

Biomechanics in Paralympic Cross-Country sit skiing: Evidence-based tests for classification

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ABSTRACT

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The International Paralympic Committee required the development of a new evidence-based classification system, by developing measures of performance and measures of impairment. In cross-country (XC) sit skiing, athletes compete sitting on a ski-ski and generate propulsion with upper limbs and, when possible, trunk movements. The purpose of this thesis was to develop a measure of performance and a measure of impairment of trunk that can be used for classification purposes. Firstly, biomechanics (maximal speed, generated force, cycle characteristics, and muscle activation) of skiing on snow and on an ergometer was compared (article I). The assessment of biomechanics and of trunk kinematics on the ergometer was used to develop a measure of performance (article III). Secondly, trunk kinematics during balance test performed with personal sit-ski was used to propose a measure of impairment (article II). During the process, a need for a new specific testing device was identified. A new mechanical system was designed to quantify trunk kinematics and strength respectively during balance and strength tests. Collected results allowed developing a measure of trunk impairment that can be used for classification purposes (article IV). A total of 24 elite XC sit skiers were recruited. Two separate investigations were completed during the World Cup: (1) performance tests were conducted on snow and in a laboratory (articles I, III) and balance tests with personal sit-ski were performed in the laboratory (article II); (2) strength and balance tests with the new testing device were performed in the laboratory (article IV). In addition, a cluster analysis was applied to divide athletes according to their performance and impairment and to identify the minimum set of parameters that allowed for athletes' clustering. Pushing cycle results showed that generated force or maximal speed, together with cycle time, trunk maximal backward inclination, and trunk range of motion allowed clustering athletes according to their performance (articles I, III). Results of balance test and strength test respectively showed that trunk range of motion and generated force with and without a backrest allowed clustering athletes according to their impairment (articles II, IV). In conclusion, the proposed tests and the identified set of parameters may be considered for the XC sit skiing new evidence-based classification system.

Keywords: performance, adapted ergometer, impairment, strength, trunk control, spinal cord injury