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IS BODY FAT A PREDICTOR VARIABLE FOR RACE PERFORMANCE IN RECREATIONAL FEMALE IRONMAN TRIATHLETES?

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Abstract

Introduction and aim of the study: Low body fat is related to race performance in endurance athletes. We investigated whether characteristics of anthropometry, training or previous performance were related to race time in recreational female Ironman triathletes.

Methods: In 31 female Ironman triathletes, with (mean and SD) 36.8 (6.2) years, 60.8 (6.2) kg body mass, 1.66 (0.06) m body height and a body mass index of 21.6 (1.3) kg/m^2, anthropometric characteristics, such as body mass, body height, body mass index, circumferences and length of limbs, skin-fold thicknesses and body fat percentage, and characteristics of training, such as volume and intensity in all sub disciplines, were related to total race time including split times using correlations analysis. Also, personal best times in marathon running, Olympic and Ironman triathlons were related to race time.

Results: Neither anthropometric nor training characteristics were related to total race time or split times. Personal best time in a marathon (r=0.51), personal best time in an Olympic distance triathlon (r=0.70) and personal best time in an Ironman triathlon (r=0.70) were significantly and positively related to total race time. Personal best time in an Olympic distance was significantly and positively related to personal best time in an Ironman triathlon (r=0.63).

Conclusion: We must assume that previous performance is of higher importance than anthropometric or training characteristics for a successful race outcome in recreational female Ironman triathletes.

Key words: *body fat, skin-fold thickness, swimming, cycling, running*

Introduction

Ironman Triathlons over 3.8 km swimming, 180 km cycling and 42.2 km running are increasing in popularity. Every year, more and more athletes participate in these races to qualify for the Ironman World Championship in Hawaii [1]. Finishing such an ultra-endurance race needs an enormous physical effort.

A question is which kind of body anthropometry may sustain this type of performance in the fastest possible time. For male short-distance triathletes, Landers et al. found that low levels of adiposity were important for total race time and most of the sub-disciplines [2]. In addition, longer segmental lengths were important for a successful swimming outcome. According to Sleivert & Rowlands, male elite triathletes were generally tall, and had low body weight and low levels of body fat [3].

In contrast to these anthropometric findings, Leake & Carter concluded that training parameters such as training distance, training time and training experience in years as an active athlete were more important than anthropometric measurements in the prediction of performance for female triathletes in short-distance races [4]. According to O'Toole [5] and Gulbin & Gaffney [6], training distances and previous best performances in an Olympic distance triathlon appear to be more important than training paces in preparation for an ultra-endurance triathlon, when both male and female Ironman triathletes were considered. Hendy and Boyer, however, stated that pace of training in the same sport was the best predictor of swim and run performance in both sprint and endurance triathlons [7]. There are studies of male short-distance triathletes [2,8] and male ultra-distance triathletes over distances longer than the Ironman Triathlon [9-11] about the relationship of anthropometry with performance. However, there is little data about the association of anthropometry and training on race performance in an Ironman Triathlon [5]. In an Ironman triathlon, athletes have to run a marathon at the end of the race. In female high-level runners, a significant association between both the suprailiacal and the abdominal skin-fold with marathon performance time has been demonstrated [12].

The aim of this study was to investigate in recreational female Ironman triathletes whether we could find an association between anthropometric, training and previous performance characteristics with race time in an Ironman triathlon. We hypothesised that, in accordance with previous findings in male Ironman triathletes, (i) low body fat would be associated with total race time, (ii) the skin-fold thicknesses at both the suprailiacal and the abdominal site would be related to the split time in the marathon, and (iii) the personal best time would be related to race time in female Ironman triathletes.

Methods

The organiser of the IRONMAN SWITZERLAND in 2009 contacted all athletes, via a newsletter, three months before the race and asked them to participate in our investigation. On 12 July 2009, IRONMAN SWITZERLAND took place in the heart of the City of Zurich, Switzerland. A total of 359 female Ironman triathletes started in the morning at 07:00 a.m. At the start, the air temperature was 14° Celsius and the water in Lake Zurich was 20° Celsius. Due to the low water temperature, wet suits were allowed. At the start, the sky was clear and became cloudy slowly during the afternoon and evening. The highest temperature, 22° Celsius, was reached in the afternoon. The athletes had to swim two laps in the lake to cover the 3.8 km distance, and then had to cycle two laps of 90 km each which was followed by running four laps of 10.5 km each. In the cycling section, the highest point to climb from Zurich (400 metres above sea level) was the 'Forch' (700 metres above sea level), while the running course was completely flat in the City of Zurich. Nutrition was provided for the cycling and running courses by the organisers. They offered bananas, energy bars, energy gels and carbohydrate drinks as well as caffeinated drinks and water on the cycling course. On the running course, in addition to the aforementioned nutrition, different fresh fruits, dried fruits, nuts, chips, salt bars and soup were provided.

A total of 37 non-professional female Ironman triathletes volunteered to participate in the investigation. The study was approved by the Institutional Review Board for use of Human subjects of the Canton of St. Gallen, Switzerland. The athletes were informed of the procedures and gave their informed written consent. Thirty-one athletes in our study group finished the race successfully within the time limit of 16 hours. Six triathletes had to give up during the run due to medical complications such as exhaustion and overuse injuries of the lower limbs.

Before the start of the race body mass, body height, length of the right arm and the right leg, the circumferences of limbs, and the thicknesses of skin-folds were measured on the right side. With this data, we calculated body mass index, the sum skin-folds, and percent body fat using an anthropometric method. 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 circumferences and the lengths of limbs were measured using a nonelastic tape measure (cm) (KaWe CE, Kirchner und Welhelm, Germany). The length of the right 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 right leg from *trochanter major* to the *malleolus lateralis* to the nearest 0.1 cm, again on the right side. The circumference of the hip was determined at the level of the *trochanter major* to the nearest 0.1 cm. The circumference of the upper arm was measured in the middle of the right upper arm (between *acromion* and *olecranon*) to the nearest 0.1 cm; the circumference of the right thigh was taken at the level where the skin-fold thickness of the thigh was measured (20 cm above the upper margin of the patella) and the circumference of the right calf was determined at the maximum circumference of the calf. The skin-fold data was obtained using a skin-fold calliper (GPM-Hautfaltenmessgerät, Siber & Hegner, Zurich, Switzerland) and recorded to the nearest 0.2 mm. The skin-fold measurements were taken once for all eight skin-folds and then the procedure was repeated twice more and the mean of the three times was then used for the analyses. The timing of the taking of the skin-fold measurements was standardised to ensure reliability. According to Becque et al., readings were performed 4 s after applying the calliper [13]. One trained investigator took all the skin-fold measurements as inter-tester variability is a major source of error in skin-fold measurements. An intra-tester reliability check was conducted on 27 male and 11 female runners prior to testing. Intraclass correlation (ICC) within the two judges was excellent for both men and women for all anatomical measurement sites (ICC>0.9) [14]. Percent body fat was calculated using the following anthropometric formula for women: Percent body fat = $-6.40665 + 0.41946(\Sigma 3SF) - 0.00126(\Sigma 3SF)^2 + 0.12515(\text{hip}) + 0.06473(\text{age})$, according to Ball et al. [15].

Upon inscription to the investigation the athletes were asked to record their training units showing the distance and time for all three disciplines. Each athlete maintained a comprehensive training diary consisting of all endurance training sessions showing distance and duration per discipline and training unit, since training volume is important for endurance athletes [16]. The athletes also reported their number of finished marathon runs, short-distance triathlons and Ironman races, including their personal best times.

Statistical Analysis

The Shapiro-Wilk test was used to check for normality distribution. Normally distributed data are presented as mean and standard deviation (SD). A potential association between body mass, body height, body mass index, the length and circumferences of limbs, skin-fold thicknesses, the sum of eight skin-folds and percent body fat, and total race time including split time was investigated using Pearson correlation analysis. The coefficient of variation of performance (CV%=100xSD/mean) was calculated for total race time including split times and personal best times. The total race time was also expressed as a percentage of the race time of the female race winner.

Results

The 31 female subjects completed the total race distance within 12:24 (1:20) h:min (CV=11%), corresponding to 134 (15)% of the female winner of 9:14 h:min. During the race, they were swimming at 2.9 (0.4) km/h, cycling at 28.6 (2.8) km/h and running at 9.2 (1.3) km/h. They completed the 3.8 km swim within 01:19 (0:12) h:min (CV=14.8%), the 180 km cycling within 06:21 (0:39) h:min (CV=10.3%) and the marathon within 04:39 (0:40) h:min (CV=14.4%). The six non-finishers completed both the swim and the bike section but dropped out during the run after 22 (12) km due to exhaustion (four athletes) and over use injuries of the lower limbs (two athletes). None of the anthropometric characteristics (see Table 1) and the skin-fold thicknesses (see Table 2) were related to the total race time or the split times during the Ironman.

Table 3 represents the training characteristics. During training, finishers were swimming at 2.6 (0.6) km/h, cycling at 25.6 (4.2) km/h, and running at 10.3 (1.4) km/h. Compared to racing, they swam (P<0.05) and cycled (P<0.01) more slowly during training, but ran faster (P<0.01). There was no relationship between speed during training and speed during racing for swimming (r=0.30, P>0.05) cycling (r=-0.14, P>0.05), or running (r=0.27, P>0.05). No relationship between

Table 1. *The age and anthropometric variables for finishers, and the association with total race time and split times in finishers. Data are presented as mean (SD). No relationship between age and anthropometric variables with race time including split times was found.*

Anthropometric characteristics	Finisher (n=31)	Total race time	Time swim split	Time bike split	Time run split
Age (years)	36.8 (6.2)	0.26	0.28	0.29	0.15
Body mass (kg)	60.8 (6.2)	0.08	- 0.07	- 0.15	0.28
Body height (m)	1.66 (0.06)	0.02	- 0.14	- 0.09	0.14
Body mass index (kg/m^2)	21.6 (1.3)	0.05	- 0.09	- 0.16	0.27
Circumference of upper arm (cm)	26.5 (1.8)	0.14	- 0.08	0.00	0.39
Circumference of thigh (cm)	53.1 (3.2)	0.18	- 0.03	- 0.09	0.39
Circumference of calf (cm)	36.3 (2.4)	0.15	- 0.12	0.04	0.37
Length of arm (cm)	74.0 (3.7)	0.05	- 0.01	- 0.09	0.20
Length of leg (cm)	82.1 (4.4)	- 0.07	- 0.20	- 0.20	0.07
Body fat percentage (%)	24.9 (6.4)	0.07	0.00	- 0.12	0.21

Table 2. *The skin-fold thicknesses of the finishers and the association of the skin-fold thicknesses with the total race time and the split times. Data are presented as mean (SD). No relationship between the skin-fold thicknesses and the race time including the split times could be detected.*

Skin-fold thicknesses	Finisher (n=31)	Total race time	Time swim split	Time bike split	Time run split
Pectoral skin-fold (mm)	4.8 (2.3)	- 0.03	0.01	- 0.19	- 0.09
Mid-axilla skin-fold (mm)	7.3 (2.2)	0.18	0.21	0.09	0.29
Triceps skin-fold (mm)	11.7 (5.5)	0.08	0.06	- 0.09	0.23
Subscapular skin-fold (mm)	8.4 (3.1)	0.20	0.04	- 0.01	0.24
Abdominal skin-fold (mm)	12.0 (4.1)	- 0.04	0.08	- 0.16	0.17
Suprailiac skin-fold (mm)	14.7 (7.9)	0.21	0.15	0.00	0.26
Front thigh skin-fold (mm)	23.6 (10.4)	- 0.08	- 0.03	- 0.21	0.10
Medial calf skin-fold (mm)	14.5 (8.4)	0.13	- 0.08	- 0.08	0.28
Sum of upper body skin-folds (mm)	59.0 (21.9)	0.14	0.09	- 0.01	0.29
Sum of lower body skin-folds (mm)	38.1 (17.7)	- 0.01	- 0.04	- 0.16	0.18
Sum of eight skin-folds (mm)	97.2 (38.4)	0.04	0.04	- 0.11	0.22

Table 3. *The training variables of the finisher and the association of the training variables with the total race time and the corresponding split times. Data are presented as mean (SD). No relations between the training variables and the race time including the split times were found*

Training characteristics	Finisher (*n*=31)	Total race time	Time swim split	Time bike split	Time run split
Training volume (h/week)	14.2 (3.6)	- 0.29	- 0.25	- 0.24	- 0.31
Hours of swimming per week	2.8 (1.2)	- 0.10	- 0.37	-	-
Hours of cycling per week	7.4 (2.4)	- 0.38	-	- 0.32	-
Hours of running per week	4.1 (1.1)	0.04	-	-	0.04
Kilometres of swimming per week	6.3 (3.1)	- 0.10	- 0.37	-	-
Kilometres of cycling per week	191.3 (68.3)	- 0.36	-	- 0.34	-
Kilometres of running per week	42.9 (12.2)	- 0.01	-	-	- 0.10
Speed in training in swimming (km/h)	2.6 (0.6)	- 0.13	- 0.29	-	-
Speed in training in cycling (km/h)	25.6 (4.2)	0.30	-	0.25	-
Speed in training in running (km/h)	10.3 (1.4)	- 0.03	-	-	- 0.23

Table 4. *The characteristics of pre race experience of the finisher and the association of the variables of pre race experience with the total race time. Data are presented as mean (SD). P-value is inserted in case of a significant association. All personal best times were related to the total race time.*

Characteristics of pre race experience	Finisher (*n*=31)	*r*
Years as active triathlete	5.4 (2.4) (*n*=31)	- 0.42
Number of finished marathons	3.7 (2.4) (*n*=22)	- 0.34
Personal best time in a marathon (min)	223.8 (23.2) (CV=10.3%)	0.51 *P*=0.0154
Number of finished short distance triathlons	8.3 (7.9) (*n*=23)	- 0.27
Personal best time in short distance triathlon (min)	151.7 (14.8) (CV=9.7%)	0.70 *P*=0.0002
Number of finished Ironman triathlons	2.5 (1.9) (*n*=23)	- 0.03
Personal best time in Ironman triathlon (min)	730.9 (65.8) (CV=9.0%)	0.70 *P*=0.0002

Table 5. *The association of the skin-fold thicknesses with the personal best marathon time (n=22). No relationship could be found.*

Skin-fold thicknesses	*r*
Pectoral skin-fold	0.11
Mid-axilla skin-fold	0.09
Triceps skin-fold	0.32
Subscapular skin-fold	0.38
Abdominal skin-fold	0.17
Suprailiac skin-fold	0.32
Front thigh skin-fold	0.27
Medial calf skin-fold	0.18
Sum of upper body skin-folds	0.31
Sum of lower body skin-folds	0.25
Sum of eight skin-folds	0.29
Percent body fat	0.39

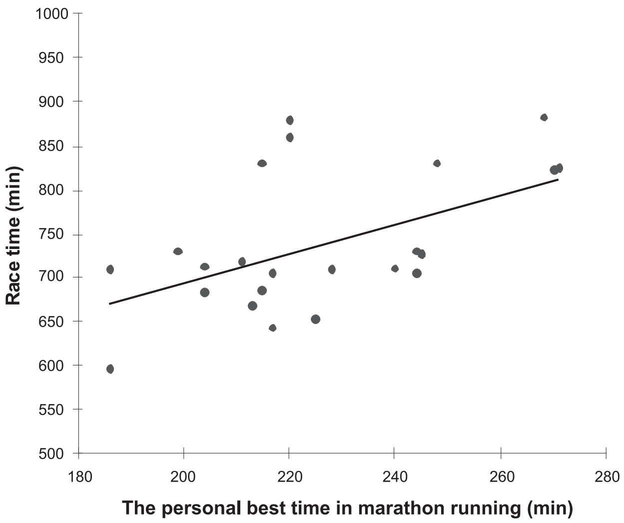

Figure 1. *The personal best time in marathon running was significantly and positively related to the total race time in the Ironman race (n=22) (r=0.51, P=0.0154)*

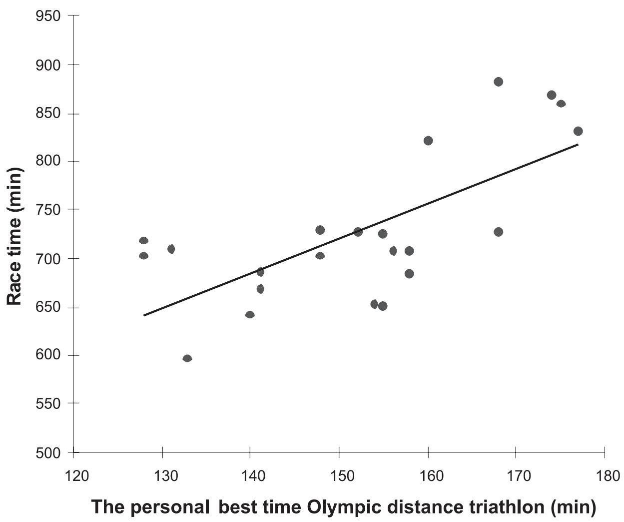

Figure 2. *The Personal best time in an Olympic distance triathlon was significantly and positively related to the total race time in the Ironman race (n=21) (r=0.70, P=0.0002)*

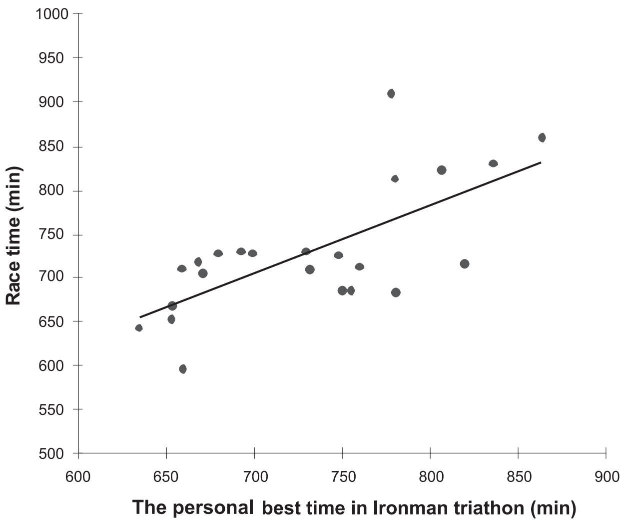

Figure 3. *The personal best time in an Ironman triathlon was significantly and positively related to the total race time in the present Ironman race (n=23) (r=0.70, P=0.0002)*

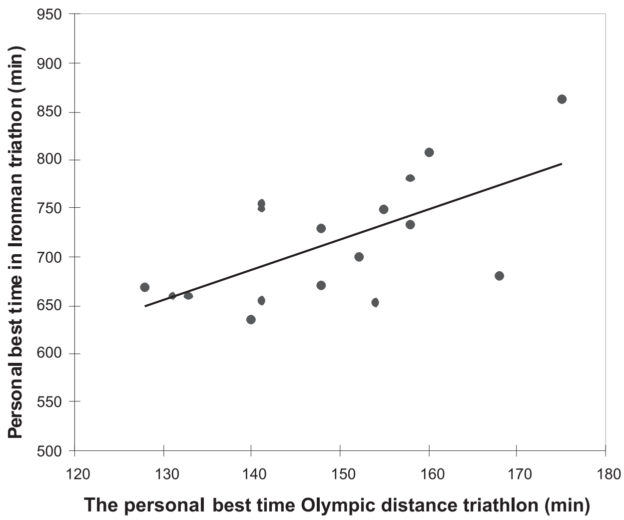

Figure 4. *The personal best time in an Olympic distance triathlon was significantly and positively related to the personal best time in the Ironman triathlon (n=17) (r=0.63, P=0.0069)*

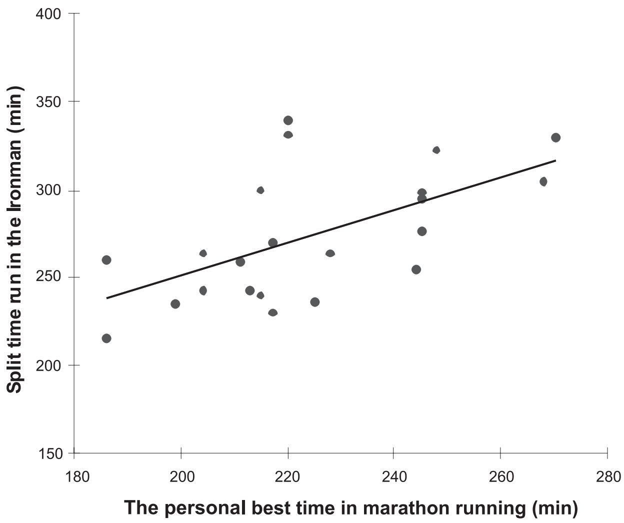

Figure 5. *The personal best time in a marathon was significantly and positively related to the split time in the run during the Ironman race (n=22) (r=0.60, P=0.0034)*

training characteristics and total race time, respecting split times, was found.

Previous performances expressed in finished marathons, Olympic distance triathlons and Ironman triathlons are represented in Table 4. The personal best time in a marathon (see Figure 1), the personal best time in an Olympic distance triathlon (see Figure 2) and the personal best time in an Ironman triathlon (see Figure 3) were significantly and positively related to total race time. In addition, the personal best time in an Olympic distance was significantly and positively related to the personal best time in an Ironman triathlon (see Figure 4). The personal best time in a marathon was highly significantly faster compared with the marathon time during the Ironman (*P*<0.01). In addition, the personal best time in a marathon was significantly and positively related to the split time in the marathon run during the Ironman (see Figure 5). The skin-fold thicknesses were not related to the personal best marathon time (see Table 5).

Discussion

The aim of this study was to investigate in recreational female Ironman triathletes whether we could find an association between anthropometric, training and previous performance characteristics with race time in an Ironman triathlon. We hypothesised that, in accordance with the findings for male Ironman triathletes, (i) low body fat would also be associated with the final race time for female Ironman triathletes, (ii) the skin-fold thicknesses at both the suprailiacal and the abdominal site would be related to the split time in the marathon, and (iii) personal best times would be related to race times. In contrast to these hypotheses, we found no association for both the anthropometric and the training characteristics with the Ironman race performance; however, the personal best time in a marathon, an Olympic distance triathlon and an Ironman triathlon were significantly and positively related to the Ironman race time.

Association of anthropometric characteristics with race time

We based our hypothesis, of low body fat being related to race time in an Ironman triathlon, upon studies of female and male triathletes over the Olympic distance, where low body fat was assumed to be related to race performance [2,3]. In contrast to these studies, we found no association between anthropometric characteristics and race performance in female Ironman triathletes, as has been found in a study with smaller samples of recreational female Ironman triathletes [17,18]. This might be because of gender, or the longer distance compared with the Olympic distance. Laurenson et al. concluded that no ideal or unique anthropometric profile could be established for female triathletes competing over the Olympic distance [8].

A further hypothesis was that the skin-fold thicknesses at both the suprailiacal and abdominal sites would be related to the split time in the run during the Ironman. Arrese & Ostáriz showed in 11 female high-level runners a significant and positive association between both the suprailiacal skin-fold thickness (r=0.62, P=0.042) and the abdominal skin-fold thickness (r=0.61, P=0.046) and a marathon performance time [12]. In contrast to their findings, we found neither for the split time in the run during the Ironman nor for the personal best time in a marathon, an association with these skin-fold thicknesses. These different findings might be explained by the samples of athletes used. Arrese & Ostáriz investigated high-level runners with a faster personal best marathon time of 2:35 h:min compared with 3:43 h:min of our female triathletes [12]. The coefficient of variance for marathon performance time in the 11 high-level athletes of Arrese & Ostáriz was 4.4% compared to 10.3% for our athletes [12]. Furthermore, the runners of Arrese & Ostáriz were younger (30.9 compared with 36.8 years), lighter (45.6 kg compared with 60.1 kg) and smaller (1.58 m compared with 1.66 m) [12].

Association of training characteristics with race time

We also investigated a potential association between the training characteristics and the Ironman race time, since Leake & Carter reported that training parameters were more important than anthropometric measurements in the prediction of performance in 16 female triathletes [4]. O'Toole [5] and Gulbin and Gaffney [6] concluded that distances in training would be more important compared with intensity, whereas Hendy and Boyer [7] described the opposite. However, in this sample of female Ironman triathletes, we found that neither the volume nor for the intensity in training had an association with the Ironman race time. These disparate findings might be explained by the different distances and gender.

Association of previous performance characteristics with race time

We investigated the associations of both the number and personal best time in a marathon, an Olympic triathlon and an Ironman triathlon. We found highly significant and positive associations between the personal best times in a marathon, an Olympic distance triathlon and an Ironman triathlon with the Ironman race time. This specific finding had been reported for Ironman triathletes and ultra-endurance runners. Gulbin & Gaffney described that previous best performances in an Olympic distance triathlon, together with weekly cycling distances and longest training rides, could partially predict overall performance [6]. They investigated 230 male and 12 female Ironman triathletes at the Ironman Lanzarote. Also in male ultra-runners during a 24-h run, only the personal best marathon time was related to race performance, not anthropometry or training [19]. In these subjects, the number of finished marathons, Olympic triathlons and Ironman triathlons was not related to race time. Obviously, the number of previously completed races is not important but rather the personal best times. Also for male Triple Iron triathletes [11] and both male and female Ironman triathletes [17,18], the personal best time in an Ironman triathlon was related to race time.

This study is limited because of the rather low number of female athletes. However, Gulbin and Gaffney had, in their study of 242 Ironman triathletes, 230 male and only 12 female athletes [6] and Arrese & Ostáriz investigated 11 female high-level runners in the marathon distance [12]. A further limitation is the fact that we did not investigate the influence of other variables such as $\dot{V}O_2$max, anaerobic threshold, motivation, nutritional status and running efficiency since these variables might also affect race outcome.

To conclude, we must assume that previous performance is of higher importance than anthropometric or training characteristics for female recreational Ironman triathletes. In future studies, the aspect of motivation should be investigated, since perfectionism in triathletes is associated with goals helping to achieve the best possible performance [20].

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References

1. Lepers R. Analysis of Hawaii Ironman performance in elite triathletes from 1981 to 2007. *Med Sci Sports Exerc* 2008; 40: 1828-34.
2. Landers GJ, Blanksby BA, Ackland TR, Smith D. Morphology and performance of world championship triathletes. *Ann Hum Biol* 2000; 27: 387-400.
3. Sleivert GG, Rowlands DS. Physical and physiological factors associated with success in the triathlon. *Sports Med* 1996; 22: 8-18.
4. Leake CN, Carter JE. Comparison of body composition and somatotype of trained female triathletes. *J Sports Sci* 1991; 9: 125-35.
5. O'Toole ML. Training for ultraendurance triathlon. *Med Sci Sports Exerc* 1989; 21: S209-13.
6. Gulbin JP, Gaffney PT. Ultraendurance triathlon participation: typical race preparation of lower level triathletes. *J Sports Med Phys Fitness* 1999; 39: 12-5.
7. Hendy HM, Boyer BJ. Specificity in the relationship between training and performance in triathlons. *Percept Mot Skills* 1995; 81: 1231-40.
8. Laurenson NM, Fulcher KY, Korkia P. Physiological characteristics of elite and club level female triathletes during running. *Int J Sports Med* 1993; 14: 455-9.
9. Knechtle B, Duff B, Amtmann G, Kohler G. Cycling and running performance not anthropometric factors are associated with race performance in a Triple Iron Triathlon. *Res Sports Med* 2007; 15: 257-69.
10. Knechtle B, Kohler G. Running performance not anthropometric factors is associated with race success in a Triple Iron Triathlon. *Br J Sports Med* 2009; 43: 437-41.
11. Knechtle B, Knechtle P, Rosemann T, Senn O. Personal best time, not anthropometry or training volume, is associated with race performance in a Triple Iron Triathlon. *J Strength Cond Res* 2010 (in press).
12. Arrese AL, Ostariz ES. Skinfold thicknesses associated with distance running performance in highly trained runners. *J Sports Sci* 2006; 24: 69-76.
13. Becque MD, Katch VL, Moffatt RJ. Time course of skin-plus--fat compression in males and females. *Hum Biol* 1986; 58: 33-42.
14. Knechtle B, Joleska I, Wirth A, et al. Intra- and inter-judge reliabilities in measuring the skin-fold thicknesses of ultra--runners under field conditions. *Percept Mot Skills* 2010; 111: 105-210.
15. Ball SD, Swan P, and Desimone R. Accuracy of anthropometry compared to dual energy X-ray absorptiometry. A new generalizable equation for women. *Res Q Exerc Sport* 2004; 75: 248-58.
16. Schumacher YO, Mroz R, Mueller P, et al. Success in elite cycling: A prospective and retrospective analysis of race results. *J Sports Sci* 2006; 24:1149-56.
17. Knechtle B, Wirth A, Baumann B, et al. Differential correlations between anthropometry, training volume and performance in male and female Ironman triathletes. *J Strength Cond Res* 2010; 24: 2785-93.
18. Knechtle B, Wirth A, Baumann B, et al. Personal best time, percent body fat, and training are differently associated with race time for male and female ironman triathletes. *Res Q Exerc Sport* 2010; 81: 62-8.
19. Knechtle B, Wirth A, Knechtle P, et al. Personal best marathon performance is associated with performance in a 24-h run and not anthropometry or training volume. *Br J Sports Med* 2009; 43: 836-9.
20. Stoeber J, Uphill MA, Hotham S. Predicting race performance in triathlon: the role of perfectionism, achievement goals, and personal goal setting. *J Sport Exerc Psychol* 2009; 31: 211-45.

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A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection