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Validation and cross-sectional exploration of a test protocol to measure anaerobic and aerobic power in wheelchair athletes

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INTRODUCTION:
Wheelchair athletes currently lack standardized wheelchair-specific tools for an objective monitoring of their anaerobic and aerobic power production. Therefore, the aim of this study was to evaluate the validity of an individualized and standardized test protocol to measure the wheelchair-specific anaerobic and aerobic capacity in any individual wheelchair athlete and to provide a cross-sectional exploration of their performance capacities.
METHODS:
Wheelchair athletes from basketball, rugby, tennis, triathlon and track & field performed an isometric strength test, a 10 s sprint test, a 30 s Wingate anaerobic test (WAnT) and a 1 min stepwise aerobic graded exercise test (GXT) on an instrumented roller ergometer. Using previously developed regression equations [1], the measured isometric strength was used to estimate the WAnT result ($R^2 = 0.75$) and set an individual WAnT resistance. The measured WAnT result was used to estimate the GXT result ($R^2 = 0.81$) and scaled the individual GXT resistance steps. The WAnT was considered valid when peak rim velocity stayed below 3 m/s. The GXT was considered valid when two out of three criteria were met: respiratory exchange ratio ≥ 1.10, heart rate ≥ 95% of predicted heart rate and rate of perceived exertion ≥ 8.
RESULTS:
The test battery was completed by 38 wheelchair athletes of different sport disciplines in their own sports wheelchair. The five strongest athletes turned out to be too strong for the isometric strength test on the ergometer. Consequently, their WAnT resistance was underestimated, giving them the highest peak rim velocities (between 2.8 and 3.0 m/s). Instead, the sprint test was feasible for every athlete and showed the best estimate of the WAnT ($R^2 = 0.85$). The resistance settings for the GXT were valid for every athlete. Isometric strength ranged from 140 N (tennis player) to 445 N (track and field athlete). Anaerobic power ranged from 72 W (rugby player) to 251 W (track and field athlete). Aerobic power ranged from 53 W (rugby player) to 156 W (tennis player).
CONCLUSION:
The WAnT resistance was accurately estimated from the isometric strength for most athletes but was not feasible for the stronger athletes. The sprint test outperformed the isometric test as an estimator for the WAnT resistance and can instead be used as estimator for the WAnT resistance. The WAnT scaled the protocol for the GXT accurate and led to valid tests. The wide range in isometric strength, anaerobic power and aerobic power showed that this test protocol can be used in a diverse group of wheelchair athletes. The wider use of this individualized and standardized test protocol will lead to a more uniform way of wheelchair-specific exercise capacity testing and improved comparability of different studies.

[1] Janssen TWJ, van Oers CAJM, Hollander AP, Veeger HEJ, van der Woude LHV. Isometric strength, sprint power, and aerobic power in individuals with a spinal cord injury. Med Sci Sports Exerc. 1993;25:863–870.

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