown that pacing strategies during triathlon are influenced by distance (16). Strength of the study was that it examined one of the largest samples of Ironman triathletes ever studied. To date, the relative contribution of the three triathlon disciplines to the overall performance has not been well studied, in contrast to the changes in speed within each discipline (17). Although the role of nationality on Ironman triathlon performance was already known (18), no information about the role of origin on pacing existed previously. The findings were of great practical importance for coaches and trainers working with Ironman triathletes. It is recommended that coaches consider the nationality of their athletes' opponents due to the impact of nationality on pacing.

4.2. Conclusions

In summary, we found differences between sexes and among nationalities regarding pacing in Ironman triathletes. Women in contrast to men spent relatively less time in swimming, running and transition time, and more time in cycling. Nationality influenced all splits, but its effect was larger in cycling and running and smaller in swimming and transition time. Therefore, nationality should be considered in optimizing pacing strategy in Ironman triathlon.

Footnotes

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