Reliability and validity of a specific upper body testing device and concept for the cross-country skiing Sprint

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Introduction
The introduction of Sprint, Team Sprint, mass start competitions, 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. Especially in Sprint competitions using the classical style the major used techniques are double poling (DP) and DP-Kick, while six under the best eight, including rank 1 to 3 of the WC in Drammen 2005 used DP in all the runs up to the final. Several investigations have shown that upper body performance and strength capacities have a close connection to XC ski race performance (e.g. Mahood, 2001). Especially for the Sprint disciplines, specific maximal strength and strength endurance are generally defined as important sources of performance, while positive effects of specific upper body maximal strength training on endurance performance was already been shown (Hoff, 2002). Such stress the great importance of specific training and diagnostics of strength capacities for the XC skiing Sprint. Specific standardized test concepts for traditional XC skiing have already been developed, while test concepts especially for the XC skiing Sprint are rarely, difficult to simulate in a controlled laboratory situation and mostly are not investigated on reliability and validity. The aim of the study was the development and analysis on reliability and validity of a test concept serving for diagnostics of specific upper body strength capacities for the XC skiing Sprint.

Methods
31 elite XC skiers of the Austrian, Slovakian and Suisse National and Student-National Team volunteered as subjects in the study. 19 subjects performed twice the so called “Two-phase Test” (2PT) for determination of specific upper body strength capacities including a “4 repetition maximal test” (4RT) and a “40 repetition test” (40RT), using a DP imitation (DPI) on a rollerboard (Lindinger, 2004) to check for reliability. 31 subjects performed both the 2PT and a 50-m DP sprint speed test (DP50) on a tartan indoor track to check for validity of the 2PT for determination of maximal DP sprint speed. 20 subjects performed the 2PT and a 1000-m DP test (DP1000) on the treadmill, to check for validity of the 2PT as predictor of DP Sprint performance over race distance. The 4RT includes four DPIs with maximal velocity for determination of maximal values in all measured parameters. After a break of 2 min, the subject had to perform the 40RT with maximal speed at each of the 40 reps (all-out). Velocity and force variables were measured. In the 40RT, the mean of the 40 reps and a strength endurance index (SI=Difference mean velocity over the 1000-m to maximal velocity at start) were measured. In the future, testing data should be used to determine standards and norms in order to reveal deficits, enervations and athlete development and in this way serve as an instrument for guiding or control the training.

Results
Measured parameters of the 4RT showed high to excellent reliability (r = 0.83 to 0.99, P<0.001). All mean values of the 40RT showed excellent reliability (r >0.97, P<0.001) except for SI showing just moderate to high reliability (r = 0.71 to 0.87, P<0.001) with the highest value for peak velocity (v peak). All parameters of the 4RT correlated highly to 50-m time (r = -0.75 to -0.92, P<0.001), while highest correlation was found for v peak. Velocity and Force variables of the 4RT correlated moderately to t1000 (-0.6 to -0.73, P < 0.01). Mean values of the 40RT correlated moderate to highly to t1000 (-0.76 to -0.81, P<0.001) again showing the highest value for v peak. SI of the 40RT correlated moderately to SI of the DP1000 (0.62-0.79, P<0.01).

Discussion/Conclusion
High to excellent reliability, except for test-retest correlations of SI, was found for the 2PT. This might be explained by the fact that in the calculation of SI, two variables measured in separate test modes were used for calculation. Thus, small variability in those variables might cause a higher variability in the calculation of SI. The high relationship of maximal velocity and force variables measured in the 4RT to 50-m and 1000-m DP sprint performance showed on the one hand the high specificity of the DPI, already shown by Lindinger (2004), and on the other hand that the 4RT alone serves as a simple, reliable and valid test concept for diagnostics of upper body and continutive DP performance in XC skiing. v peak measured in the 2PT showed the highest correlation of all variables to 50-m and 1000-m Sprint performance. Hence, v peak seems to be the most stable and highest Sprint predicting variable measured in the 2PT. Just moderate correlation was found for SI of the 2PT to SI of the DP1000. This might result on the one hand out of the just moderate to high reliability of SI in the 2PT and assumed but not measured in DP1000 and on the other hand in the fact that performance in DPI is restricted to upper body performance while the function of the lower body as in DP was excluded. In the future, testing data should be used to determine standards and norms in order to reveal deficits, enervations and athlete development and in this way serve as an instrument for guiding or control the training.

References