Fitness testing

The term fitness includes many components that are all crucial to overall athletic performance.

Aerobic Fitness: Otherwise known as maximal aerobic capacity is a measure of the maximal amount of oxygen that can be extracted by the muscles of the body and is usually expressed in values related to a person's bodyweight (i.e., ml/kg/min). A value of 60 ml/kg/min has been proposed as a pre-requisite for participation in elite soccer [(1)]; however, normal people have values of about 35 ml/kg/min. Additionally, maximal aerobic capacity is linked to many health benefits; therefore, it is important that athletes train and measure their aerobic fitness routinely. The test most commonly used outside of laboratories for determining maximal aerobic capacity is the multi-stage fitness test (commonly known as the bleep test). The bleep test involves continued and progressive running between two markers (each 20 m apart) at a speed that is determined by the "bleeps" sounded from a specially designed CD (Note that modified versions which use light signals have also been used in research but the audio version is the most common). The test runs continuously until players can't keep up with the CD and is terminated when two successive bleeps are missed. The last successful shuttle before the test was terminated is the performance measure. Data from the test is used with a specially designed equation [(2)] to determine an athletes maximal aerobic capacity.

Agility: Agility is defined as a rapid whole body movement, involving a change of velocity or direction, in response to a sport specific stimulus [(3)]. A common misconception regarding agility is that it is believed to be highly influenced by factors relating to straight line speed such as maximum speed and acceleration. However, research has found that agility is independent of such factors and is influenced predominantly by two components; change of direction speed and perceptual skill [(4)]. Common approaches to the measurement of agility have been to use completion time as the performance measure in tests such as the 5-0-5 test, L-run, Illinois agility test, T-test and the hurdle-test. However, due to the pre-planned nature of such tests, perceptual components of athletic performance are often ignored. A limited number of scientific studies have incorporated the perceptual contributions of agility and therefore have designed tests that better reflect the demands of competitive encounters by incorporating movements that require at least one change of direction as a result of reacting to a stimulus; a skill termed reactive agility [(5)].

Body Fat Percentage: The percentage of body fat can be used as an independent measure or to determine other values such as fat-free mass. For those who have access to measures of body composition, skin-fold callipers will probably be a common sight. More laboratory based measures include air displacement plethysmography (or BODPOD), hydrostatic weighing and dual X-ray absorptiometry. Due to the cost and lack of access to such methods, a commonly used field measure of body composition is Bio-electrical Impedance Analysis (BIA); a procedure which involves sending a low and

safe electrical current through the body via small electrodes placed on the hands and feet. The current passes freely through the fluids contained in muscle tissue, but encounters difficulty/resistance when it passes through fat. This resistance of the fat to the current is termed 'bioelectrical impedance', and is accurately measured by BIA machines. When set against a person's height and weight, the machine can then produce body composition values. However certain controls are recommended in order to obtain accurate values; including: no caffeine in 24 hr before testing, no strenuous exercise 24 hr before testing, no food in the 3 hr before testing and a maintenance of hydration status.

Sprint Testing: The ability to develop maximal speed or accelerate to maximum speeds in a short time could contribute directly to success in a number of sports. Being the first person to the ball and/or maintaining or regaining possession could lead to a goal being scored or a shot being blocked in soccer; therefore sprint tests are an important part of any battery of fitness tests. Aside from athletics, most sprints in team sports are less than 30 m long; consequently, this distance is a good length to test sprint speeds as it enables slightly longer distances for players who need that distance to get to maximum speeds and also enables the faster accelerating players to test their 10 and 20 m times throughout the sprint. Timing gates are commonly used (portable devices that use beams of light to time sprints as the athlete breaks the beam of light for each interval that the devices are placed) to measure 10, 20 and 30 m split times within a 30 m sprint. Athletes begin from a standing start, usually 30 cm behind the start line, and upon the testers command sprint maximally for the full duration of the sprint. It is important for the athlete to sprint through the gates and not slow down on approach to the end of the distance as this can affect the results. Averages of more than one run (with 4 min recovery) between sprints are usually used. Although the procedure for the 30 m sprint test is detailed here, distances can be modified according to preference.

Vertical Jump: Vertical jump tests measure the maximal lower body explosive power and are directly applicable to all sports where high levels of lower body power production is desirable. The most commonly used tests are those that involve a countermovement (i.e., a dip before you jump) but other tests that involve a pause before jumping can also be performed. The difference between the two tests is that they focus on different power producing capabilities of the lower body by using or removing the potential for the muscles elastic properties to contribute to the jump height. Jump mats that give a digital readout of jump height are commonly used to measure performance; however scientific research uses force platforms.

Strength Testing: The strength of an athlete relates to the maximum amount of force that can be exerted without any constraints upon the time of contraction. Although other aspects of strength exist (i.e., speed strength), maximal strength is usually tested using repetition maximums which relate to the number of repetitions that can be completed with correct form (i.e., 5 RM is the maximum weight that can be lifted for 5 reps only). Sub-maximal lifts (i.e., 3, 5 or 10 RM) are favoured in younger or inexperienced lifters when

assessing maximal strength. Specially designed equations are then used to calculate the percentage of maximal strength that the repetition range represents and so maximal values can be predicted. When testing athletes, measurement of the 5RM of the squat exercise is commonly advocated as the best lower body exercise for sports performance.

Additional Reading

1. Reilly, T. (1997). "Energetics of high-intensity exercise (soccer) with particular reference to fatigue." J Sports Sci **15**(3): 257-63.

2. Ramsbottom, R., J. Brewer and C. Williams (1988). "A progressive shuttle run test to estimate maximal oxygen uptake." Br J Sports Med **22**(4): 141-4.

3. Sheppard, J. M., W. B. Young, T. L. Doyle, T. A. Sheppard and R. U. Newton (2006). "An evaluation of a new test of reactive agility and its relationship to sprint speed and change of direction speed." Journal of Science and Medicine in Sport **9**: 342-349.

4. Young, W. B., R. James and I. Montgomery (2002). "Is muscle power related to running speed with changes of direction?" Journal of Sports Medicine and Physical Fitness **42**: 282-288.

5. Farrow, D., W. Young and L. Bruce (2005). "The development of a test of reactive agility for netball: A new methodology." Journal of Science and Medicine in Sport **8**: 52-60.