Physiological demands of competitive elite cross-country skiing

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Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av medicine doktorsexamen framläggs till offentligt försvar i Föreläsningssal 6, Högskolan Dalarna, fredagen den 5 juni, kl. 09:00. Avhandlingen kommer att försvaras på svenska.

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Researchers have, for decades, contributed to an increased collective understanding of the physiological demands in cross-country skiing; however, almost all of these studies have used either non-elite subjects and/or performances that emulate cross-country skiing. To establish the physiological demands of cross-country skiing, it is important to relate the investigated physiological variables to the competitive performance of elite skiers. The overall aim of this doctoral thesis was, therefore, to investigate the external validity of physiological test variables to determine the physiological demands in competitive elite cross-country skiing. The subjects in Studies I-IV were elite male (I-III) and female (III-IV) cross-country skiers. In all studies, the relationship between test variables (general and ski-specific) and competitive performances (i.e. the results from competitions or the overall ski-ranking points of the International Ski Federation (FIS) for sprint (FISsprint) and distance (FISdist) races) were analysed. Test variables reflecting the subject’s general strength, upper-body and whole-body oxygen uptake, oxygen uptake and work intensity at the lactate threshold, mean upper-body power, lean mass, and maximal double-poling speed were investigated. The ability to maintain a high work rate without accumulating lactate is an indicator of distance performance, independent of sex (I, IV). Independent of sex, high oxygen uptake in whole-body and upper-body exercise was important for both sprint (II, IV) and distance (I, IV) performance. The maximal double-poling speed and 60-s double-poling mean power output were indicators of sprint (IV) and distance performance (I), respectively. Lean mass was correlated with distance performance for women (III), whereas correlations were found between lean mass and sprint performance among both male and female skiers (III). Moreover, no correlations between distance performance and test variables were derived from tests of knee-extension peak torque, vertical jumps, or double poling on a ski-ergometer with 20-s and 360-s durations (I), whereas gross efficiency while treadmill roller skiing showed no correlation with either distance or sprint performance in cross-country skiing (IV). The results in this thesis show that, depending on discipline and sex, maximal and peak oxygen uptake, work intensity at the lactate threshold, lean mass, double-poling mean power output, and double-poling maximal speed are all externally valid physiological test variables for evaluation of performance capability among elite cross-country skiers; however, to optimally indicate performance capability different test-variable expressions should be used; in general, the absolute expression appears to be a better indicator of competitive sprint performance whereas the influence of body mass should be considered when evaluating competitive distance performance capability of elite skiers.

Keywords
Performance capability, maximal oxygen uptake, lactate threshold, lean mass, double poling, power output, maximal speed, sprint skiing, distance skiing.