Chinese Journal of Physiology 55(3): 156-162, 2012
DOI: 10.4077/CJP.2012.BAA014

Personal Best Times in an Olympic Distance Triathlon and a Marathon Predict an Ironman Race Time for Recreational Female Triathletes

Christoph Alexander Rüst[1], Beat Knechtle[1, 2], Andrea Wirth[2], Patrizia Knechtle[2], Birte Ellenrieder[3], Thomas Rosemann[1], and Romuald Lepers[4]

[1]*Institute of General Practice and Health Services Research, University of Zurich, Zurich, Switzerland*
[2]*Gesundheitszentrum St. Gallen, St. Gallen, Switzerland*
[3]*Klinik für Orthopädische Chirurgie und Traumatologie, Kantonsspital St. Gallen, Switzerland*
and
[4]*INSERM U887, University of Burgundy, Faculty of Sport Sciences, Dijon, France*

Abstract

The aim of this study was to investigate whether the characteristics of anthropometry, training or previous performance were related to an Ironman race time in recreational female Ironman triathletes. These characteristics were correlated to an Ironman race time for 53 recreational female triathletes in order to determine the predictor variables, and so be able to predict an Ironman race time for future novice triathletes. In the bi-variate analysis, no anthropometric characteristic was related to race time. The weekly cycling kilometers (r = -0.35) and hours (r = -0.32), as well as the personal best time in an Olympic distance triathlon (r = 0.49) and in a marathon (r = 0.74) were related to an Ironman race time ($P < 0.05$). Stepwise multiple regressions showed that both the personal best time in an Olympic distance triathlon ($P = 0.0453$) and in a marathon ($P = 0.0030$) were the best predictors for the Ironman race time (n = 28, $r^2 = 0.53$). The race time in an Ironman triathlon might be partially predicted by the following equation ($r^2 = 0.53$, n = 28): Race time (min) = 186.3 + 1.595 × (personal best time in an Olympic distance triathlon, min) + 1.318 × (personal best time in a marathon, min) for recreational female Ironman triathletes.

Key Words: body fat, gender, endurance, performance

Introduction

Ironman triathlons covering the distances of 3.8 km swimming, 180 km cycling and 42.2 km running are increasing in popularity. Every year, tens of thousands of athletes participate in these races in order to qualify for the Ironman World Championship in Hawaii (22, 23). Triathletes need to train in three different disciplines in preparation for such a race because finishing exerts such an enormous physical effort. The question is which of these characteristics of anthropometry, physiology, training, previous experience or psychology, were the most important for adequate race preparation.

In recent years, several studies have tried to determine the predictor variables for an Ironman race time, especially for male Ironman triathletes. Percent body fat (14, 15), the sum of upper body skin-fold thicknesses (13), the personal best time in both an Olympic distance triathlon (8, 17) and a marathon (17) were related to an Ironman race time for male Ironman triathletes. In a recent study of male Ironman triathletes,

Corresponding author: Beat Knechtle, Ph.D., M.D., Beat Knechtle, Facharzt FMH für Allgemeinmedizin, Gesundheitszentrum St. Gallen, Vadianstrasse 26, 9001 St. Gallen, Switzerland, Tel: +41 (0) 71 226 82 82, Fax: +41 (0) 71 226 82 72, E-mail: beat.knechtle@hispeed.ch
Received: February 23, 2011; Revised: April 3, 2011; Accepted: May 4, 2011.
 ISSN : 0304-4920. http://www.cps.org.tw

running speed during training, a personal best time in a marathon and a personal best time in an Olympic distance triathlon were related to the Ironman race time. These three variables explained 64% of the variance in the Ironman race time (17). In another study, the previous best performance in an Olympic distance triathlon, coupled with the weekly cycling distances and the longest training ride, could partially predict an overall Ironman race performance when both male and female Ironman triathletes were included (8).

For female Ironman triathletes, however, there is limited data regarding predictor variables for an Ironman race time. Leake and Carter (21) reported that training parameters were more important than anthropometric measurements in the prediction of performance for 16 female triathletes. In studies investigating small samples of recreational female Ironman triathletes, weekly training hours (14, 15), personal best times in an Ironman triathlon (14, 18), personal best times in a marathon (18), and personal best times in an Olympic distance triathlon (18) were related to an Ironman race time.

The aim of this present study was to investigate, in a larger sample of recreational female Ironman triathletes, which of the basic variables of anthropometry, training or previous performance was related to an Ironman race time. It was an intention of this investigation to create an equation for predicting an Ironman race time for novice recreational female Ironman triathletes using basic measurements any athlete or coach could determine without the need for highly sophisticated equipment.

Materials and Methods

Subjects

A cross-sectional, observational field study was performed at the 'IRONMAN SWITZERLAND'. Since female participation in Ironman races is rather low (14, 15, 18), data from four consecutive years from 2007 to 2010 were collected in order to increase the sample size to have enough statistical power. The organizer of the 'IRONMAN SWITZERLAND' contacted all the female athletes *via* a newsletter three months before each race and asked them to participate in this investigation. A total of 59 non-professional female Ironman triathletes volunteered to participate in our investigation over this four year period. Each subject was included only upon the first participation in the race. The study was approved by the Institutional Review Board for the use of Human subjects of the Canton of St. Gallen, Switzerland. The athletes were informed of the procedures and gave their informed written consent. Fifty-three athletes out of our study group finished the race successfully within the time limit of 16 h. Six triathletes had to give up during the run because of medical complications such as exhaustion and overuse injuries of the lower limbs.

The Race

In the 'IRONMAN SWITZERLAND' the athletes have to swim two 1.9 km laps in Lake Zurich, cycle two 90 km laps, and then run four 10.5 km laps. In the cycling section, the highest point of ascent from Zurich (400 m above sea level) is the 'Forch' (700 m above sea level), while the run course is completely flat in the City of Zurich.

Measurements

Before the start of the race body mass, body height, the lengths of the arm and the leg, the circumferences of the limbs (upper arm, thigh, and calf), and the thicknesses of skin-folds at eight sites (pectoralis, axillar, triceps, subscapular, abdomen, suprailiac, thigh, and calf) were measured on the right side of the body. 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 lengths of limbs were measured using a nonelastic tape measure (cm) (KaWe CE, Kirchner und Welhelm, Germany) to the nearest 0.1 cm. The length of the arm was measured from *acromion* to the end of *phalanx distalis* of the third finger, the length of leg from *trochanter major* to the middle of *malleolus lateralis*. The circumference of the upper arm was measured at mid-upper arm, the circumference of the thigh was taken at mid-thigh and the circumference of the calf was measured at mid-calf. The skin-fold data were obtained using a skin-fold caliper (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 measurements was used for the analyses. The timing of the taking of the skin-fold measurements was standardized to ensure reliability. According to Becque *et al.* (2) the readings were performed 4 s after applying the caliper. 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 11 female runners prior to testing. Intra-class correlation (ICC) was excellent for each of the two judges for all the anatomical measurement sites (ICC > 0.9). Agreement tended to be better individually than between the measurers, but still reached excellent reliability (ICC > 0.9) for the summary measurements of the

Table 1. Age and anthropometric characteristics and bivariate association with the Ironman race time (n = 53)

		Pearson r
Age (years)	37.0 ± 6.7	0.23
Body height (m)	1.67 ± 0.06	-0.17
Body mass (kg)	59.9 ± 5.9	0.05
Body mass index (kg/m^2)	21.3 ± 1.6	0.25
Length of leg (cm)	82.8 ± 5.3	-0.19
Length of arm (cm)	74.4 ± 3.6	-0.15
Circumference of upper arm (cm)	26.4 ± 1.5	0.16
Circumference of thigh (cm)	53.1 ± 2.9	0.15
Circumference of calf (cm)	36.0 ± 2.1	0.12
Percent body fat (%)	23.8 ± 5.7	0.10

Table 2. Training characteristics and pre race experience of the subjects and bivariate association with the Ironman race time (n = 53)

		Pearson r
Weekly training hours (h)	14.1 ± 3.5	-0.20
Weekly kilometers swimming (km)	6.2 ± 2.7	-0.14
Weekly hours swimming (h)	2.8 ± 1.1	0.12
Speed during swimming (km/h)	2.8 ± 0.6	-0.25
Weekly kilometers cycling (km)	196.6 ± 83.5	-0.35, $P = 0.0150$
Weekly hours cycling (h)	7.4 ± 2.5	-0.32, $P = 0.0201$
Speed during cycling (km/h)	26.0 ± 3.6	-0.10
Weekly kilometers running (km)	41.0 ± 10.7	-0.06
Weekly hours running (h)	4.1 ± 1.0	0.03
Speed during running (km/h)	10.7 ± 1.4	-0.24
Personal best time Olympic distance triathlon (min) (n = 41)	152.5 ± 15.3	0.49, $P = 0.0013$
Personal best time in a marathon (min) (n = 36)	230.7 ± 26.1	0.74, $P < 0.0001$

P-value is inserted in case of a significant association. Significance level was set at $P < 0.05$.

skin-fold thicknesses (11). Percent body fat was calculated using the following anthropometric formula for women: Percent body fat = $-6.40665 + 0.41946 \times (\Sigma 3SF) - 0.00126 \times (\Sigma 3SF)^2 + 0.12515 \times (\text{hip}) + 0.06473 \times (\text{age})$, according to Ball *et al*. (1) where Σ3SF means the sum of three skin-folds (triceps, suprailiacal and thigh) and hip means the circumference of the hip in cm. The circumference of the hip was determined at the level of the trochanter major to the nearest 0.1 cm.

Upon inscription to the investigation, each athlete was asked to maintain a comprehensive training diary, recording each endurance training session and showing both the distance and duration in each discipline, since training volume is important for endurance athletes (27). The athletes received an EXCEL-sheet to record each training session. Speed per unit was calculated using kilometres and time per training unit. The athletes also recorded their personal best time in both an Olympic distance triathlon and in a marathon. The personal best times were defined as the best time ever achieved over these distances, independent of the course or any environmental factors.

Statistical Analysis

Normally distributed data are presented as means ± standard deviations (SD). A potential association between the characteristics of anthropometry, training and previous performance was investigated using Pearson correlation analysis. Stepwise multiple regression analysis was then used to determine the best variables correlated with the Ironman race time. The significant variables were used to create an equation for predicting an Ironman race time. A power calculation was performed according to Gatsonis and Sampson (7). To achieve a power of 80% (two-sided Type I error of 5%) to detect a

Table 3. Multiple linear regression analysis with race time as the dependent variable (n = 28)

	ß	SE	*P*
Mean weekly cycling kilometers	0.21	0.23	0.35
Mean weekly cycling hours	-7.09	7.58	0.35
Personal best time in an Olympic distance triathlon	2.99	0.71	0.0453
Personal best time in a marathon	1.07	0.35	0.0030

The coefficient of determination (r^2) of the model was 53%. Significance level was set at $P < 0.05$.

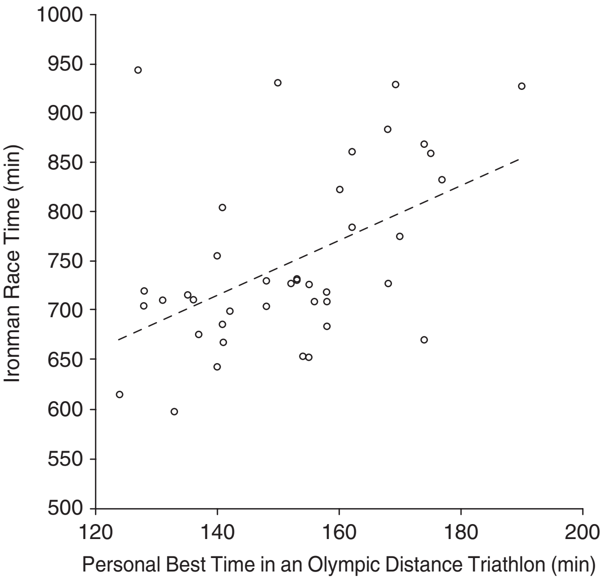

Fig. 1. The personal best time in an Olympic distance triathlon was significantly and positively related to the Ironman race time (n = 41) (r = 0.49, $P = 0.0013$).

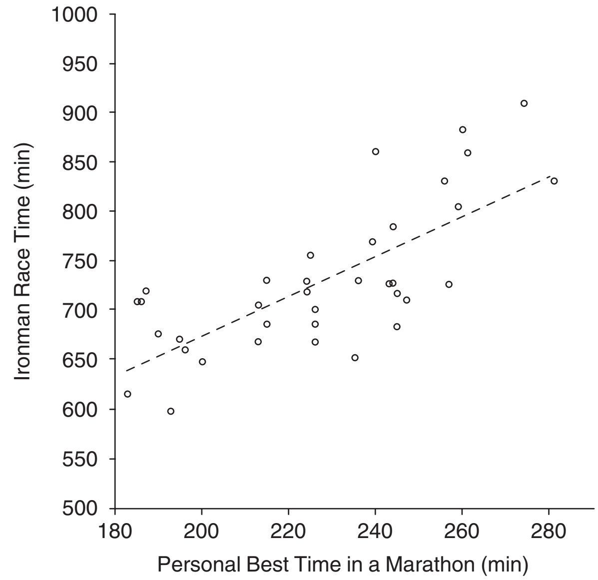

Fig. 2. The personal best time in a marathon correlated significantly and positively to the Ironman race time (n = 36) (r = 0.74, $P < 0.0001$).

minimal association between race time and anthropometric characteristics of 20% (*i.e.* coefficient of determination $r^2 = 0.2$) a sample of 40 participants was required. Bland-Altman analysis was used to determine absolute limits of agreement between predicted and effective race time. A level of 0.05 was used to indicate significance.

Results

The 53 athletes completed the race within 751 ± 89 min. In the bi-variate analysis, none of the anthropometric characteristics were related to the Ironman race time (Table 1). Considering the characteristics of training and previous performance, the mean weekly cycling kilometers, the mean weekly cycling hours and the personal best time in both an Olympic distance triathlon and a marathon were related to the Ironman race time after bivariate analysis (Table 2). Stepwise multiple regressions showed that the personal best time in both the Olympic distance triathlon (Fig. 1) and in the marathon (Fig. 2) were the best predictor variables for an Ironman race time when corrected with all significant variables after bivariate analysis (Table 3). The personal best marathon time was significantly and positively related to the run split time in the Ironman race (r = 0.57, $P < 0.0001$). The race time in an Ironman triathlon might be partially predicted by the following equation for recreational female Ironman ($r^2 = 0.52$, n = 28): Race time (min) = 186.3 + 1.595 × (personal best time in an Olympic distance triathlon, min) + 1.318 × (personal best time in a marathon, min). The predicted Ironman race time was 725 ± 51 min and correlated highly significantly to the achieved Ironman race time (Fig. 3). Fig. 4 shows the level of agreement using Bland-Altman method (Bias = -93.5 ± 93.5 min) between the effective and the predicted race time. Intra class correlation (ICC) between effective and predicted Ironman race time was 0.70.

Discussion

The aim of this study was to investigate which

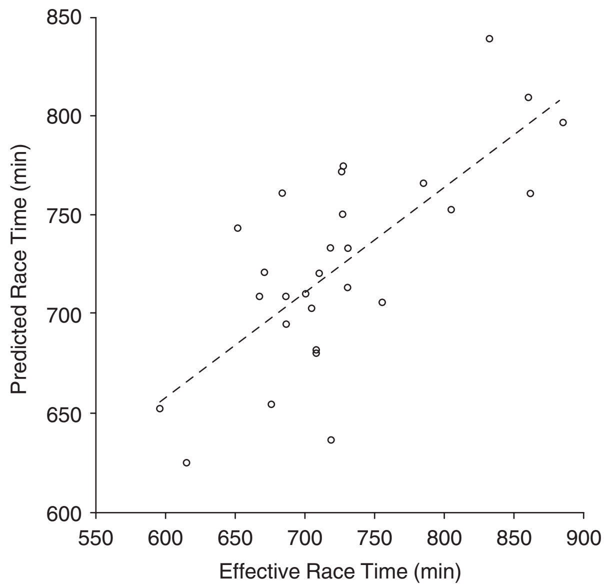

Fig. 3. The predicted Ironman race time correlated significantly to the achieved Ironman race time (n = 28) (r = 0.73, $P < 0.0001$).

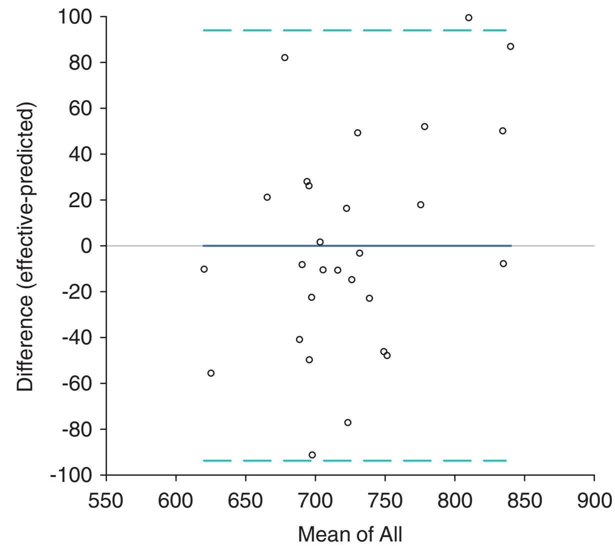

Fig. 4. Bland-Altman plots comparing predicted with effective race time.

of the basic variables of physical characteristics, training or previous performance were related to an Ironman race time for recreational female triathletes in order to create an equation for predicting an Ironman race time for future novice female Ironman triathletes. After multi-variate analysis, both the personal best times in an Olympic distance triathlon and in a marathon were related to the Ironman race time; anthropometric and training characteristics, however, were not.

The association of a personal best time in a marathon and in an Olympic distance triathlon with the Ironman race time showed highly significant correlation coefficients after bi-variate analysis and remained the single predictor variables after multi-variate analysis. This specific finding, that a personal best time in a race shorter than the actual race is a predictor variable for race time has been reported for male Ironman triathletes (8, 17), female Ironman triathletes (18), and male ultra-endurance runners (12, 16). Gulbin and Gaffney (8) described that previous best performances in Olympic distance triathlons coupled with weekly cycling distances and longest training rides could partially predict an Ironman race time when investigating both male and female Ironman triathletes in the same sample. For male Ironman triathletes (17), speed in running during training, together with a personal best time in a marathon and an Olympic distance triathlon, were related to the Ironman race time. These three variables explained 64% of the variance in the Ironman race time (17). In male ultra-runners during a 24-hour run, only the personal best marathon time was related to race performance, not anthropometry or training (16). In multi-stage mountain ultra-marathoners, again the personal best marathon time was related to total race time (12).

Since Leake and Carter (21) reported that training parameters were more important than anthropometric measurements in the prediction of performance for 16 female triathletes, we also investigated a potential association between training characteristics and the Ironman race time. O'Toole (24) and Gulbin and Gaffney (8) concluded that distances in training were more important than intensity, whereas Hendy and Boyer (9) described the opposite. In the bi-variate analysis, the weekly cycling kilometers (r = -0.35) and the weekly cycling hours (r = -0.32) were related to an Ironman race time in these female triathletes. However, neither the volume in kilometres nor the speed in training was found to be associated with the Ironman race time when corrected for the variables of anthropometry and previous performance. These disparate findings might be explained by the different distances and genders. Gulbin and Gaffney (8) found, in their 242 lower level Ironman triathletes of 230 male and 12 female athletes, that weekly cycling distances were related to an Ironman race time. However, they did not include anthropometric measurements in their considerations as was considered in this investigation. Furthermore, they had more male than female athletes in their sample.

For male triathletes, body fat was an important predictor variable for race time over both the Olympic (19, 28) and Ironman (14, 15) distances. In contrast to these studies, no association between anthropometric characteristics and the Ironman race was found for these recreational female Ironman triathletes, as has already been described in studies using smaller samples of recreational female Ironman triathletes (14, 15, 18). This might be due to gender or the longer distance involved compared with the Olympic distance. Laurenson *et al*. (20) concluded that no ideal or unique anthropometric profile could be established for female triathletes competing over the Olympic distance. Also for female marathoners, body fat percentage did not correlate with the finish time (3). The present findings now confirm that anthropometric characteristics were not able to predict an Ironman race time for female Ironman triathletes.

The personal best time in an Olympic triathlon will be influenced by a wide range of physiological, psychological and behavioural factors. The inclusion of a personal best time in the Olympic distance as a predictive variable in the multi-variate analyses can identify the influence of additional factors which may include the difficulty in defining the concept of 'pre- race experience'. In future studies, recreational female Ironman triathletes should be compared with recreational female marathoners in order to find similarities or differences between these two groups of athletes.

This study is limited because of the rather small number of subjects. However, Gulbin and Gaffney (8) had in their study of 242 Ironman triathletes a total of 230 male and only 12 female athletes. This study is also limited as nutritional intake was not assessed. It is very likely that race nutrition will influence overall race time in Ironman events (10). The problem of fluid intake and, especially, exercise-associated hyponatremia might have an influence on race time (29, 30). In further studies, nutrition should also be considered. The determination of physiological characteristics such as maximum oxygen uptake or lactate threshold would be useful (4, 25). In addition, the determination of muscle fiber composition would give more physiological insights (6). Apart from the variables of physiology, anthropometry, training and previous experience, the aspect of motivation might also considerably influence an Ironman race outcome (26, 31). This data analysis is also limited since environmental conditions were not included. Environmental factors might influence race performance (5, 32). It has been shown that marathon performance progressively slows when the temperature increases from 5°C to 25°C (5). Furthermore, the time between the personal best times and the Ironman race might be very different for each athlete and therefore influence this association.

To summarize, the present findings suggest that a previous performance in marathon running and Olympic distance triathlons is of greater importance than anthropometric or training characteristics in recreational female Ironman triathletes. Race time in an Ironman triathlon might be predicted by the following equation ($r^2 = 0.52$, $n = 28$): Race time (min) = 186.3 + 1.595 × (personal best time in an Olympic distance triathlon, min) + 1.318 × (personal best time in a marathon, min) for recreational female Ironman triathletes. Further studies examining the physiological and psychological characteristics of Ironman triathletes are required to better understand the determinants of an Ironman triathlon performance. The inclusion of physiological variables might increase the coefficient of correlation for the equation to predict an Ironman race time.

Acknowledgments

We thank the crew of 'IRONMAN SWITZERLAND' for their generous support and the athletes for their promptness in the collection of data during the race. For her help in translation, we thank Mary Miller from Stockton-on-Tees, Cleveland, England.

Author Disclosures

The authors have no conflict of interest and received no external funding.

References

1. Ball, S.D., 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* 75: 248-258, 2004.
2. Becque, M.D., Katch, V.L. and Moffatt, R.J. Time course of skin-plus-fat compression in males and females. *Hum. Biol*. 58: 33-42, 1986.
3. Christensen, C.L. and Ruhling, R.O. Physical characteristics of novice and experienced women marathon runners. *Brit. J. Sports Med*. 17: 166-171, 1983.
4. Dengel, D.R., Flynn, M.G., Costill, D.L. and Kirwan, J.P. Determinants of success during triathlon competition. *Res. Q. Exerc. Sport* 60: 234-238, 1989.
5. Ely, M.R., Cheuvront, S.N., Roberts, W.O. and Montain, S.J. Impact of weather on marathon-running performance. *Med. Sci. Sports Exerc*. 39: 487-493, 2007.
6. Flynn, M.G., Costill, D.L., Kirwan, J.P., Fink, W.J. and Dengel, D.R. Muscle fiber composition and respiratory capacity in triathletes. *Int. J. Sports Med*. 8: 383-386, 1987.
7. Gatsonis, C. and Sampson, A.R. Multiple correlation: exact power and sample size calculations. *Psychol. Bull*. 106: 516-524, 1989.
8. Gulbin, J.P. and Gaffney, P.T. Ultraendurance triathlon participation: typical race preparation of lower level triathletes. *J. Sports Med. Phys. Fitness* 39: 12-15, 1999.
9. Hendy, H.M. and Boyer, B.J. Specifity in the relationship between training and performance in triathlons. *Percept. Mot. Skills* 81: 1231-1240, 1995.
10. Kimber, N.E., Ross, J.J., Mason, S.L. and Speedy, D.B. Energy balance during an Ironman triathlon in male and female triathletes. *Int. J. Sport Nutr. Exerc. Metab*. 12: 47-62, 2002.
11. Knechtle, B., Joleska, I., Wirth, A., Knechtle, P., Rosemann, T.

and Senn, O. Intra- and inter-judge reliabilities in measuring the skin-fold thicknesses of ultra-runners under field conditions. *Percept. Mot. Skills* 111: 1-2, 2010.

12. Knechtle, B., Knechtle, P. and Rosemann, T. Race performance in male mountain ultra-marathoners: anthropometry or training? *Percept. Mot. Skills* 110: 721-735, 2010.
13. Knechtle, B., Knechtle, P. and Rosemann, T. Upper body skin-fold thickness is related to race performance in male Ironman triathletes. *Int. J. Sports Med*. 32: 20-27, 2011.
14. Knechtle, B., Wirth, A., Baumann, B., Knechtle, P. and Rosemann, T. Personal best time, percent body fat and training volume are differently associated with race time in male and female Ironman triathletes. *Res. Q. Exerc. Sport* 81: 62-68, 2010.
15. Knechtle, B., Wirth, A., Knechtle, P., Baumann, B., Rosemann, T. and Senn, O. Differential correlations between anthropometry, training volume and performance in male and female Ironman triathletes. *J. Strength Cond. Res*. 24: 2785-2793, 2010.
16. Knechtle, B., Wirth, A., Knechtle, P., Zimmermann, K. and Kohler, G. Personal best marathon performance is associated with performance in a 24-h run and not anthropometry or training volume. *Brit. J. Sports Med*. 43: 836-839, 2009.
17. Knechtle, B., Wirth, A. and Rosemann, T. Predictors of race time in male Ironman triathletes: physical characteristics, training, or prerace experience? *Percept. Mot. Skills* 111: 437-446, 2010.
18. Knechtle, B., Wirth, A. and Rosemann, T. Is body fat a predictor variable for race performance in recreational female Ironman triathletes? *Med. Sport* 15: 6-12, 2011.
19. Landers, G.J., Blanksby, B.A., Ackland, T.R. and Smith, D. Morphology and performance of World championship triathletes. *Ann. Hum. Biol*. 27: 387-400, 2000.
20. Laurenson, N.M., Fulcher, K.Y. and Korkia, P. Physiological characteristics of elite and club level female triathletes during running. *Int. J. Sports Med*. 14: 455-459, 1993.
21. Leake, C.N. and Carter, J.E. Comparison of body composition and somatotype of trained female triathletes. *J. Sports Sci*. 9: 125-135, 1991.
22. Lepers, R. Analysis of Hawaii Ironman performances in elite triathletes from 1981-2007. *Med. Sci. Sports Exerc*. 40: 1828-1834, 2008.
23. Lepers, R. and Maffiuletti, N.A. Age and gender interactions in ultraendurance performance: insight from the triathlon. *Med. Sci. Sports Exerc*. 43: 134-139, 2011.
24. O'Toole, M.L. Training for ultraendurance triathlons. *Med. Sci. Sports Exerc*. 21: S209-S213, 1989.
25. O'Toole, M.L., Douglas, P.S. and Hiller, W.D. Lactate, oxygen uptake and cycling performance in triathletes. *Int. J. Sports Med*. 10: 413-418, 1989.
26. Parry, D., Chinnasamy, C., Papadopoulou, E., Noakes, T. and Micklewright, D. Cognition and performance: anxiety, mood and perceived exertion among Ironman triathletes. *Brit. J. Sports Med*. 45: 1088-1094, 2011.
27. Schumacher, Y.O., Mroz, R., Mueller, P., Schmid, A. and Ruecker, G. Success in elite cycling: A prospective and retrospective analysis of race results. *J. Sports Sci*. 24: 1149-1156, 2006.
28. Sleivert, G.G. and Rowlands, D.S. Physical and physiological factors associated with success in the triathlon. *Sports Med*. 22: 8-18, 1996.
29. Speedy, D.B., Noakes, T.D., Rogers, I.R., Thompson, J.M., Campbell, R.G., Kuttner, J.A., Boswell, D.R., Wright, S. and Hamlin, M. Hyponatremia in ultradistance triathletes. *Med. Sci. Sports Exerc*. 31: 809-815, 1999.
30. Speedy, D.B., Rogers, I.R., Noakes, T.D., Wright, S., Thompson, J.M., Campbell, R., Hellemans, I., Kimber, N.E., Boswell, D.R., Kuttner, J.A. and Safih, S. Exercise-induced hyponatremia in ultradistance triathletes is caused by inappropriate fluid retention. *Clin. J. Sport Med*. 10: 272-278, 2000.
31. Stoeber, J., Uphill, M.A. and Hotham, S. Predicting race performance in triathlon: the role of perfectionism, achievement goals and personal goal setting. *J. Sport Exerc. Psychol*. 31: 211-245, 2009.
32. Wegelin, J.A. and Hoffman, M.D. Variables associated with odds of finishing and finish time in a 161-km ultramarathon. *Eur. J. Appl. Physiol*. 111: 145-153, 2011.