Analysis of loading of a cross-country skiing sprint competition simulation

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Introduction

The introduction of Sprint, Team Sprint and the improvement of equipment and technique allowing athletes to ski at higher speeds, led to new and altered demands in the training and testing of cross-country (XC) skiers. Due to still a lack of experience and the just developing specialisation of athletes on the discipline Sprint, originating out of a long inacceptance of the Sprint in the World-Cup (WC), the late invention in the world championships (Lahti 2001 skating, Oberstdorf 2005 classic) and Olympic Games (Salt Lake City 2002), different approaches in the control of training, the use of training methods and technique can be observed. Up to present there is a lack of published investigations about loading (physiological, biomechanical), demand and predictors of performance for the XC-Sprint. Thus, most knowledge is based on coaches’ experiences or adapted from studies in other sports like sprint and middle-distance running. In contrast to running in athletics, in the XC-Sprint not only a single run is necessary but a high performance stability over 4 heats (1-1.5km each) over a time of 3 to 4 hours. Test concepts especially for the XC-Sprint are rarely and mostly not investigated on their reliability and validity. The specific aims of the study were 1) to develop a sprint simulation using roller skis on the treadmill, 2) to perform an analysis of loading of a XC-Sprint competition and 3) to examine relationships of measured biomechanical and physiologic variables with sprint performance.

Methods

12 athletes of the Austrian national team participated in the study. All athletes were familiar with roller skiing on a treadmill at high velocities. Based on data of Sprint competitions in the WC and rules of the FIS, a WC-Sprint competition in the classic technique was developed and simulated on the treadmill. Each athlete had to pass through a 3 ½ h protocol including warm-up, maximal speed tests in double poling (DP) and diagonal (DIAG), a VO2peak-Test and 3 sprint heats. Activity between the single tests was standardized. Treadmill speed in the heats was controlled by a self-control device, while the first two heats had a speed limit, and the 3rd was open allowing the athlete to manage the profile faster as the program alleged. The heat had a distance of 1100m and a time target of 3:15min. 40 blood lactate (BL) samples (Biosen), heart rate (Polar) and VO2 (Cosmed K4b2) were measured. The maximal speed tests and the 3 heats were video analysed for determination of poling frequency (Fq) and technique use.

Results

DP- and DIAG maximal speed showed the highest correlation to Sprint performance. (r = 0.94; r =0.87 p<0.001), followed by total amount of pole plants over the heat (r = -0.77, p<0.01). Moderate non significant correlation to Sprint performance was found for the amount of use of DP-Kick and VO2peak (r = 0.55; r = -0.50, p>0.05). No correlation was found for Fq. In the 3 heats BL was 14.4±3.6, 12.4±3.7, 13±3.3 mmol/l (Range 8.5 to 23.7mmol/l), with a significant decrease from heat1 to heat2, heart rate was 187±6, 189±7, 188±7 bpm and VO2 was 97%, 93%, 90% of VO2peak, while there was a significant decrease in VO2 in heat 2 (p<0.05) and heat 3 (p <0.01) compared to heat 1. Regarding all three heats, no significant change of running time occurred.

Discussion/Conclusion

BL values were over 8.5 mmol/l in all heats, with a maxima of 23.7 mmol/l. Heart rate was around maximal heart rate of the VO2peak-test. The significant decrease of BL from heat 1 to heat 2 may be a result of energy depletion. The decrease of VO2 from heat 1 to heat 2 and 3, while heat time was unchanged, may be a result of exercise-induced Hypoxia or Bronchospasm or other mechanical disturbances of respiration (Judelson, 2004). Highest correlation to Sprint performance was found for DP maximal speed, explained by the use of DP in major parts of the simulated track, but also in competitions. The high correlation of DIAG maximal speed and the non significant moderate correlation of VO2peak to Sprint performance showed that Sprint performance was more dependent on neuromuscular characteristics like the maximal speed in the single techniques, than very high aerobic performance. These results get in line with investigations of Rusko et al. (1996) in running, showing that neuromuscular characteristics in addition to aerobic power and running economy were determinants of running over distances from 400-m to 1500-m. Investigations of Hoff (2002) about positive effects of an increase of specific explosive and maximal strength on work economy in XC skiing support our findings. Potential lies in the use of the technique DP-Kick especially at moderate grade and changes of track profile. Best performing athletes tried to use DP-Kick in a great part of the uphill parts and in parts of changing grades, while athletes of moderate performance very seldom used DP-Kick. Negative correlation of the total amount of pole plants, but no correlation of Fq to sprint performance illustrated that faster athletes had due to higher running speeds the same Fq, but consequently needed clearly less pole plants. This result showed that faster athletes could produce more propulsion at equal Fq. Recapitulatory, XC-Sprint performance in the classical style is mainly dependent of maximal speed in the single techniques, running economy and use of technique while high VO2peak seems not to be of highest priority.

References