Original Article

No association of skin-fold thicknesses and training with race performance in male ultra-endurance runners in a 24-hour run

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ABSTRACT

Knechtle B, Knechtle P, Rosemann T. No association of skin-fold thicknesses and training with race performance in male ultra-endurance runners in a 24-hour run. *J. Hum. Sport Exerc.* Vol. 6, No. 1, pp. 94-100, 2011. In male high-level long-distance runners over 10,000 m, a positive association between both the front thigh and medial calf skin-fold thickness and running performance has been demonstrated. It is assumed that the thickness of skin-folds of the lower limb is related to training in highly trained runners. We investigated in 22 male ultra-endurance runners in a 24-hour run the relationship between skin-fold thicknesses and race performance. The 22 runners achieved a total of 154 (47) km during the 24 hours, varying from 73.079 km to 231.956 km. No association for both the skin-fold thicknesses and the training variables with race performance could be demonstrated. Furthermore, skin-fold thicknesses showed no relationship with both volume and intensity during training. We must assume that in ultra-endurance runners in a 24-hour run, other variables such as motivation and nutrition must be associated with race outcome. **Key words**: BODY FAT, BODY COMPOSITION, PERFORMANCE, ANTHROPOMETRY.

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Submitted for publication April 2009.
Accepted for publication November 2010.
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.4100/jhse.2011.61.11

INTRODUCTION

Running is a very popular sports discipline and can be performed over different distances. An abundant variety of physiological, anthropometrical and training variables seem to influence running performances depending upon the length and duration of performance.

The relationship between skin-fold thicknesses and running performance is an intensively discussed topic. Hagan, Smith and Gettman (1981) reported that apart from other variables, the sum of 7 skin-fold thicknesses is correlated to marathon performance time. Bale, Bradbury and Colley (1986) showed that total skin-fold thickness, the type and frequency of training and the number of years running were the best predictors of running performance and success in the 10 km distance. In recent studies, an association between the thicknesses of selected skin-folds of the upper and lower body with running performance has been demonstrated in top class male and female runners (Arrese and Ostáriz, 2006; Legaz and Eston, 2005).

In these studies, elite runners of distances from 100 m to 10,000 m and the marathon had been investigated (Arrese and Ostáriz, 2006; Legaz and Eston, 2005). High correlations were found in male runners between both the front thigh and medial calf skin-fold thickness and 10,000 m race times (Arrese and Ostáriz, 2006). It is supposed that the thickness of skin-folds at the lower limb is a result of intense training in running (Legaz and Eston, 2005).

The relationship between skin-fold thicknesses and race performance was investigated in all running distances from 100 m to 10,000 m and the marathon distance in top level athletes; but not in ultra-distances. We therefore intended to investigate whether correlations between skin-fold thicknesses and race performance in ultra-endurance runners in 24-hour ultra-runners exist.

MATERIAL AND METHODS

Participants and race

In 2007 the organiser of the 19th edition of the 24-hour run in Basel, Switzerland, contacted all participants in the race by a separate newsletter, 3 months before the race, in which they were asked to participate in the study. Eighty-six male Caucasian ultra-runners intended to start and 22 athletes with 45.9 (6.6) years, 1.77 (0.07) m body height, 72.3 (8.0) kg body mass and a BMI of 23.0 (1.7) kg/m^2 were interested in our investigation. They all gave their informed written consent in accordance with the guidelines established by the Institutional Ethics Committee. The training and race history of the runners is represented in Table 1. All participants had finished at least 9 marathons with an average of 35 (22) finished marathons and 11 subjects had already finished at least one 24-hour run. The 19th edition of the 24-hour run in Basel took place on May 12th and 13th 2007. Runners from all over Europe started at the International Swiss Championship on May 12th at noon to perform as many laps of 1'141.86 m as possible on a flat course. The weather was fine and dry and the temperature varied between 10°C (night) and 31°C (noon). The athletes could take food and beverages from an abundant buffet being provided by the organiser as well as their own food from their own support crew.

Table 1. *Training and race history of the successful finishers. Results are presented as mean (SD).*

Training and pre race experience	
Training volume (h/week)	10.2 (3.8)
Training volume (km/week)	94.4 (30.1)
Average speed in running during training (km/h)	9.6 (1.8)
Years of competitive running	12.8 (6.7)
Number of finished marathons	35.2 (22.7)
Personal best in marathon (min)	183 (21)
Number of finished 24-hour runs	5.9 (8.0)
Personal best in 24-hour run (km)	185.7 (28.2), n = 11

Procedure

Before the start of the race, skin-fold thicknesses at 8 sites were measured by an experienced investigator at the following sites: pectoral, triceps, axillar, subscapular, abdominal, suprailiacal, front thigh and medial calf. Skin-fold data was obtained using a skin-fold calliper (GPM-Hautfaltenmessgerät, Siber & Hegner, Zurich, Switzerland) and recorded to the nearest 0.2 mm. One trained investigator took all the measurements as inter-tester variability is a major source of error in skin-fold measurements. The skin-fold measurements were taken once for the entire 8 skin-fold sites and then repeated 3 times by the same investigator; the mean of the 3 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, Katch and Moffat (1986), readings were performed 4 s after applying the calliper. An intra-tester reliability check was conducted on 27 male runners prior to testing. No significant difference between the 2 trials for the sum of 8 skin-folds was observed ($p > 0.05$). The intra-class correlation was high at $r = 0.95$. The same investigator was also compared to another trained investigator to determine inter-tester reliability. No significant difference existed between the testers ($r = 0.97$; $p > 0.05$). Percent body fat was calculated using the following anthropometric formula for males according to Ball, Altena and Swan (2004): Percent body fat = $0.465 + 0.180(\Sigma 7SF) - 0.0002406(\Sigma 7SF)^2 + 0.0661(\text{age})$, where $\Sigma 7SF$ = sum of skin-fold thickness of chest, midaxillary, triceps, sub scapular, abdomen, suprailiac and thigh mean. This formula was evaluated using 160 men aged 18 to 62 years old and cross-validated using DXA (dual energy X-ray absorptiometry). 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. Athletes were asked to maintain a comprehensive training diary consisting of daily workouts showing distance and duration in the 3 months before the race. Training consisting of the number of training units with duration, kilometres and pace, weekly kilometres run, weekly hours run, minimal and maximal kilometres run per week were also recorded. Additionally, they reported their number of years as an active runner, their number of finished marathons and their personal best performance in a 24-hour run.

Statistical analysis

Data is presented as mean (SD). The coefficient of variation of performance (CV% = 100 x SD/mean) was calculated. The Pearson correlation coefficient was used to test for univariate associations between race time and both the anthropometric and training variables as well as to assess the relationship between anthropometric and training variables. Bonferroni correction was used to compensate for multiple testing effects (n = 12 for anthropometric variables and n = 3 for training variables).

RESULTS

The 22 runners achieved a total of 154 (47) km (CV = 30.5 %) during the 24 hours, varying from 73.079 km for the weakest runner to 231.956 km for the best runner. No association for both the anthropometric variables (Table 2) and the training variables (Table 3) with race performance was found. Furthermore, the thicknesses of skin-folds were not related to either volume or speed in training (Table 4).

Table 2. *The relationship between the anthropometric variables and total race time for the 22 athletes. Results are presented as mean (SD).*

Anthropometric variables		r	p
Skin-fold pectoralis (mm)	6.6 (3.3)	- 0.15	0.5095
Skin-fold axillar (mm)	7.0 (2.2)	- 0.36	0.1025
Skin-fold triceps (mm)	8.0 (2.0)	- 0.18	0.4246
Skin-fold subscapular (mm)	9.1 (2.2)	0.02	0.9402
Skin-fold abdominal (mm)	16.8 (8.0)	- 0.27	0.2189
Skin-fold suprailiacal (mm)	12.2 (5.4)	- 0.31	0.1576
Skin-fold thigh (mm)	9.9 (5.2)	- 0.11	0.6208
Skin-fold calf (mm)	7.2 (3.3)	- 0.15	0.5166
Sum of upper body skin-folds (mm)	59.7 (19.0)	- 0.29	0.1943
Sum of lower body skin-folds (mm)	17.1 (7.2)	- 0.15	0.5113
Sum of 8 skin-folds (mm)	76.8 (23.4)	- 0.28	0.2091
Percent body fat (%)	14.8 (3.5)	- 0.26	0.2392

Table 3. *The relationship between the anthropometric variables and total race time for the 22 athletes. Results are presented as mean (SD).*

Training variables		r	p
Training volume (h/week)	10.2 (3.8)	0.19	0.3911
Training volume (km/week)	94.4 (30.1)	0.24	0.2794
Average speed in running during training (km/h)	9.6 (1.8)	- 0.02	0.9152

Table 4. *Association between selected anthropometric and training variables (n = 22).*

Anthropometric variables	Weekly kilometres run	Weekly hours run	Speed in running
Skin-fold pectoralis (mm)	r = 0.14 p = 0.5361	r = 0.43 p = 0.0475	r = - 0.45 p = 0.0355
Skin-fold axillar (mm)	r = - 0.20 p = 0.3696	r = 0.08 p = 0.7153	r = - 0.46 p = 0.0329
Skin-fold triceps (mm)	r = 0.11 p = 0.6303	r = 0.21 p = 0.3394	r = - 0.29 p = 0.1953
Skin-fold subscapular (mm)	r = - 0.02 p = 0.9347	r = 0.07 p = 0.7588	r = - 0.20 p = 0.3631
Skin-fold abdominal (mm)	r = - 0.08 p = 0.7363	r = 0.06 p = 0.8025	r = - 0.26 p = 0.2520
Skin-fold suprailiacal (mm)	r = - 0.22 p = 0.3173	r = - 0.03 p = 0.8981	r = - 0.32 p = 0.1482
Skin-fold thigh (mm)	r = 0.13 p = 0.5590	r = 0.25 p = 0.2594	r = - 0.25 p = 0.2704
Skin-fold calf (mm)	r = 0.18 p = 0.4177	r = - 0.02 p = 0.9231	r = 0.22 p = 0.3350
Sum of upper body skin-folds (mm)	r = - 0.09 p = 0.7068	r = 0.13 p = 0.5626	r = - 0.38 p = 0.0781
Sum of lower body skin-folds (mm)	r = 0.18 p = 0.4257	r = 0.17 p = 0.4449	r = - 0.08 p = 0.7281
Sum of 8 skin-folds (mm)	r = - 0.01 p = 0.9501	r = 0.16 p = 0.4810	r = - 0.34 p = 0.1272
Percent body fat (%)	r = - 0.06 p = 0.7887	r = 0.19 p = 0.4069	r = - 0.41 p = 0.0602

DISCUSSION

In this investigation of male ultra-endurance runners in a 24-hour run, no association between both skin-fold thicknesses and training variables with race performance could be detected. Furthermore, the thicknesses of skin-folds were not related to both volume and intensity in training.

We expected to find a positive association between both body fat and sum of skin-folds with running time in these ultra-runners runners, however, no associations could be found. Interestingly, already Conley and Krahenbuhl (1980) reported no significant relationship between both body fat and sum of skin-folds with performance in an elite group of 10,000 m runners (32 min 6 s, CV = 3.1 %). Arrese & Ostáriz (2006) claimed that the skin-fold thicknesses in the lower limb are positively associated with running time over several distances when investigating elite runners. Regarding skin-fold thicknesses, none of the measured and calculated skin-fold thicknesses was related to race performance in our runners (Table 2). Arrese & Ostáriz (2006) showed a high correlation between the front thigh skin-fold and the medial calf skin-fold with a 10,000 m race time in elite male runners, but not in marathoners.

Low amounts of body fat might be advantageous for ultra-runners. In the literature, there are studies showing an effect of thin skin-fold thicknesses on running performance, especially up to 10,000 m. However, in our ultra-runners, percent body fat showed no association with race performance (Table 2). In general, the amount of fat and the thickness of skin-folds seem to be of importance for performance in runners. It has been shown that endurance performance is negatively related to body fat (Leedy, Ismail, Kessler and Christian, 1965). The study of Hetland, Haarbo and Christiansen (1998) demonstrated that regional and total body fat was negatively correlated with the performance in a standardised incremental laboratory treadmill test. Interestingly, also in non-runners, fat percentage is significantly associated with 12-min running performance (Mattila, Tallroth, Marttinen and Pihlajamäki, 2007). Bale, Bradbury and Colley (1986) reported that total skin-fold thickness, together with the type and frequency of training and the numbers of years running were the best predictors of running performance and success at the 10 km distance. However, in our ultra-endurance runners, skin-fold thicknesses showed no correlation with race performance (Table 2).

In runners, decreased skin-fold thicknesses in the lower limb were measured after a longer training period; this might be particularly useful in predicting running performance (Legaz and Eston, 2005). Three years of training reduced skin-fold thickness and the change in performance was related to the change in skin-fold thickness of triceps, front thigh and medial calf. The lower skin-fold values found in runners might be due to the high performance (Legaz Arrese, Gonzalez Badillo and Serrano Ostariz, 2005). We therefore assumed to find associations between skin-fold thicknesses respectively percent body fat and training variables such as volume and intensity. However, no relationship between average weekly running kilometres and intensity during running in training could be found (Table 4).

CONCLUSIONS

In this study of male ultra-endurance runners in a 24-hour run, no association between skin-fold thicknesses and race performance has been detected as has been reported for high-level long-distance runners over 10,000 m. Additionally, no relationship between thickness of skin-folds and training could be found as was assumed for elite runners. We presume that anthropometric variables such as skin-fold thicknesses are of lower importance in an ultra-run such as a 24-hour run. We suppose that other factors such as motivation and nutrition are of major importance for running performance in an ultra-endurance run.

Acknowledgments
We thank the crew of 'Sri Chinmoy Marathon Team Switzerland' for their support to collect data. For their help in translation, we thank Matthias Knechtle, Lausanne, Switzerland and Mary Miller from Stockton-on-Tees, Cleveland in England, crew member of an ultra-endurance support crew. A special thank goes to Hans Drexler, MD and PhD, Braunschweig, Germany, for his constructive criticism.

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

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