The Bases Expert Statement on Measurement and Interpretation of Aerobic Fitness in Young People

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Alan Barker, Prof Craig Williams FBASES, Dr Keith Tolfrey FBASES, Dr Samantha Fawkner and Dr Gavin SandercocK.

Introduction
Aerobic fitness is routinely measured in young people1 and typically involves the use of indirect and direct measures of aerobic fitness to identify children most at risk of cardio-metabolic disease and in greatest need of support (Tolfrey et al., 2012). Consequently, there is a strong rationale and interest in the sport and exercise science community to measure aerobic fitness in young people. However, the most appropriate methods to measure and interpret fitness in this population remain controversial. This statement will therefore, provide an expert summary of the key issues and conclude with recommendations for researchers and practitioners.

Background and evidence
Can young people produce a valid VO2max measurement?

As only ~10 to 60% of children and adolescents display a VO2 plateau during exhaustive exercise across a variety of protocols (e.g., step-incremental or ramp) and modalities (e.g., treadmill and cycling), it has become conventional to use the term ‘peak’ VO2 in this population (Armstrong & Weltman, 1994). Consequently, objective secondary criteria, based on attaining a predefined heart rate (e.g., 85% of age predicted maximum) and/or respiratory exchange ratio (e.g., RER 1.0), are routinely used to verify a ‘true’ VO2max response. In some settings, however, has demonstrated that the use of secondary criteria results in the acceptance of a ‘sub-maximal’ peak VO2 representing only ~80 to 90% of the achieved peak VO2 and can falsely reject a ‘true’ VO2max measurement in children (Barker et al., 2011). The authors called for researchers and practitioners to abandon the use of such secondary criteria and championed the use of a supra-maximal protocol to obtain a maximal effort. In the current study, the children performed a supra-maximal protocol at 150% of peak power achieved during the incremental test after 15 min of rest. This protocol identified a valid VO2max measurement in 12 out of 13 children, demonstrating the achievement of a VO2max expression of muscle activity during exercise should be used to adjust VO2max for body size as this offers a slight advantage compared to total FFM when scaling VO2max in young people (Graves et al., 2013). Alternatively, a direct measure of the active muscle mass involved during exercise provides the most valid body size variable to adjust VO2max (Tolfrey et al., 2006), but requires access to expensive technology such as a magnetic resonance imaging scanner.

Can a reliable and valid estimate of VO2max be obtained from field-based measures?

The valid measurement of VO2max in the laboratory setting requires expensive equipment and technical expertise which may be impractical for use in large cohort studies. Field-based tests, which are relatively easy to administer in large groups, and require limited equipment, are a practical alternative. The 20-m shuttle run test (20-mSRT) is the most widely used field-based test to assess aerobic fitness in young people and UK cereal manufacturers have relied on this test for many years (SandercocK et al., 2012). As the test demands limited space, it can be conducted indoors, which controls for environmental conditions, and is not reliant on soft ground. A systematic review recently concluded the 20-mSRT is type 6 (mL·kg^-1·min^-1) 1 when interpreting children’s performance (Mahar et al., 2012).1 Some Local Authorities and the Association for Physical Education have recommended two test cut-off scores. Research Quarterly for Exercise and Sport, 81, 400-409.

Reference:

1. The term ‘young people’ in this expert statement refers to children and adolescents aged <18 years.

2. The 20-mSRT estimates peak VO2 as, despite a slightly lower effort, the achievement of VO2peak was not verified appropriately in the majority of these studies.

In the laboratory setting:

• A combined incremental and supramaximal exercise test protocol should be used to obtain a valid measurement of VO2max in young people both in health and disease.
• Secondary criteria (e.g., heart rate and RER thresholds) should not be used to verify the attainment of VO2max in young people as they result in a ‘sub-maximal’ peak VO2.
• Allometric scaling procedures should be used to scale VO2max for body size provided sufficient data are available to derive a sample specific scaling factor. However, as normative data or thresholds for health are currently only available in the ratio standard format it may be prudent to express VO2max using both methods.
• As body mass does not account for differences in body composition, VO2max should be adjusted for using FFM in young people.

In the field setting:

• The 20-mSRT is currently the method of choice to provide a safe, reliable and valid estimate of VO2max in the field setting, and UK reference data are readily available.

Performance in the 20-mSRT should be expressed as laps, levels of distance completed, as the peak prediction of peak VO2 using the test data is associated with error.

• If the 20-mSRT cannot be undertaken, distance walk/run tests are a suitable popular alternative but have poorer reliability and validity in young people.

2 Barker, A.R., Williams, C.A., Jones, A.M. & Armstrong, N. (2011). The 20m-SRT estimates peak VO2 as, despite a slightly lower effort, the achievement of VO2peak was not verified appropriately in the majority of these studies.

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