Introduction

The current study compared the speed and heart rate profiles of male and female world-class cross-country skiers during an international skiing and classical skiing competition at comparable external conditions. Subsequently, the differences in time, speed and heart rate distribution for uphill, flat and downhill terrain between techniques and genders were analyzed. We hypothesized that speed differences between skating and classical would be greatest in flat sections, that uphill sections would be the most performance differentiating terrain and that a more even pacing strategy across the varying terrain would be employed in skating compared to classical competitions.

Methods

Four men and five women performed a 15-km (men) and 10-km (women) cross-country skiing FIS regulated competitions in the skating and classical technique with an individual time-trial racing format. The skating and classical competitions were performed on two consecutive days while being continuously measured by a global positioning system (GPS) device and a heart rate monitor. The races were performed on a 5-km competition course that was mapped with a coupled GPS and barometer in an inertial navigation system (INS) to provide a valid course and elevation profile. The skiers’ data were adapted to the standard racecourse for analysis of time, speed and heart rate for uphill, flat and downhill sections for the total races and on each consecutive 5-km lap.

Results

The average competition time of the skating competition was significantly lower than the classical competition time, both for men and women (P < 0.01). The relative time spent in the flat sections did not differ between skating and classical skiing, whereas both gender groups spent relatively less time in the uphill and relatively more in the downhill sections during the skating compared to the classical competition (all P < 0.01). The average speed differences between skating and classical skiing were 9 and 11% for men and women respectively; and these values were 12 and 15% for uphill, 8 and 13% for flat (all P < 0.05) and 2 and 1% for downhill terrain. The speed was on average 9 and 11% faster for men than for women in skating and classical skiing, respectively; with corresponding numbers of 11 and 14% for uphill, 6 and 11% for flat and 4 and 5% for downhill terrain (all P < 0.05). The relative difference between skating and classical was significantly higher for women than for men in the flat section only (P < 0.05). No significant difference in the average heart rate within any specific terrain section was seen between skating and classical skiing. However, male and female skier had a relatively higher heart rate in uphill and lower heart rate in downhill terrain, independent of technique.

Discussion

The main findings were 1) average competition speeds were approximately 9 and 11% higher while skating compared to classical skiing for men and women respectively, 2) The uphill section were responsible for the greatest performance differences between techniques and genders, and 3) the minor differences in heart rate between techniques and genders for the entire competition and within each terrain were not associated with any speed differences.

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Silver medalist at the 2018 Winter Olympics in Pyeongchang, South Korea, Skiing is a popular sport worldwide.

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Figure A-B. The upper graphs represent the racecourse profile with the relative elevation with regard to zero (start), and uphill, flat and downhill sections in different tones of grey. The lower graphs represent the average speed (m s-1) in the defined sections for both classic (black stapled lines) and skating (grey solid lines) races for men (15 km; A) and women (10 km; B).

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