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The paediatric version of the steep ramp test

Description

Exercise tests to determine cardiopulmonary fitness are commonly used by physiotherapists working with children and adolescents. However, there is a need for an easy-to-use exercise test, which does not require respiratory gas analysis and is suitable for the clinical situation. The paediatric version of the steep ramp test (SRT) is such a test. It is simple and only requires a stationary bike. People are required to cycle against rapidly increasing workloads. The primary outcome measure is the achieved maximal workload (W_{peak}, in Watts).

The paediatric version of the SRT consists of a three-minute warm up at 25 Watts, followed by an increase in workload of 10, 15 or 20 Watts every 10 seconds, depending on the child's body height ($<$ 120 cm, between 120 and 150 cm, and $>$ 150 cm, respectively).[1,2] This contrasts with the adult version of the SRT, which consists of three minutes of unloaded cycling, followed by a rapid increase in workload of 25 Watts every 10 seconds until exhaustion.[3] To assess a child's W_{peak} more accurately, a ramp version of the SRT protocol is recommended (workload increments of 2, 3, or 4 Watts every two seconds).[1,2] The child is instructed to maintain a pedalling frequency of approximately 80 rpm, and the protocol continues until the child is no longer able to maintain a pedalling frequency of 60 rpm, despite strong verbal encouragement. This point is defined as peak exercise. Other measurements such as heart rate, oxygen saturation, blood pressure and dyspnoea or exertion can be used to provide additional information. Paediatric normal values for children and adolescents aged between 8 and 18 years are available for the SRT;[1] these are required to interpret test results.

Reliability and validity: In healthy children, the test-retest reliability is good for absolute W_{peak} (ICC = 0.986; $p < 0.001$), as well as for W_{peak} normalised for body mass (ICC = 0.935; $p < 0.001$).[2] These properties make the SRT excellent for discrimination between healthy children and children with chronic disease/disability. The average absolute W_{peak} has acceptable limits of agreement (24.5 to -37.3 Watts or, as expressed as a percentage, 9% to -13%); hence the smallest detectable change equals 30.9 Watts, or 11%.[2] Therefore, the SRT seems to be appropriate for evaluating change in the clinical setting on a case-by-case basis. In a healthy paediatric population, W_{peak} attained at the SRT is highly associated with the peak oxygen uptake (VO_{2peak}) achieved during a cardiopulmonary exercise test (CPET) ($r = 0.958$; $p < 0.001$).[2] De Backer et al[4] also observed a significant correlation between the SRT W_{peak} and VO_{2peak} ($r = 0.82$; $p < 0.01$). SRT performance is therefore a good indication of cardiopulmonary fitness.

The paediatric version of the SRT is not only appropriate for children and adolescents but also for adults with particular conditions. For example, it has been shown to be highly reliable in adults who have survived cancer[4] and adults with chronic obstructive pulmonary disease[5], with reported ICC values for the attained W_{peak} of 0.996 ($p < 0.001$) and 0.990 ($p < 0.001$), respectively.

Commentary

Because of its feasibility, reliability, validity and availability of normative data, the SRT is a simple exercise test that physiotherapists can use to test cardiopulmonary fitness or monitor training progress. Due to its short duration, the SRT can be performed regularly and, consequently, it is easy to incorporate this test in an interval exercise-training program. In different adult studies, the intensity of interval training (three times per week for 20 minutes with a work/recovery ratio of 30/60 seconds) was set at 50% of the W_{peak} achieved during the SRT. To maintain a sufficient training stimulus, training intensity can be adjusted based on SRT performance every two weeks.

Importantly, the W_{peak} of a SRT is greater than the W_{peak} of a standard incremental CPET even though the SRT is shorter[2,6] and less demanding than the CPET. Maximal heart rates and minute ventilation during the SRT were reported to be the same[6] or lower[2] than the CPET. These factors all make the SRT more appealing and acceptable to children and adolescents. A W_{peak} that is significantly below average indicates that a person may have reduced cardiopulmonary fitness compared to his/her healthy peers. The SRT, however, only provides a crude indication of fitness, so a more sophisticated CPET with respiratory gas exchange analysis may sometimes be required. Performing a CPET is the gold standard for assessing whether an individual has reduced cardiopulmonary fitness and, if so, whether this is due to an abnormal cardiovascular, pulmonary or metabolic response during exercise.

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