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Predictor variables for 7-day race in ultra-marathoners

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Abstract

We evaluated the association of anthropometric, training, physiological and psychological variables with race performance in a 7-day running stage race. Participants: 12 recreational runners 49.6 ± 6.8 years (mean ± SD), 75.1 ± 13.3 kg, 177.0 ± 7.0 cm, body mass index value 23.8 ± 3.1 kg/m^2. Methods: Questionnaires and physiological measurements. Results: We found the significant pre race minus post race difference in body mass (Δ) and the post race minus pre race difference (Δ) in a rating of perceived exertion. In contrast no significant correlations were between select variables and race time.

Keywords: Prolonged running, field study, amateur sport;

1. Introduction

Running is very popular sports discipline and can be performed over different distances. Ultra-endurance races are of increasing popularity (Knechtle & Kohler, 2007), but the number of researches performed on long-lasting races is very limited - probably because of practical difficulties. There are many different factors which influence performance in endurance exercise, depending upon the length and duration of the performance.

However, there is little scientific data about the effect of anthropometry on race performance in ultra-marathon running (Knechtle, B., Knechtle, P., Rosemann & Lepers, 2010b) and little is known about the effects of constant running over a few days (Knechtle & Kohler, 2007). The data from the existing literature is not consistent and even partly contradictory. Ultra-marathon running is also associated with different problems such as dehydration (Kao et al., 2008) and a decrease in skeletal muscle mass. Apart from anthropometry, training variables like pre race experience and training volume seem to influence running performance (Yeung, S.S., Yeung, E.W. & Wong, 2001; Knechtle, B., Wirth, Knechtle P., Zimmermann & Kohler, 2009c; Knechtle, B., Knechtle, P., Rosemann & Lepers, 2010a; Knechtle, 2010b).

Considering the present literature on long-distance runners up to the marathon distance, in this study we would expect significant relationships between anthropometric, training, physiological and psychological variables and race performance in ultra-marathons. We also evaluated associations between pre race and post race changes in body mass, temperature, hematocrit and a rating of perceived exertion.

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2. Methods

2.1. Subjects

The number of 47 recreational runners, 38 men and 9 women, were intending to start the race, and a total of 15 ultra-runners were interested in the investigation. The athletes were informed of the procedures and gave their informed written consent. Total 12 runners (10 men and 2 women) underwent seven stages and we assigned them to statistical analysis. The average participant was 49.6 ± 6.8 years old (mean ± standard deviation), males 49.8 ± 7.4 years, females 48.5 ± 2.5 years. The height was 177.0 ± 7.0 cm, males 178.8 ± 6.2 cm, females 168.0 ± 1.0 cm. The mean body weight was 75.1 ± 13.3 kg, males 78.9 ± 11.1 kg, females 56.0 ± 4.0 kg. Body mass index value (BMI) was 23.8 ± 3.1 kg/m^2, males 24.6 ± 2.7 kg/m^2, females 19.9 ± 1.7 kg/m^2. The subjects covered 301 km at average time 37 hours during the 7 days.

2.2. The race

Moravian Ultra Marathon is the running competition over a distance of 301 km with an international participation (Hungary, Slovakia, Austria, Germany) and includes 7 classic marathons in 7 consecutive days, 43 km daily. It took place from 3rd July to 9th July 2011. The race was selected on the basis of our practical experience, but also because it is the longest running and most difficult stage race held in the Czech Republic. The varied daily running was in hilly terrain on often unpaved trails with an elevation from about 700 to 1500 m. At the start the temperature was 10° Celsius and it was raining heavily. During the various stages the temperature rose to 28° Celsius, the weather changed and was hot sunny. Throughout the stages there were aid stations with food and beverages.

2.3. Measurements and calculations

The used methods were questionnaires and physiological measurements. The parameters such as age, gender, a resting heart rate, years as active runner, average yearly training volume in kilometers, the number of similar completed races, a rating of perceived exertion (RPE scale 6-20; Borg, 1998) and other data were processed from questionnaires given to test subjects personally the day before the race. The questionnaires were created specifically for this type of research. Some data was added to the questionnaire by competitors at the finish. The physiological parameters (body mass, height, hematocrit and temperature) were determined by measuring before and immediately after the race. Blood samples were drawn to determine hematocrit levels and they were derived from capillary finger tip. Overall ranking in the race was specified regardless of the order in the category due to an objective statistical evaluation. It was calculated from the total number of 47 athletes who entered the race regardless of sex and age of competitors.

2.4. Statistical analysis

The association of select anthropometric, training, physiological and psychological variables with race time was investigated using correlation analysis. Pearson and Spearman correlation coefficients were used for statistical data processing, which should reveal any relationship variables and race performance. We also examined significant differences between pre race and post race changes in body weight, temperature, hematocrit and a rating of perceived exertion. We used Wilcoxon paired t-test for dependent selection of pre race and post race changes. Normally distributed data was presented as mean and standard deviation (SD). The data was evaluated on the level of significance 0.05 in the program Statistic 7.0.

3. Results

3.1. Anthropometric data

The pre race minus post race difference (Δ) in body mass (from 76.5 ± 13.1 kg to 72.0 ± 12.0 kg) was significant ($p << 0.01$). Changes in body weight were quantified as a decrease 6 % (4 kg). According to the responses from questionnaires, the runners consumed 1.3 ± 0.4 liters of fluids every day before the race and 1.2 ± 0.4 liters of fluid during one race stage. In contrast there were no significant correlations between age, body height, pre race and post race body weight or BMI and race time.

3.2. Training data

Correlations between years as an active runner, average yearly training volume in kilometers, the number of completed similar races and race time were not significant. Training variables in ultra-runners in this study showed no significant association with running ultra-endurance stage performance.

3.3. Physiological data

Laboratory value for the resting heart rate was 51.3 ± 6.2 beats/min, males 50.9 ± 6.6 beats/min, females 53.0 ± 3.0 beats/min. We did not found significant correlations between the resting heart rate, pre race and post race body temperature or values of hematocrit and race time. The post race minus pre race difference (Δ) in temperature (from 36.0 ± 0.7 ° Celsius to 36.3 ± 0.6 ° Celsius) showed no significant changes. The pre race minus post race difference in values of hematocrit (from 45.1 ± 4.3 % to 39.0 ± 4.8 %) was large, but not statistically significant.

3.4. Race performance

The coefficient of variation of performance (CV% = 100 x SD/mean) for total race time was 16. We can observe race time of various groups in different stages of the race (Figure 1. Stages and race time).

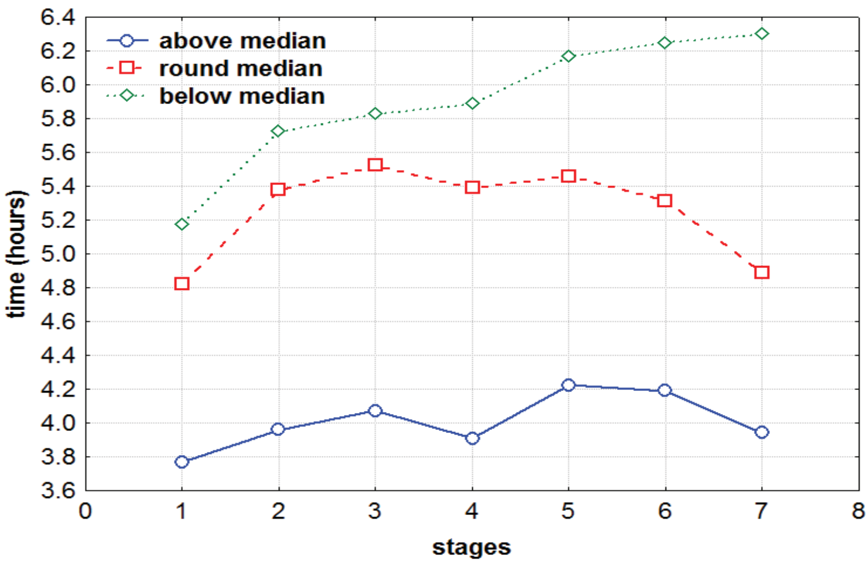

Figure 1. Stages and race time

The decrease or the increase in race time has to do with tactics in the race, with an overall pace. We divided runners to three groups (n per group = 4) according to their race times in stages over several consecutive days. The differences in race time between the group above median and the group below median were nearly double. The variance in race performance in better and worse runners was that better ones began the race with the high speed and they were able to return to this speed after the 4th stage, which was for all groups critical, because the runners run out the power. In contrast the group below median was still worse and their speed was lower and lower. For the group around median and the group above median it is assumed that performance came according the sinusoid. Runners cyclically improved and deteriorated.

3.5. Psychological data

The subjects were instructed to rate how they felt pre race and immediately post race. Using the 10-point Borg Scale the runners rating of perceived exertion (RPE scale 6-20, Borg, 1998) increased from pre- to post race from 10.4 ± 2.8 to 15.3 ± 2.3. The mean RPE post race corresponding to a perceived effort „hard (heavy)“ (Borg, 1998). We found no correlation between the order in the race and pre race or post race changes in the rating of perceived exertion. In contrast the post race minus pre race difference (Δ) in the rating of perceived exertion was significant ($p \ll 0.01$).

4. Discussion and conclusions

In anthropometric data we did not find significant correlation between age, body weight, body height or body mass index and race time. Also according to Knechtle, Duff, Schulze Rosemann and Senn (2009a), Knechtle et al. (2009c) anthropometry does not seem to have a major effect on race performance in ultra-marathon running. However, Hoffman (2008) reported body mass index is related to marathon performances in ultra-running, also Knechtle B., Knechtle P., Rosemann & Lepers (2010a) and Knechtle et al. (2010b) demonstrated that age and chosen skin-folds are related to endurance running for 100 km race time. On the other hand, according to the same author, chosen training variables are more important for a fast race time in male 100-km runners than any of the determined anthropometric variables (Knechtle et al., 2010a).

There was no significant correlation between years as active runner, average yearly training volume in kilometers, the number of completed similar races and race time. In this study during the race performance the decrease or the increase in race time has to do with tactics in the race, with an overall pace. Runners cyclically improved and deteriorated. According to Knechtle et al. (2009c) training volume does not seem to have a major effect on race performance in ultra-marathon running, neither pre-race experience and training volume nor previously completed races are associated with race time of the finishers (Knechtle et al., 2009a). On the contrary Knechtle et al. (2010a) could demonstrate that pre race experience might be of importance, not training parameters; on the other hand performance in 100 km races may be predicted also by training volume (Knechtle et al., 2010b). In female 100 km runners only pre race experience is associated with race performance, but not training parameters (Knechtle et al., 2010a).

No significant correlation was find between post race and pre race temperature, the laboratory-determined value of resting heart rate, pre race or post race rating of perceived exertion or values of hematocrit and race time. The post race minus pre race difference (Δ) in temperature showed no significant association. We did not find significant correlation between post race change in weight and post race change in RPE. In contrast the post race minus pre race difference in RPE was significant ($p \ll 0.01$). Our results suggest big declines in mental function during a prolonged running stage race.

The main result of this study is that this multi-day ultra-endurance run led to a statistically significant decrease in body mass in recreational ultra-runners. This is in contrast to the results of former ultra-endurances races with breaks where body mass remained stable (Väänänen & Vihko, 2005) or even increase (Raschka & Plath, 1992). However, in ultra-endurance performances for hours or even days without break, a decrease in body mass (Bircher, Enggist, Jehle & Knechtle, 2006) has been demonstrated. One problem in our study is the fact that we measured the athletes immediately after arriving at the finish line and could not determine correctly whether they were dehydrated or not. As it takes some time for the body to compensate for the dehydration, the timing of measuring body mass after the race might also be of importance. The hydration status in our study, assessed from changes in body weight, indicated a dehydration indirectly quantified as a decrease 6 % in body mass from the first stage to the last seventh stage of the race. According to the responses from questionnaires, fluid intake during the hot stages was for the runners with longer race times not sufficient. The question still remains, whether dehydration really occurs during ultra-endurance performances? During dehydration, we would generally expect an increase in hematocrit, but ultra-endurance performance leads to a hypervolemia with hemodilution and a decrease in hematocrit. In our test group post race values of hematocrit decreased, differences in values of hematocrit were large, but not statistically significant. According to Knechtle and Kohler (2007) it takes some time for the body to compensate for the physical race effects. Wirnitzer and Faulhaber (2007) concluded that hemodilution is shown as a long term effect of repeated endurance strain. This also confirmed Knechtle and Kohler' opinion, that there was the possibility of significant decrease in skeletal muscle mass, not only dehydration. We do not know exactly why there was such a big decrease in body weight. Among the reasons for this, for example, is the fact that we did not use methods for establishing if the decrease was of muscle mass or body fat; in future research we would definitely use stricter measures to establish the decline in body mass.

From this analysis, it is concluded that select training, anthropometry, physiological and physiological variables were not related to race time. On the contrary we found the significant pre race minus post race difference (Δ) between changes in body mass and the post race minus pre race difference (Δ) in the rating of perceived exertion. To summarize, the hydration status, likely decrease in skeletal muscle mass and the psychological parameters could seemed to be of importance for a 7-day stage running race.

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