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Title of the paper: IS HEART RATE A VALID MEASURE TO MONITOR EXERCISE INTENSITY DURING TRAIL RUNNING IN UNDULATING TERRAIN?

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Abstract text Introduction During incremental lab tests, heart rate linearly increases and correlates with oxygen uptake and energy expenditure (Saltin et al. 1968, Circulation). Therefore heart rate is commonly used by athletes and coaches to control and evaluate exercise intensities in training and competition. During trail running however, the metabolic demand of the working muscle quickly changes due to steep up- and downhill sections and different surface conditions (i.e. forest tracks, dirt roads, gravel, rocks, wood and various other obstacles) (Jensen et al. 1999, J Sports Sci). It remains unclear, whether heart rate adequately reflects exercise intensities during high intensity trail running in challenging undulating terrain. Methods After the determination of running economy and maximal oxygen uptake (VO2max) in an incremental lab test, nine competitive runners (3 women: 31.3±8.5 yrs, 61.7±3.7 kg, 21.3±5.1%fat, 207±12 mL O2/kg/km, 53±3 mL/kg/min; 6 men: 28.9±4.1 yrs, 71.6±6.1 kg, 12.8±3.2%fat, 208±7 mL O2/kg/km, 65±5 mL/kg/min) performed a trail run time trial on an outdoor cross-country track consisting of two laps with 3 steep up- and 3 steep downhill sections each and variations in track surface (total distance: ~7km, total change in altitude: ~850m). Cardio-respiratory and global positioning data (MetaMax3B_R2, Cortex, Leipzig, GER) were measured with a portable breath-by-breath gas analyzer and a chest belt (Polar Electro OY, Kempele, FIN) to assure time alignment of all data. Results Comparing lap times of the trail run, the first lap (20:11±01:58 min:s) was completed faster than the second one (21:30±01:57 min:s; $p<0.01$). In the up- and downhill sections, the athletes ran with 79±2% and 72±4% of VO2max while heart rate was about 93±2% and 92±2% of HRmax, respectively. ANOVA with repeated measure revealed a significant difference between the up- and downhill sections in the first and second lap respectively for oxygen uptake (both $p<0.01$), energy expenditure ($p=0.04$, $p=0.03$), oxygen pulse (both $p=0.02$) and running velocity (both $p<0.01$). In contrast, heart rate ($p=0.32$, $p=0.27$), ventilation ($p=0.26$, $p=0.24$) and breathing frequency ($p=0.67$, $p=0.61$) remained unaffected by running up- and downhill. Discussion & Conclusion While oxygen uptake and energy expenditure varied widely with each up- and downhill section, heart rate did not reflect the changing metabolic demand. Therefore, heart rate during trail running does not seem to provide an adequate measure to describe exercise intensities in undulating terrain and with variations in track surface.

Topic: Training and Testing

Keyword I: trail run

Keyword II: heart rate

Keyword III: oxygen uptake