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Comparison of training, anthropometric, physiological and psychological variables of ultra-endurance cyclists and runners

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Abstract

We compared training, anthropometric, physiological and psychological characteristics between 14 cyclists, participants in a 24-hour mountain bike race and 12 runners, participants in a 7-day running ultra-marathon. Methods: Questionnaires and physiological measurements. Results: The differences in ages between cyclists and runners were significant ($p << 0.01$). The pre-race minus post-race differences (Δ) in body mass (from 76.5 ± 13.1 kg to 72.0 ± 12.0 kg) and (Δ) in value of hematocrit (6.1 ± 3.5 %) were significant only in runners. The post-race minus pre-race difference (Δ) in the rating of perceived exertion was significant in both groups.

Keywords: 7 stages running race, 24-hour mountain bike race, field study;

1. Introduction

Ultra-endurance exercise can be performed in different sport activities. However, a consensus on the definition of these activities does not exist. According to Zaryski and Smith (2005) and other authors ultra-endurance competition is defined as event that exceed than 6 hours in duration and can last up to 40 hours or several days. The longer events rely on long-term preparation, sufficient nutrition, accommodation of environmental stressors, and psychological toughness. Despite the fact that the number of athletes is increasing and ultra-endurance events have become very popular during the last decade, knowledge is sparse about the effects of prolonged strenuous exercise and the determining factors of ultra-marathon performance are poorly identified.

For the comparison we chose the 24-hour ultra-endurance mountain bike race and the ultra-endurance running 7-stage race. We compared two different sport disciplines, two different types of ultra-marathon events, but both performed on various terrain trails. It was supposed that ultra-cycling in contrast to ultra-running leads to similar but also dissimilar results. According to Knechtle and Kohler (2007) there seem to be differences between performances with breaks, for example during the night (multi-stage marathon) and non-stop performances without defined breaks (24-hour race). In addition, factors associated with a 24-hour mountain bike performance are very rarely investigated. The principal objective of this study was therefore to compare select anthropometric, training,

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physiological and psychological variables in two different sport performances, in two separate concrete races, in two separate settings, in two divergent groups of recreational ultra-endurance athletes, cyclists and runners.

2. Methods

We performed two independent cross-sectional observational pieces of research. The ultra-endurance outdoor racing activity, the similar date, the similar changing weather, the same investigative methods and the same research team were common for both tested groups. The used methods were questionnaires, physiological measurements and chip technology Sport soft in cyclists group. The athletes were informed of the experimental procedures and gave their written consent. They were asked to complete the questionnaire which they had received personally the day before the race. The questionnaires were created specifically for this type of research. The parameters such as age, gender, a resting heart rate, years as an active athlete, average yearly training volume, the number of similar completed races, a rating of perceived exertion (RPE scale 6-20; Borg, 1998) and other data were processed from the questionnaires. Some data was added to the questionnaire at the finish. The physiological parameters (body mass, height, temperature, hematocrit) were determined by measuring before and immediately after the race. Blood samples were drawn to determine hematocrit levels and they were derived from fingertip capillaries. Overall ranking in the race was specified regardless of the order in the category due to an objective statistical evaluation.

We investigated differences between the group of cyclists and the group of runners. We compared select anthropometric, training, physiological and psychological variables and the pre-race minus post-race differences (Δ) in body mass, in temperature, in hematocrit and in a rating of perceived exertion. We used the Wilcoxon paired t-test for dependent selection and chi-square test. Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. The data was evaluated on the level of significance 0.05 in the program Statistic 7.0.

2.1. Race performances

The largest and the oldest 24-hour race in the Czech Republic Bike Race Marathon MTB Rohozec in Liberec took place from 11th June to 12th June 2011. One race circuit was 12.6 km. The elevation in one round was 250 m. The track surface consisted of paved and unpaved roads and paths. The start was Le-Mans style. The total score was counted only from the whole rounds, which the riders completed. The aim was to achieve the highest race mileage in 24 hours. At the start the temperature was 14 ° Celsius and it was sunny weather. During the race the temperature varied from the lowest value of 5 ° Celsius to the highest 25 ° Celsius and the weather changed rapidly from sunny, cloudy to rainy. There was one aid station with food and beverages located at the start and finish.

The Moravian Ultra Marathon is a running stage competition over a distance of 301 km and includes 7 classic marathons in 7 subsequent days, 43 km daily. It took place from 3rd July to 9th July 2011. The race is the longest running and most difficult stage race held in the Czech Republic. It is a varied daily running route over hilly terrain often on 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 stages the temperature dropped to 28° Celsius, the weather changed and it became hot and sunny. Throughout the stages there were aid stations with food and beverages.

3. Results

3.1. Comparison of anthropometric data

The cycling group consisted of 16 recreational mountain bike ultra-endurance cyclists (14 men and 2 women). Since two cyclists did not complete the race, one due to an injury during the race and the other one for an irreparable technical defect on a bicycle, the data was processed from 14 athletes (12 men and 2 women). The cyclists covered 163.8 - 421.2 km, at average velocity of 15.9 km/hour. The running group consisted of 12 runners (10 men and 2 women) from the original 15 runners. The runners covered during 7 days 301 km at average time 37 hours. The

average cyclist was 36.9 ± 8.8 years old (mean ± standard deviation), males 37 ± 8.6 years, females 36.5 ± 9.5 years. The average runner was 49.6 ± 6.8 years old, males 49.8 ± 7.4 years, females 48.5 ± 2.5 years. The differences in ages between cyclists and runners were significant ($p << 0.01$).

The mean height in cyclists was 180.7 ± 7.2 cm, males 182.3 ± 6.4 cm, females 171.5 ± 3.5 cm. The mean height in runners was 177.0 ± 7.0 cm, males 178.8 ± 6.2 cm, females 168.0 ± 1.0 cm. The differences in height between cyclists and runners were not significant. The mean body weight in cyclists was 80.6 ± 9.5 kg, males 82.8 ± 8.4 kg and females 67.3 ± 1.3 kg. The mean body weight in runners was 75,1 ± 13,3 kg, males 78.9 ± 11.1 kg, females 56.0 ± 4.0 kg. The differences in body weight between cyclists and runners were not significant. Body mass index (BMI) in cyclists was 24.7 ± 2.4, males 24.9 ± 2.5 and females 22.9 ± 1.4. BMI in runners was 23.8 ± 3.1, males 24.6 ± 2.7, females 19.9 ± 1.7. There were no differences in BMI between cyclists and runners.

Dehydration in the cyclists' group was indirectly quantified as a 2 % decrease in body weight pre to post race, in the runners' group as a decrease 6 % in body mass. The pre race minus post race difference (Δ) in body mass (from 76.5 ± 13.1 kg to 72.0 ± 12.0 kg) in the runners' group was significant ($p << 0.01$), Δ in cyclists group (from 80.6 ± 9.5 kg to 78.7 ± 9.0 kg) was not significant. The differences in pre-race weights or post-race weight between both groups were not significant. According to the responses from the questionnaires runners consumed 1.3 ± 0.4 liters of fluids before the race and 1.2 ± 0.4 liters of fluid during one race stage - every day. Cyclists consumed 1.9 ± 0.3 liters of fluids before the race and 3.1 ± 0.7 liters of fluids during the 24-hour race.

3.2. Comparison of training indices

Cyclists and runners were recruited among experienced ultra-endurance athletes and all of them had cycle or run at least one similar race. There were no significant differences in years as active athlete, the average yearly training volume, the number of similar completed races between cyclists and runners.

3.3. Comparison of physiological characteristics

The significant pre-race minus minus post-race difference (Δ) in value of hematocrit was found in runners (6.1 ± 3.5 %). In contrast no significant differences were in pre-race values of hematocrit between cyclists (43,3 % ± 4,3 %) and runners (45,1 % ± 4,3 %) and in post-race values of hematocrit between cyclists (43,4 % ± 3,7 %) and runners (39,0 % ± 4,8 %).

In the cycling group the resting heart rate was 55.0 ± 12.1 beats/min, males 53.9 ± 12.7 beats/min, females 61.5 ± 2, 5 beats/min. In the running group 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. The differences in the resting heart rate between both groups were not significant.

The pre-race and post-race changes in temperature in cyclists ranged from 36.1 ± 0.6 °C to 35.8 ± 0.7 °C and from 36.0 ± 0.7 °C to 36.3 ± 0.6 °C in runners. The differences in temperature between both groups were not significant.

3.4. Comparison of psychological characteristics

The values of the rate of perceived exertion (Borg scale, Borg, 1998) increased from 8.0 ± 1.7 to 16.6 ± 1.4 (from "very light" to "very hard") in cyclists and from 10.4 ± 2.7 to 15.0 ± 2.2 (from "light" to "hard") in runners. The post-race minus pre-race difference (Δ) in RPE values was statistically significant in cyclists ($p << 0.01$) and also in runners ($p < 0.05$). The pre-race minus post-race difference in body mass was not significant with the post-race minus pre-race differences in RPE in both groups.

4. Discussion and conclusions

The differences in ages between cyclists and runners were significant. In this study cyclists were nearly 37 years old and runners were nearly 50 years old. We must assume that runners were older compared to cyclists. In other

similar research the age of runners was 45 years (Knechtle B., Knechtle P., Rosemann & Senn, 2011), 42 years in Knechtle and Kohler (2007) and 53 years in Fallon, Sivyer G., Sivyer K. and Dare (1999). For both sexes at the 100 km running race the percentage of finishers significantly increased for the 40-49 and the 50-59 year age groups over the studied period from 1998 to 2010 (Knechtle, Rüst, Rosemann & Lepers, 2011). In comparison with cyclists in other similar studies their mean age was 39 years in Knechtle and Rosemann (2009), 34 years in Wirnitzer and Kornexl (2008) and 32 years in Linderman, Demchak, Dallas and Buckworth (2003). We concluded, that in comparison with other studies the age of athletes in both disciplines is a standard.

The differences in weights, heights and BMI between cyclists and runners were not significant in the present study. The mean cyclists' weight was 81 kg, the mean height 181 cm and the mean BMI 25. The runner's mean weight was 75 kg, the mean height 177 cm and the mean BMI 24. According to research in Wirnitzer and Kornexl (2008) the cyclists mean body mass was 58 kg and the mean height was 1.67 cm. The cyclists mean weight was 75 kg, the mean height 1.79 cm and BMI 23 in Knechtle and Rosemann (2009). In comparison with runners their mean weight was 73 kg, height 178 cm and BMI 23 in Knechtle and Kohler (2007). In other similar researches 73 kg, 1.78 cm and BMI 23 in Knechtle et al. (2010) and BMI was 23 in males and 21 in females in Hoffman (2008). From this comparison it is concluded, that both ultra-marathons cyclists and runners can vary widely in physical characteristics with BMI values that would classify some individuals as underweight and others as overweight.

During extreme endurance events that last several days an energy deficit results (Bircher, Enggist, Jehle & Knechtle, 2006). The fluid intake in our tested cyclists was not effective enough. In comparison with research in Wirnitzer and Kornexl (2008) the cyclists fluid intake was 4 liters per stage mean in stage mountain biking race. In this study a 2 % decrease in body weight pre to post race was shown in cyclists. In Bircher et al. (2006) one tested cyclist lost similarly 2 kg body mass in more than 5 days race. Although the decrease in body mass indicated dehydration, the cyclists may have been relatively over-hydrated as indicated by the nonsignificant decrease in hematocrit. A reduction of the fat mass has not been confirmed during a long lasting endurance event such as a 24 hours road cycling race (Knechtle, B., Knechtle, P., Müller & Zwyssig, 2003). During an ultra distance cycle race, the energy deficit does not correspond to the loss of subcutaneous adipose tissue and muscle mass and this difference cannot properly be explained (Bircher et al., 2006). Changes in core pre-race and post-race temperature could also reflect dehydration, but also the exhaustion of the organism. However the differences between changes in temperature were not significant in both groups in the present study. As no large weight changes were noted at the conclusion of the 24-hour mountain biking race, indicating that significant dehydration and over-hydration were unlikely to have occurred. This is confirmed by no statistically significant differences in pre-race and post-race values of hematocrit in cyclists.

In contrast a 6 % decrease in body mass was shown in runners. The fluid intake in tested runners was not effective enough. In this study in runners' pre-race minus post-race values of hematocrit showed statistically significant changes. The hematocrit decreased and this confirmed Knechtle and Kohlers' (2007) opinion, that there is the possibility of significant decrease of skeletal muscle mass - more than dehydration. A possible reason for these different findings in both groups might be according to Knechtle B., Wirth, Knechtle P., Zimmermann, Kohler and Wirth (2009) that ultra-cycling in contrast to ultra-running, leads to no reduction in skeletal mass. There also appear to be a number of differences in biochemical responses between staged and continuous races over similar long distances (Fallon et al., 1999). We concluded, that these may be related to the population studied, the total distance covered, intensity of exercise, rest periods, differences in the acute phase response to musculoskeletal tissue damage, or failure to consider the effects of plasma volume changes.

Comparison of training variables in this study showed no significant differences between both groups. The small statistical size might limit statistical calculations. However, in existing literature, smaller samples were investigated. Furthermore, in a larger sample of ultra-athletes in both groups, the comparison of training and anthropometric variables might lead to different findings.

In the present study significant differences in ages between cyclists and runners were demonstrated. The main results of the present study showed, that the percent of older ultra-athletes, especially runners, significantly increased. The other result was the significant pre race minus post race difference (Δ) in hematocrit and (Δ) in body mass in runners. The hydration status, likely decrease of skeletal muscle mass could seemed to be of importance for

a stage running race. From this analysis concluded that in comparison between cyclists and runners other evaluated select anthropometry, training and physiological variables were not significant. In contrast post-race minus pre-race changes (Δ) in RPE values were statistically significant in both groups. Our results suggest big declines in mental function during a 24-hour cycling race and a 7 stage running race. The nature of these extreme, different types of races has illuminated some differences among ultra-endurance athletes. Since a cross-sectional study with correlation analysis cannot provide cause and effect, a longitudinal study with stricter measures to establish the decline in body mass is needed.

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