Personal Best Time, Not Anthropometry or Training Volume, is Associated With Total Race Time in a Triple Iron Triathlon

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Abstract

Knechtle, B, Knechtle, P, Rosemann, T, and Senn, O. Personal best time, not anthropometry or training volume, is associated with total race time in a Triple Iron triathlon. *J Strength Cond Res* 25(4): 1142–1150, 2011—The purpose of this study was to investigate in 81 male recreational ultratriathletes (64 finishers and 17 nonfinishers) the relationship of anthropometry, prerace experience, and training with race outcome in a Triple Iron triathlon, using bi and multivariate analyses. In the bivariate analysis, the sum of 8 skinfolds ($r = 0.38$) and the sum of upper body skinfolds ($r = 0.37$) were positively related to total race time. None of the anthropometric variables was related to the swim or bike split. Circumference of upper arm ($r = 0.42$), percent body fat ($r = 0.43$), the sum of 8 skinfolds ($r = 0.47$), and the sum of upper body skinfolds ($r = 0.45$) were positively associated with the time in the run split. None of the training variables was related to total race time or split times. Personal best time in an Ironman triathlon ($r = 0.59$) and a Triple Iron triathlon ($r = 0.82$) were positively and highly significantly related to total race time. When all significant variables after bivariate analysis were included in a regression model, personal best time in a Triple Iron triathlon ($p < 0.0001$) remained the single predictor variable. For practical considerations, athletes with a background as an ultrarunner might have an advantage in successfully finishing a Triple Iron triathlon. However, ultrarunners should also have enough prerace experience in competing in Ironman and Triple Iron triathlons to successfully finish such a race.

Key Words ultraendurance, body fat, skin-fold, intensity

Introduction

Triathletes have to train and race in 3 different disciplines. This requires the athlete to train more–regarding investment of time–and differently, when compared with athletes training and racing in only a single discipline. Long-distance triathlons such as an Ironman triathlon covering 3.8-km swimming, 180-km cycling, and 42.195-km running are enormously popular. Every year, an increasing number of athletes participate in these races to qualify for the Ironman Hawaii (22). Apart from the Ironman distance, longer triathlons do exist such as the Triple Iron Triathlon covering 11.4-km swimming, 540-km cycling, and 126.6-km running. For more than 20 years, a growing number of athletes have performed in these increasingly popular races. Unfortunately, only a few studies with small sample sizes have been investigated, because seldom more than 30 athletes participate and finish in such a race (8,13).

For finishing a Triple Iron triathlon, it needs an enormous effort. The question is whether anthropometry or training variables, apart from physiological parameters, will enhance the ability to finish this type of ultraendurance performance in the fastest possible time. In short-distance triathletes, low levels of adiposity are important for total race time (16), and elite triathletes are generally described as average to light-weight and with low levels of body fat (25). Regarding the association of anthropometry with race time in ultraendurance triathletes, no effect was demonstrated in performing over 10 times an Ironman distance within 10 days (10), or over the Triple Iron Triathlon distance (8,13). Instead, in short-distance triathletes, training parameters were more notable than anthropometric measurements in the prediction of performance (18) and Laurenson et al. (17) concluded that no ideal or unique anthropometric profile with influence on overall performance could be established.

Previous race experience might also affect ultraendurance performances, because in a recent study of ultrarunners, a positive relationship of a personal best time in marathon running to performance in a 24-hour run was demonstrated, whereas anthropometry and training volume revealed no impact (15). In short-distance triathletes, previous best

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performance in a short-distance triathlon coupled with weekly cycling distances and longest training rides could partially predict overall performance in Ironman triathletes (5).

There are no data regarding the question as to whether anthropometry, training volume, or previous best performance is associated with achievement in ultradistance triathlons of longer than the Ironman distance. The aim of this present investigation was therefore to investigate, in male ultratriathletes in a Triple Iron Triathlon, whether anthropometry, training volume, or previous race experience was relevant in successfully finishing a Triple Iron Triathlon. We hypothesized, having regard to present-day literature, that low levels of body fat would be related to total race time and a high training volume would lead to low body fat.

Methods

Experimental Approach to the Problem

To increase the sample size, we included data from the same race course in 2 subsequent years. All entrants of the Triple Iron Triathlon Germany 2007 and 2008 were contacted, via a separate newsletter from the organizer, at the time of inscription to the race and informed about our investigation. From July 27–29, 2007, and July 25–27, 2008, the Triple Iron Triathlon Germany was held in Lensahn, Schleswig-Holstein, Germany, covering 11.6-km swimming, 540-km cycling, and 126.6-km running. The swim was held in a 50-m heated outdoor pool with a temperature of 25°C, and wetsuits were allowed. After passing through the transition area, 67 laps of a hilly course of 8 km per lap had to be cycled in the surroundings of the town. After the cycling section, the athletes had to change to the flat run course of 96 laps of 1.31 km per lap in the town of Lensahn. The cycling course was nearly free of road traffic, whereas the running course was completely free of traffic and illuminated during the night. All athletes had their own support crew to provide nutrition and change of clothing and equipment. The athletes had to arrive at the finish line within 58 hours. The general weather conditions were comparable in both races. In the 2007 event, the weather was cloudy on the first day, with no rain, and the temperature rose to 28°C. On the first night toward sunrise, it was cold, and it rained a little. The second day was initially cloudy, then in the afternoon, the sun appeared and the temperature rose to 28°C. In 2008, the weather on the first day was cloudy with wind, and the temperature rose to 22°C. On the first night, little rain fell, and the temperature dropped to 12°C. The following day, the sky was cloudy, and the temperature rose to 25°C. On the second night, the temperature dropped again to 12°C and did not rise higher on the next day.

Subjects

In total, 88 male athletes started in these 2 races, and 81 participated in our investigation. The athletes racing in both years were included for only 1 year, the first year of participation. The subjects were informed of the experimental risks and gave their informed written consent before the investigation. The investigation was approved by the Institutional Review Board for use of Human subjects. A total of 64 male Caucasian nonprofessional ultratriathletes of our study group finished the races successfully within the time limit of 58 hours. The other 17 athletes dropped out because of medical problems such as exhaustion and overuse injuries of the lower limbs. Table 1 shows the anthropometry of finishers and nonfinishers, Table 2 their prerace experience, and Table 3 their training parameters.

Table 1. Comparison of age and anthropometric variables between finishers and nonfinishers.*

Variables of anthropometry	Finishers ($n = 64$)	Nonfinishers ($n = 17$)
Age (y)	39.0 (35.4–44.0)	39.0 (35.3–46.3)
Body height (m)	1.78 (1.73–1.83)	1.78 (1.76–1.84)
Body mass (kg)	76.7 (72.1–83.0)	79.9 (72.0–84.8)
Body mass index ($kg \cdot m^{-2}$)	24.2 (23.2–25.5)	23.1 (23.0–25.9)
Length of leg (cm)	85.5 (82.7–88.0)	87.0 (85.0–89.0)
Length of arm (cm)	79.0 (77.0–81.0)	79.0 (78.0–81.3)
Circumference of upper arm (cm)	30.3 (29.3–31.8)	31.2 (29.7–32.9)
Circumference of thigh (cm)	56.0 (54.0–57.5)	57.5 (55.3–59.5)
Circumference of calf (cm)	38.9 (37.9–40.0)	39.0 (37.3–40.2)
Percent body fat (%)	13.7 (12.1–16.7)†	15.1 (14.0–22.1)
Sum of 8 skinfolds (mm)	72.3 (60.5–91.5)†	80.8 (69.2–135.9)
Sum of upper body skinfolds (mm)	55.4 (44.4–67.0)†	66.5 (53.3–103.0)
Sum of lower body skinfolds (mm)	17.8 (14.6–22.2)	21.0 (15.4–22.6)
Skeletal muscle mass (kg)	40.3 (37.7–42.5)	41.1 (38.5–43.1)

*Values are given as median (interquartile range [IQR]).
†Finishers had significant less body fat and both lower total skinfolds and lower upper body skinfolds.

TABLE 2. Comparison of previous race experience and personal best times for finishers and nonfinishers.*

Prerace experience	Finishers ($n = 64$)	Nonfinishers ($n = 17$)
Number of finished Ironman Triathlon races	5 (3–15)	3 (1–20)
Personal best time in Ironman Triathlon (min)	657 (629–688)	696 (637–772)
Number of finished Triple Iron Triathlon races	3 (2–6)	3 (1–4)
Personal best time in Triple Iron Triathlon (min)	2,590 (2,351–2,903)	2,488 (2,298–2,998)

*Values are given as median (IQR). No differences were detected.

Procedures

From the time of entering the race, with the inscription, the athletes kept a comprehensive training diary recording their training units in swimming, cycling, and running, together with the distance (km), duration (hours), and speed ($km \cdot h^{-1}$) for each training session and discipline up to the start of the race. In addition, every athlete indicated his number of finished Ironman and Triple Iron Triathlons and his personal best time in each type of race.

Before the start of the race, body mass, body height, length of arm and leg, circumferences of limbs, and thicknesses of skinfolds were measured. One trained investigator took all the measurements because intertester variability is a major source of error in anthropometric measurements. With these data, we calculated body mass index (BMI), percent body fat, the sum skinfolds, and skeletal muscle mass using anthropometric methods.

Body mass was measured using a commercial scale (Beurer BF 15, Beurer, Ulm, Germany) to the nearest 0.1 kg. Body height was measured using a stadiometer to the nearest 1.0 cm. The length of the arm was measured from *acromion* to the tip of the third finger to the nearest 0.1 cm on the right side; the length of the leg from *trochanter major* to the *malleolus lateralis* to the nearest 0.1 cm again on the right side. The circumference of the upper arm was measured in the middle of the right upper arm to the nearest 0.1 cm; circumference of the right thigh was taken at the level where the skinfold thickness of the thigh was measured (20 cm above the upper pole of the patella), and circumference of the right calf was measured at the maximum circumference of the calf. Skinfold data were obtained using a skinfold calliper (GPM-Hautfaltenmessgerät, Siber & Hegner, Zurich, Switzerland) and recorded to the nearest 0.2 mm. The skinfold measurements were taken once for all 8 skinfolds, and then the procedure was repeated twice by the same investigator; the mean of the 3 measurements was then used for the analyses. The timing of recording the skinfold measurements was standardized to ensure reliability. According to Becque et al. (4), readings were taken 4 seconds after applying the calliper. We assessed, the prerace, intra, and interinvestigator reliability of skinfold measurements in 27 male ultrarunners. The same highly trained investigator who performed the measurements for the

TABLE 3. Comparison of volume and intensity during training in total and for the subdisciplines for both finishers and nonfinishers.*

Variables of training	Finishers ($n = 64$)	Nonfinishers ($n = 17$)
Training volume ($h \cdot wk^{-1}$)	18.0 (15.0–22.0)†	12.0 (11.7–19.0)
Hours of swimming per week in training	3.0 (2.0–4.0)‡	2.0 (1.3–2.5)
Hours of cycling per week in training	10.0 (7.0–11.2)	8.0 (6.0–12.0)
Hours of running per week in training	6.0 (4.5–6.6)†	4.0 (3.0–5.7)
Kilometers of swimming per week in training	8.5 (5.4–10.5)‡	4.5 (3.3–7.0)
Kilometers of cycling per week in training	250 (200–300)	200 (180–300)
Kilometers of running per week in training	60 (45–75)†	40 (28–67)
Speed in swim training ($km \cdot h^{-1}$)	3.0 (2.4–3.0)†	2.5 (2.0–2.8)
Speed in cycle training ($km \cdot h^{-1}$)	28.6 (25.0–30.0)	29.2 (24.0–31.4)
Speed in run training ($km \cdot h^{-1}$)	10.0 (10.0–11.3)	10.0 (8.3–10.6)

*Results are presented as median (IQR). Finishers were investing more time in training, especially in swimming and running.
†$p < 0.05$.
‡$p < 0.01$.

TABLE 4. Comparison of speed in training with speed in racing for the 3 subdisciplines of the finishers ($n = 64$).*

	Speed in training ($km\cdot h^{-1}$)	Speed in racing ($km\cdot h^{-1}$)
Swimming	3.0 (2.4–3.0)	2.8 (2.6–3.1)
Cycling	28.6 (25.0–30.0)†	23.4 (21.7–26.3)
Running	10.0 (10.0–11.3)†	6.4 (5.8–7.4)

*Values are given as median (IQR). During the race, athletes were significantly slower cycling and running compared to training.
†$p < 0.01$.

current study reached an intraclass correlation coefficient of 0.99 for the sum of 8 skinfolds (data submitted for publication). The corresponding measurement errors for duplicate measurements were 1.10 mm for the sum of 8 skinfolds with a small effect on the prediction of percent body fat. The same investigator was compared with another trained investigator to determine objectivity. No significant difference existed between the 2 testers ($p > 0.05$).

Percent body fat was calculated using the anthropometric formula according to Ball et al. (3): Percent body fat $= 0.465 + 0.180\ (\sum 7SF) - 0.0002406\ (\sum 7SF)^2 + 0.0661$ (age), where $\sum 7SF$ = sum of skinfold thickness of chest, midaxillary, triceps, subscapular, abdomen, suprailiac, and thigh. This formula was evaluated using 160 men aged 18–62 years and crossvalidated with dual energy X-ray absorptiometry (DXA). The mean differences between DXA percent body fat and calculated percent body fat ranged from 3.0 to 3.2%. Significant ($p < 0.01$) and high ($r > 0.90$) correlations existed between the anthropometric prediction equations and DXA. Skeletal muscle mass was calculated using the anthropometric formula: Skeletal muscle mass $= Ht \times (0.00744 \times CAG^2 + 0.00088 \times CTG^2 + 0.00441 \times CCG^2) + 2.4 \times sex - 0.048 \times age + race + 7.8$, where Ht = height, CAG = skinfold-corrected upper arm girth, CTG = skinfold-corrected thigh girth, CCG = skinfold-corrected calf girth, sex = 1 for men and 0 for women, race = 0 for white, according to Lee et al. (19). This anthropometric method was evaluated on 189 nonobese subjects and crossvalidated using magnetic resonance imagining evaluation.

Statistical Analyses

The Shapiro–Wilk test was applied to check for normality distribution. Nonnormally distributed data are presented as mean and interquartile range (IQR). Athletes were categorized into 2 groups (finishers 2007 and finishers 2008). Anthropometric, prerace experience, training variables, and final race time were compared between these 2 groups by Kruskal–Wallis equality-of-populations rank test. In a second step, the athletes were categorized into 2 groups (finishers and nonfinishers). Again, anthropometric and training variables were compared between the groups by Kruskal–Wallis equality-of-populations rank test. The coefficient of variation of performance ($CV\% = 100 \times SD/\text{mean}$) for total race time and the split times for the whole sample of finishers ($n = 64$) were calculated.

For further analysis, as a first step, the association of the variables of prerace experience, training, and anthropometry with total race time, including split times, was investigated using bivariate correlation analysis. Spearman correlation

TABLE 5. Association of age and anthropometric variables with total race time and split times.*

Age and anthropometric variables	Total race time	Time swim split	Time bike split	Time run split
Age (y)	−0.05	−0.10	−0.04	−0.04
Body height (cm)	0.10	−0.23	−0.12	0.14
Body mass (kg)	0.26	−0.08	0.02	0.14
Body mass index ($kg\cdot m^{-2}$)	0.25	0.12	0.16	0.35
Length of leg (cm)	0.12	−0.05	−0.07	0.07
Length of arm (cm)	0.06	−0.16	−0.09	0.04
Circumference of upper arm (cm)	0.31	−0.11	0.17	0.42, $p = 0.0005$
Circumference of thigh (cm)	0.13	−0.02	0.03	0.18
Circumference of calf (cm)	0.10	−0.05	0.02	0.21
Percent body fat (%)	0.35	0.09	0.30	0.43, $p = 0.0004$
Sum of 8 skinfolds (mm)	0.38, $p = 0.0019$	0.15	0.31	0.47, $p < 0.0001$
Sum of upper body skinfolds (mm)	0.37, $p = 0.0024$	0.16	0.31	0.45, $p = 0.0002$
Sum of lower body skinfolds (mm)	0.35	0.11	0.20	0.35

*p Value is shown when the correlation was statistically significant after Bonferroni correction ($p < 0.0038$ for 13 variables).

Table 6. Association of training variables with total race time and corresponding split times.*

Training variables	Total race time	Time swim split	Time bike split	Time run split
Training volume ($h \cdot wk^{-1}$)	−0.15	−0.26	−0.25	−0.11
Hours of swimming per week	0.23	−0.14		
Kilometers of swimming per week	0.01	−0.19		
Speed in training of swimming ($km \cdot h^{-1}$)	−0.05	−0.12		
Hours of cycling per week	−0.24		−0.32	
Kilometers of cycling per week	−0.29		−0.33	
Speed in training of cycling ($km \cdot h^{-1}$)	−0.21		−0.12	
Hours of running per week	−0.18			−0.17
Kilometers of running per week	−0.21			−0.19
Speed in training of running ($km \cdot h^{-1}$)	−0.23			−0.17

*p Value is shown when the correlation was statistically significant after Bonferroni correction ($p < 0.0050$ for 10 variables). No association between training variables and race time and split times, respectively, has been found.

Table 7. Association of variables of prerace experience with total race time.*

Prerace experience	*r*
Number of finished Ironman triathlons ($n = 54$)	−0.14
Number of finished Triple Iron triathlons ($n = 42$)	−0.18
Personal best time in Ironman triathlon	0.59, $p < 0.0001$
Personal best time in Triple Iron triathlon	0.82, $p < 0.0001$

*p Value is shown when the correlation was statistically significant after Bonferroni correction ($p < 0.0125$ for 4 variables).

Table 8. Associations between race time and athletes' characteristics using multiple linear regressions.*†

	ß	*SE*	*p* Value
Sum of 8 skinfolds (mm)	−7.8	8.9	0.38
Sum of upper body skinfolds (mm)	7.4	10.7	0.48
Personal best time in an Ironman triathlon	1.63	0.98	0.10
Personal best time in a Triple Iron triathlon	0.73	0.10	<0.0001

**ß* = regression coefficient; *SE* = standard error of the regression coefficient.
†All characteristics showing a significant bivariate association with total race time according to Tables 5–7 have been included in the model as covariates. Coefficient of determination (R^2) of the model was 87%. Personal best time in a Triple Iron triathlon remained the single predictor variable for total race time.

analysis was applied because the data were nonnormally distributed. In a second step, multiple linear regression analysis was used to further investigate the relationship of variable with significance in the bivariate analysis to race time. Sample size calculating for multiple regression analysis with an α-level of 0.05, the 4 predictor variables, an anticipated effect size (f^2) of 0.35 (large), and a desired statistical power level of 0.8, required a minimum sample size of 39. The CV (CV% = 100 × *SD*/mean) of total race time was calculated. For all statistical tests, significance was set at 0.05 level.

Results

Athletes in both the 2007 and 2008 races were no different, regarding anthropometry and final race time. In the 2007 event, 29 participants completed within 2,874 (400) minutes (CV = 13.9%); in 2008, 35 participants finished the race within 2,752 (354) minutes (CV = 12.8%). In total, the 64 athletes finished within 2,811 (379) minutes (CV = 13.4%). For swimming, the 64 racers invested 243 (31) minutes (CV = 12.7%), for cycling 1,367 (169) minutes (CV = 12.3%) and for running 1,187 (239) minutes (CV = 20.1%).

Comparison of Finishers and Nonfinishers

Finishers had a lower percentage of body fat and both a lower sum of 8 skinfolds and a lower sum of upper body skinfolds (see Table 1). No differences were found for prerace experience regarding the number of finished Ironman and

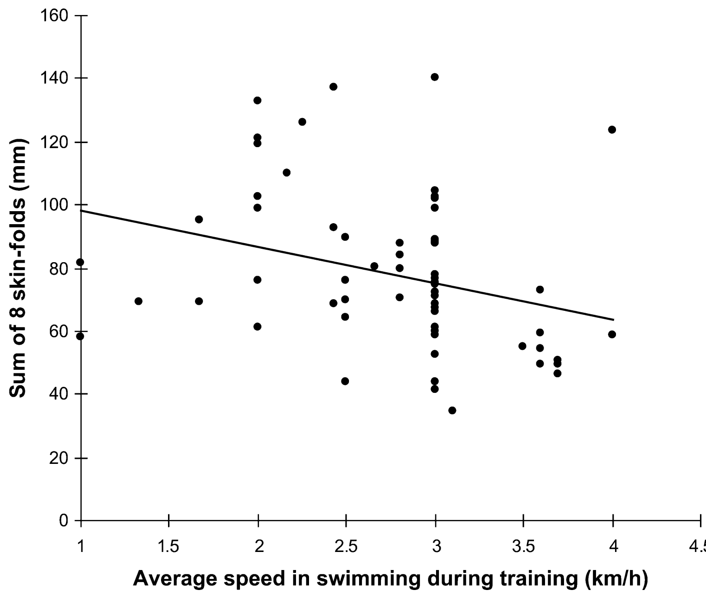

Figure 1. Average speed in swimming during training was negatively and highly significantly related to the sum of 8 skinfolds ($r = -0.44$, $p = 0.0003$).

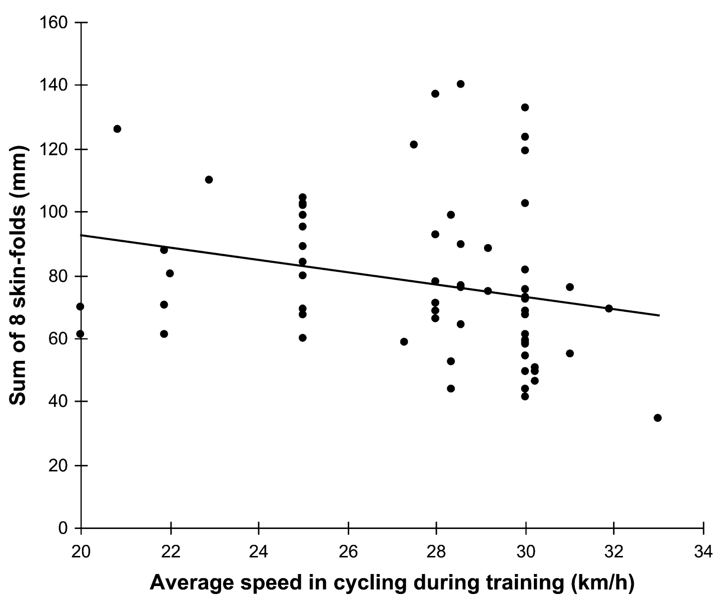

Figure 2. Average speed in cycling during training was negatively and highly significantly associated with the sum of 8 skinfolds ($r = -0.39$, $p = 0.0016$).

Triple Iron triathlons with the corresponding personal best time (see Table 2). Regarding training, finishers invested more hours in training, especially in swimming and running. Furthermore, finishers swam faster during training compared with nonfinishers (see Table 3). During the race, finishers did not swim faster compared with training; they cycled and ran slower in the race compared with training (see Table 4).

Among the nonfinishers, 1 athlete dropped out in the swim section, 5 in the bike split after 57 (11) laps, and 11 in the run section after 68 (35) laps. No athlete suffered an accident or a technical problem leading to dropout while cycling. During the run, the nonfinishers dropped out because of overuse injuries of the lower limb and exhaustion. The nonfinishers dropping out later in the bike or run sections completed the swim section within 288 (43) minutes and were no slower compared with the finishers.

Association of Anthropometry, Training, and Prerace Experience with Performance

Both the sum of 8 skinfolds and the sum of upper body skinfolds were related to total race time (see Table 5). None of the anthropometric variables was related to the swim or bike split. Considering the run split, circumference of upper arm, percent body fat, the sum of 8 skinfolds, and the sum of upper body skinfolds were associated with the time in the run split. Regarding volume and intensity in training, none of the training variables was related to total race time or split times (see Table 6). The number of finished Ironman triathlons and Triple Iron triathlons was not associated with race time, but personal best times in both disciplines were highly-significantly related to total race time (see Table 7). When all significant variables after bivariate analysis were included in a regression model, personal best time in a Triple Iron triathlon remained the single predictor variable (see Table 8).

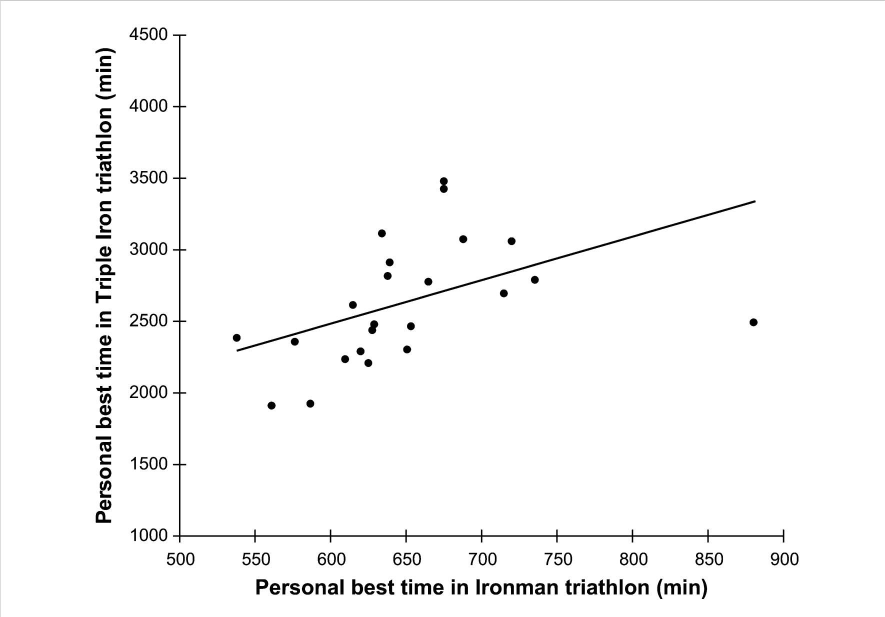

Figure 3. Thirty-five athletes had finished an Ironman and a Triple Iron Triathlon, their personal best times were highly significantly associated ($r = 0.64$, $p < 0.0001$).

Skinfold Thickness and Training

Finishers had a significantly lower sum of 8 skinfold thicknesses compared to nonfinishers (see Table 1). However, for both finishers ($r = -0.10$, $p > 0.05$) and nonfinishers ($r = 0.08$, $p > 0.05$), the average weekly training showed no association with the sum of 8 skinfolds. Regarding intensity, in finishers, average speed in swimming (see Figure 1) and cycling (see Figure 2), during training, were related to the sum of 8 skinfolds but not the speed in running ($r = -0.10$, $p > 0.05$). In nonfinishers, the speed in swimming ($r = 0.10$, $p > 0.05$), cycling ($r = 0.09$, $p > 0.05$), and running ($r = 0.00$, $p > 0.05$) was not related to skinfold thickness.

Discussion

This investigation describes a large sample of Triple Iron triathletes where personal best time in this special kind of race was the single predictor variable regarding a successful race outcome after correction of covariates.

In this sample of 81 male ultratriathletes, 17 participants (21%) dropped out during the race. Fifteen (65%) of the 17 nonfinishers failed during the run because of overuse injuries of the lower limbs; they all complained of shin splints. Two participants complained of exhaustion. According to the literature, risk factors for an overuse injury of the lower limbs such as shin splints are high training loads in running more than 60 $km \cdot wk^{-1}$ (23), more than 6 training units a week (24), more than 6 races within 12 months (27), previous lower extremity injury (6), and advanced age (24). Regarding training variables, finishers invested more hours and kilometers in running compared with nonfinishers (Table 3), but did not run faster during training. Furthermore, none of the nonfinishers complained about a risk factor of overuse injuries of the lower limbs, and they reported no overuse injury of the lower limb in the specific preparation for this race. Eleven of the 17 nonfinishers failing during the run, completed the bike section within 1,725 (283) minutes, highly significantly slower compared with the finishers with 1,367 (169) minutes ($p < 0.001$). Obviously, they had developed problems during cycling that led to failure in the run. This occurred, although cycle training showed no difference between finishers and nonfinishers.

An interesting finding is that personal best time in a Triple Iron Triathlon remained a significant independent determinant of total race time (see Table 7) for finishers when controlled for all covariates in a multivariate analysis. We would assume that the successful finishers would have more prerace experience and have trained more when compared with nonfinishers regarding this finding. We found in finishers, a higher volume in swimming and running (see Table 3), but no differences were found between finishers and nonfinishers in cycling. Astonishingly, the personal best time of the nonfinishers was no faster when compared with the finishers (see Table 2).

A personal best time might be considered as an independent determinant for success in ultraendurance performances. In a recent study of male ultrarunners in a 24-hour run, the personal best time in marathon running was associated with race performance, whereas anthropometry and training volume showed no relationship (15). In Ironman triathletes, previous best performances in short-distance triathlon coupled with weekly cycling distances and longest training rides could partially predict overall performance in an Ironman race (5). Regarding the literature, we would therefore suggest that a fast race time in a race shorter than the planned race seems to have a potential impact on performance in an ultraendurance race. For the 35 athletes who had already finished both an Ironman and a Triple Iron Triathlon, their personal best times were highly significantly associated (see Figure 3). In addition, both personal best times in an Ironman Triathlon and a Triple Iron Triathlon (see Table 7) were associated with the actual race performance. However, there was no difference in personal best times between finishers when compared with nonfinishers.

According to Landers et al. (16) and Sleivert and Rowlands (25), low levels of body fat are related to performance in short-distance triathletes. In contrast, in these ultratriathletes, body fat showed no association with race time (see Table 5). However, low skinfold thicknesses were related to performance. Both low levels of body fat (2) and low skinfolds (1) are known to correlate with performance in runners up to the marathon distance. Presumably these ultratriathletes are closer to runners regarding anthropometry.

Recent studies of runners suggest that skinfold thicknesses are related to training volume, and competitive athletes have lower skinfold thicknesses because of higher training volume (20,21). We would, therefore, expect that training volume and percent body fat would show a relationship. However, for both finishers and nonfinishers, average weekly training showed no association with the sum of 8 skinfolds. In contrast, average speed in swimming (see Figure 1) and cycling (see Figure 2), during training, were related to the sum of 8 skinfolds but not to speed in running. We must assume that intensity is more important than volume regarding the effect on body fat. This has been demonstrated in a recent study of Triple Iron triathletes, where the decrease in body fat was related to race intensity (14). However, because an observational cross-sectional study with correlation analysis cannot provide cause and effect, other factors such as diet might be related to low body fat.

Regarding Table 5, circumference of upper arm, percent body fat, the sum of 8 skinfolds, and the sum of upper body skinfolds were associated with the time in the run split. In a recent study of 29 Triple Iron triathletes, the sum of 8 skinfold thicknesses was also related to total race time and the split time in the run (11), and it was assumed that Triple Iron triathletes are closer to runners regarding anthropometry. In this present investigation of 64 Triple Iron triathletes, circumference of upper arm was related to the split time in the run, apart from skinfold thicknesses and body fat percentage. This finding agrees with previous findings in ultraendurance runners, where upper arm circumference was related to running performance in multistage ultraendurance runs over 338 km (9) and 1,200 km (12). Regarding this aspect, we can also assert recent findings using smaller samples of Triple Iron triathletes, where running performance was related to race time (8,10).

This cross-sectional study is limited regarding the influence and effects of anthropometry and both volume and intensity in training on race performance in Ironman triathletes, because only an intervention trial can answer this question. Other limitations are a lack of fitness evaluation of these athletes. This study has examined a sample of nonprofessional male ultratriathletes over the Triple Iron Triathlon distance. Our athletes finished the race within 46:51 hours: minutes (CV = 13.5%), and 54 of these 64 athletes have a personal best time in an Ironman Triathlon of 10:36 hours: minutes (CV = 8.7%). Elite male Ironman triathletes complete the distance within 8:30 hours: minutes to 9:00 hours: minutes. One might anticipate that a study of a larger cohort that included elite, and recreational triathletes would show that training parameters do, in fact, influence race performance. The small sample size of our study might be a weakness in showing that training parameters actually had no effect on race performance.

We focused this investigation on anthropometry, prerace experience, and training. Apart from overuse injuries of the lower limbs, other aspects such as nutrition and race equipment were not considered. With the provision of the numbers of finished races before this race, including personal best times, we could respect the relevance of experience. Seventeen athletes did not finish the race because of failure in the run. Unfortunately, we have no data about energy deficit (7) or disorder in fluid or electrolyte metabolism (26). In future studies, reasons for dropouts in a Triple Iron triathlon should be more deeply investigated.

Practical Applications

In successful finishers over the Triple Iron distance, personal best times over this distance remained the only significant variable related to total race time after a multivariate analysis. After bivariate analysis, low skinfold thicknesses were related to total race time. Furthermore, low upper arm circumference and low skinfold thicknesses were related to the split time in the run. Although finishers showed differences in volume and intensity in training for both swimming and running, no association for training variables with race time including split times were found. For practical considerations, athletes with a background as a marathon runner, respectively, ultrarunner might have an advantage in successfully finishing a Triple Iron triathlon. However, marathon runners, respectively, ultrarunners should also have enough prerace experience in competing in Ironman and Triple Iron triathlons to successfully finish such a tough race.

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