A comparison of arm, upper body and whole body poling in male and female cross-country skiers

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Introduction
The double poling technique in cross-country skiing is a whole body movement where the arms, trunk and legs interact in producing power. When these body segments work together an increase in power output is expected compared to their isolated movements. Since previous findings show that gender differences increase with more contribution from poling, further examination regarding the different segmental contributions during double poling is required. Therefore, we examined the aerobic and anaerobic capacities and movement efficiency during isolated arm (AP), upper body (UP) and whole body double poling (WP) and the associated gender effects.

Methods
Ten female and ten male elite cross-country skiers, matched for performance (FIS points 99±26 and 99±21), performed three submaximal stages and a 3-min all-out test on a modified Concept2 SkiErg in the three double poling modes. The regression lines of oxygen uptake vs. external power during the submaximal stages determined efficiency, and the average power output during the 3-min and 30-s tests determined performance. Body composition was measured with DXA scan.

Results
When comparing the three modes, UP power was more than 50% higher compared to AP, whereas WP power was ~35% higher than UP for both genders during the 3-min test (all P<0.001). VO₂peak was ~32% higher for UP than AP for both genders, and 29% (women) and 18% (men) higher for WP than UP (all P<0.001). When comparing gender, men produced 103, 97 and 87% more power, and had 39, 34 and 23% higher VO₂peak than women in AP, UP and WP respectively (all P<0.001). Men were able to utilize a higher fraction of the total aerobic capacity (VO₂max) than women during the 3-min test in all modes. The power output-oxygen uptake regression lines did not differ between genders, but were slightly elevated for AP compared to the other modes (P<0.05). Lean mass in the arms, upper body and whole body respectively was 60, 38 and 33% higher among men (all P<0.001).

Discussion
The current study demonstrated large increases in power when the arms, trunk and legs work together compared to more isolated movements, with a significant role of the trunk and legs in double poling. The relative gender differences within these modes were greatest with isolated arm and upper body work, and coincided with the greater distribution of muscle mass in arms and trunk among men. Differences in power output across modes and gender were further associated with differences in aerobic energy delivery capacity, but relatively independent of the ability to convert metabolic energy into power. Overall, female skiers seem to have a great potential in developing their arm and upper body capacity in double poling compared to performance matched males.