KENT SPORTS DEVELOPMENT UNIT
Sportssheet
Sport, Leisure & Olympics Service, Kent County Council

The role of fitness testing & selecting and using fitness tests.

The Role of Fitness Testing

The aims of this Sportssheet are to provide coaches and sports performers with an insight into the role of fitness testing and how it may help them in their sport. It will also address some of the issues regarding what to be aware of when undertaking a fitness test and how to utilise the results. However, it is acknowledged that success in sport is not solely built upon physical fitness, but also requires good technical ability, mental skills and attitudes, all of which must be trained to meet the demands of the sport.

How can fitness testing help you?

Whether you are a coach or participant at club or international level, in whatever sport, fitness testing can almost certainly help your performance. The potential uses and benefits of fitness testing are as follows:

- Evaluation of a performer's strengths and weaknesses, relative to the demands of their sport.
- Aiding the prescription of suitable training loads.
- Monitoring the effectiveness of training.
- Providing short-term fitness goals.

However, whilst fitness testing can be a valuable tool, it is not a panacea. Therefore the following sections identify what makes a good fitness test and how they can be used to support the performer.

What makes a good fitness test?

To provide useful information, fitness tests must fulfil certain criteria, which if not achieved could produce misleading information with undesirable consequences. Therefore fitness tests must be:

- Sport specific/applicable
- Valid
- Reliable
- Accurate
- Sufficiently sensitive to detect changes in fitness

Test specificity / applicability

To be relevant to a sport, a fitness test must mimic one or a combination of the fitness demands of that sport. For example, a treadmill would be used to assess a runner's fitness, while a cycle ergometer would be used for a cyclist. Tests devised to assess team game sports performers should incorporate the types of movements and distances involved in that sport (e.g. shuttle running). Whereas sports performers that utilise specific equipment may be required to wear full kit and carry relevant sports equipment during the test.

Kent. Delivering The Legacy
Kent County Council

Test validity

To be valid, a test must assess what it is intending to. For example, whilst completing as many press-ups as possible may be a good measure of muscular endurance, it is not a valid measure of maximal strength. Likewise, if a test lacks sport specificity it is unlikely to be a valid test for that particular sport.

Poor validity may also arise if other factors have the potential to mask what is being assessed. For example, if assessing sprinting speed in Hockey, it would be inappropriate to require the player to dribble a ball, as this would assess dribbling speed not sprinting speed.

Test reliability

Reliability refers to how repeatable and consistent a test is. Ideally if a performer repeated a test under exactly the same conditions with no change in their fitness they should produce identical results. However, in reality attaining exactly the same results are most unlikely due to slight differences by the performer from one day to the next. Coaches and performers should be aware that a relatively small change in the test scores may not mean a change in fitness.

Test accuracy

Test accuracy is incorporated into the test validity and reliability and covers the accuracy to which measurements can be recorded. For example, a highly skilled coach may be able to hand-time with an accuracy of +/- 0.1 seconds, but would not be able to accurately record to +/- 0.01 seconds.

Test sensitivity

A test must be sufficiently sensitive to detect changes in fitness or else hard earned fitness gains could go undetected, which may severely de-motivate the performer and undermine the credibility of the coach. A test's sensitivity will depend upon its reliability and measurement accuracy.

Types of fitness tests

Fitness tests for specific fitness components

Physical fitness is a complex, multifaceted phenomenon, composed of:

- Aerobic power
- Anaerobic power and anaerobic capacity
- Muscular endurance
- Muscular strength
- Flexibility and joint mobility
- Speed

For effective fitness testing the coach and performer need to identify the fitness components, which contribute to performing their sport, then select and administer an appropriate series of tests. For team and racquet sports, due to their complexity, this may require a detailed analysis of the sport.

Since each sport differs in relation to the fitness components necessary, so the fitness tests used are also likely to differ.

Laboratory and field based testing

Laboratory testing is only one form of testing and whilst it does have a place in sport and coaching science it is not always accessible or even the best means of providing the information the coach needs. Though there is sport specific equipment, which simulate a sport's demands very closely, generating valuable information (e.g. treadmills, cycle ergometers and rowing machines), this equipment may have limited value when assessing team and racquet sports.

Field tests have a distinct advantage over laboratory testing as they are conducted in the sporting environment (e.g. sports halls, playing fields, etc.) as opposed to the controlled laboratory. This increases the sport specificity of the tests as the data can be collected in context. However, to produce meaningful results field based testing requires considerable thought and care in its administration.

Since laboratory tests are generally conducted by Sport Scientists, this Sportssheet will focus upon field based testing which the coach and performer may well wish to

undertake themselves. Sources for further information on laboratory testing are listed at the end of this information sheet.

Administering meaningful fitness tests

Standardising tests

As indicated previously, a test must have good reliability in order to produce meaningful results. To maximise its reliability, as many variables as possible must be standardised. Factors which can affect the results of a test are:

- the environment,
- the test protocol,
- motivation of the performer,
- their pre-test physical state and
- familiarisation with the test itself.

Standardising the environment

Environmental factors can have a profound effect on field testing particularly when performed outdoors due to the weather primarily. Consideration should be given to the effect alterations in the weather may have on the testing environment (e.g. slippery/muddy surfaces) and the sports performer (e.g. temperature extremes). Ideally tests should be performed in very similar conditions enabling comparisons to be drawn. Therefore the coach should note environmental conditions when recording the test scores. In some circumstances it may be necessary to cancel tests if the conditions are too adverse to allow uncompromised performance.

Standardising the test protocol

Unless a test protocol is closely standardised it will not generate meaningful data that can be compared. For example, there are a number of variations of the sit-up, each of which affect the difficulty of the exercise and consequently the number of repetitions they are likely to achieve. Therefore, the preferred version needs to be selected, carefully administered and the details recorded for future test comparisons.

In tests where a time limit is used to generate a test score the quality of the movement assessed must be standardised and must not be sacrificed in the desire for speed. If conducting a test of speed or agility which requires the use of markers or cones, it is vital that the position of these is recorded precisely.

Standardising the preparation of participant(s) before tests

Test participants should be fully informed of what is expected of them. Leading up to a test it may be necessary to ask them to adhere to pre-test behaviour which could otherwise affect the results. This might include instructions about nutrition, level of training 48 hours pre-test, the consumption of alcohol and even smoking. Most physical tests are enhanced by a warm-up and therefore a standard warm up should be performed by the participants. The exact content of the warm-up will depend upon the sport and test, but is likely to be similar to that used before a competition.

If conducting a series of tests, the sequence in which they are performed can be important, as fatigue from one test can affect the results of another test. Therefore the test sequence and if appropriate, duration of recovery between tests should be standardised and if repeated either on the same individual or another squad member the tests should be carried out identically. When conducting a set of fitness tests within one session it is generally recommended that they are performed in the following sequence (i) height, weight and physique measurements; (ii) aerobic fitness; (iii) muscular strength and endurance; and (iv) flexibility. However, if the aerobic test is maximal it could impact upon the muscular strength and endurance tests and therefore these should go before aerobic fitness. Indeed in an ideal situation the tests should be performed on separate days to allow for full recovery following a maximal effort.

Enhancing test standardisation through familiarity

Familiarity with test procedures can affect the results and it may be necessary for the participant to repeat the test several times (generally 2-4 times for most field tests) before a true measurement can be attained. For some non-exhaustive tests, a repeat measurement may take place within a matter of minutes, whereas for exhaustive tests several hours or even days may be required to fully recover.

The basis of checking for familiarisation is that as fitness improvements are unlikely to occur in a matter of days, any observed improvements in the test score are likely due to increased familiarity.

If a test requires a particular technique or skill, some familiarisation/practice should be included in the warm-up preceding the test to ensure that the participant is fully familiar with the test requirements.

Analysing tests and providing feedback

After a fitness test the coach should compare the test scores with those they would expect for participants in their sport and/or against an individual's previous test results. If this results in particular fitness components being identified as requiring specific attention, then relevant training can be prescribed.

Feedback to the performer is vitally important, as it can illustrate how the process can help them improve and even increase motivation. The process of fitness testing does not stop at the end of the test as data interpretation, feedback and the application of the results are what make the process valuable. Feedback must be clear, concise and relevant to the individual's performance in their sport, with the accrued data applied in an appropriate training context.

What fitness tests cannot do

Fitness tests will not automatically create better performers and should not be used purely for selection purposes. They are a tool, which if used correctly, can provide valuable information that the coach can utilise when designing training programmes and in combination with other factors important in good performance (e.g. technical skill, tactical awareness, mental attitude, etc) can be used to improve a team's performance.

Assessing children

Fitness assessment of children raises a number of issues. The coach will be aware that not all children of the same chronological age are at the same stage of development. Consequently, their stature, physiology and exercise capacities will differ. Early developers may gain some advantage in sport at this time, but may be later overtaken by late developers; hence it can be problematic if trying to apply 'norms' to the fitness results of children. The coach may develop their own expectations of what is required of performers in a particular age group, but must be aware that the child's physique and physiological capacity may alter with their growth and maturity. Indeed it is sometimes the case that certain fitness components will decline as they mature (e.g. flexibility).

Recommended reading and other sources of information

ACSM's guidelines for exercise testing and prescription. American College of Sports Medicine (2007). 7th ed. Phil: Lippincott Williams & Wilkins.

Sport and Exercise Physiological Testing Guidelines: Volume 1: Sport Testing. British Association of Sport and Exercise Sciences (2007) Oxon: Routledge.

A Guide to Field Based Fitness Testing. NCF (1995) Leeds: National Coaching Foundation.

For information on accredited physiological testing laboratories contact

British Association of Sport and Exercise Sciences, 114 Cardigan Road, Headingley, LEEDS, LS6 3BJ, Tel: 0113 289 1020

Acknowledgements

Written by Professor Steve Bird, Kent Sport Science Support Programme, Canterbury Christ Church University. Amended by Daniel Tolhurst Canterbury Christ Church University 2008.

Selecting and using fitness Tests

This sportssheet provides further information on the types of tests used for the various components of fitness – aerobic fitness, muscular endurance, muscular strength, flexibility, speed/acceleration, power and sport specific speed/agility.

Using established tests

When developing a series of fitness tests, the coach should first refer to other coaching and sport science information. There they may find established tests which are proven for their own sport or at least suitable tests designed for similar sports that can be used with or without minor modifications. This will obviously greatly reduce the time required to deliver an effective series of tests, while providing the coach with reassurance that the tests they are using are appropriate.

Aerobic fitness tests

Tests for aerobic fitness must use the same type of exercise as the sport in which the individual participates and should generally last in the region of 8-15 minutes, any shorter and the increased anaerobic energy contribution may make the test less valid.

For runners, established tests include the 12 minute "Cooper" or 15 minute "Balke" run, in which the participants endeavour to cover as much distance as possible. Similar field tests could be developed for cyclists and other endurance events. Alternative tests require the participants to complete a set distance as quickly as possible (typically ~1.5 miles as this has been shown to be a good indicator of aerobic fitness and is generally completed in 8-15 minutes), with those achieving the quicker times being deemed to have the better aerobic fitness.

For team and racquet games players, the 20m Multi-Stage Shuttle Run Test is a popular option and requires the participants to complete 20m shuttle runs in time to a pre-recorded cassette/CD (available from sports coach UK). The speed at which they are required to run increases every minute, and the point at which participants are unable to sustain the required speed can be used to estimate their VO2max. Though, it may be simpler to record the number of levels/shuttles completed, with a greater number completed indicating better aerobic fitness.

Muscular endurance tests

These tests may assess either dynamic muscular endurance (the capacity to repeat contractions) or static muscular endurance (the capacity to sustain a muscular contraction). To be specific to a sport it is important to ensure that the test uses the appropriate muscle groups, through relevant ranges of movement and at suitable speeds. Often this may not be entirely feasible and therefore standard endurance exercises such as the sit-up and press-up may be used. Typically, tests for dynamic muscular endurance are performed to see how many exercises the participant can complete in a designated time (e.g. 30 seconds, a minute or even two minutes) or until exhaustion with unlimited time. However, the quality of the movement must be standardised and not sacrificed in the desire for speed. In an attempt to overcome this, the participants could be required to complete a closely standardised exercise (e.g. sit-ups or similar) in time to a pre-recorded cassette/CD (i.e. sports coach UK's Abdominal Curl Conditioning Test).

The flexed arm hang is an example of a static endurance test, and involves participants raising themselves on a bar/beam set just above head height with both arms so that their chin is above the bar and then hold for as long as possible. The coach would need to decide whether an overhand or underhand grip should be used and what the criteria are for ending the test.

Muscular strength tests

Tests for muscular strength should ensure that the muscles being assessed are appropriate and are used through a relevant range of movement, or in the case of static strength at a specific joint angle. In a laboratory setting, equipment such as dynamometers are often used but alternative tests may require the lifting of weights (free weights or exercise machines). Typically this would involve an appropriate warm-up followed by a lifting test until a maximum level is reached.

Depending upon the sport, the coach may wish to assess the participant's maximum strength based on a single repetition or their capacity to repeat a number of contractions. In both cases the participant starts at a relatively heavy weight and if successful in completing the required number of repetitions, rests before attempting a heavier weight.

With this form of testing the coach must be aware of the potential for each lift to cause fatigue. Hence participants should rest for 5-10 minutes between lifts and it may be necessary to implement a familiarisation session to allow a subsequent test to initiate nearer the participants maximum strength.

Flexibility / joint mobility tests

Field tests for flexibility/joint mobility range from simple "Yes / No" assessments of whether the individual can perform a specific task, to the measurement of joint angles and ranges of movement (e.g. Sit and Reach test).

By breaking down a movement into its component parts, the coach will be able to determine which joint movements are essential to performance and need to be assessed. For example, in hurdling good hip mobility and hamstring flexibility are necessary for good technique, whereas in team sports (e.g. football) an appropriate level of flexibility is required to reduce injury risk.

When standardising tests of flexibility/joint mobility the coach must pay close attention to, and note the position of all limbs, not just those being assessed. For example, if measuring hamstring flexibility in one leg the position of the other leg will influence the results. Similarly, if measuring hip flexibility, movement in the back or pelvis may cause the measurement to be overestimated.

Speed and acceleration tests

When assessing speed, the distance used needs to be appropriate to the sport and the coach must carefully determine what happens in a game or event. In a sport such as Cricket the test may be conducted over the distance between the wickets. In order to ensure the test is even more specific, the test should be conducted in full clothing and kit.

Coaches should also consider whether the participant starts the test from a stationary position or has a rolling start. For a Hockey goalkeeper rushing out to block a short corner, a stationary starting position is appropriate, whereas for an 800m runner being assessed for sprint finish ability, a rolling start at 800m race pace leading into a timed 100m sprint is more relevant.

When using a stationary start the coach may need to deem whether reaction time should be accounted for, particularly if the test duration is short.

Tests of power

The anaerobic power of a sports performer can be generated from two energy systems: (i) Creatine Phosphate and (ii) Glycolysis. As the relative contribution of these systems depends upon the duration of the maximal effort, the duration of tests for power is important.

In activities lasting less than 6 seconds (e.g. jumping, shot putt, etc) the energy primarily comes from stored Adenosine Triphosphate (ATP) and Creatine Phosphate. Jumping and throwing tests (i.e. vertical jump test) are popular in assessing these activities. Standardised throwing test can be devised to assess arm power, though technique and performance familiarity will significantly impact the test results and so should be standardised.

In activities that last between 10 and 30 seconds, anaerobic glycolysis becomes increasingly important. So for sustained sprints of around 30 seconds a different aspect of power needs to be assessed.

To assess glycolytic anaerobic power, sustained maximal sprints can be utilised. In a laboratory setting the most widely used is the 30 second "Wingate" sprint using cycle ergometer. However, the use of Cycling tests may not be relevant for other activities and a running sprint of 200-300m may be more valid.

Sport specific speed and agility

In many sports the performers must change direction rapidly. This may be assessed using tests such as star runs, where the performer runs from a central marker to other markers (usually 6-12) situated around the central marker while being timed. Alternatively a zigzag setup can be used to assess dodging/dribbling skills. The coach may wish to incorporate an assessment of turning ability and/or running forwards, backwards and sideways, as deemed applicable to the participants sport (e.g. Football, Hockey, Tennis, etc). In some cases the performer may be required to perform sport specific tasks. For example in Rugby, picking up a ball, or in Cricket, fielding a ball at each marker and throwing it in to the wickets.

Planning a fitness testing programme

Introduction

To provide the most useful information, fitness tests need to be undertaken at key stages during the year. An effective field testing programme will be planned to coincide with different phases of the competitive season. This may include fitness assessments before and after pre-season training and then further tests at suitable intervals during the season. In sports, such as Athletics where training is in phases, assessments should coincide with the end of each phase.

Examples of fitness testing programmes

A. Rugby tests

- 20m multi-stage shuttle test – aerobic fitness
- 1 repetition max test for bench press and leg press – muscular strength
- Number of sit ups, press ups and arm curls in 1 minute – muscular endurance
- 20m sprint test with rolling start – sprinting speed
- Vertical and standing long jumps – leg power
- 3 x 10m shuttle sprint – rapid acceleration
- Hamstring flexibility test – flexibility/joint mobility
- Agility run involving tackling bags, picking up ball and zigzag runs between cones carrying ball – sport specific agility

Initial assessment – Performed at the start of pre-season training to establish current fitness levels, identify fitness components which require specific attention and provide motivation. If available, player's previous results may be used for comparison.

Second assessment – Performed at the end of pre-season training to establish current fitness levels, identify improvements and highlight those requiring continued attention.

Third assessment – Performed mid-season training to establish whether any fitness components require specific focus and 'topping-up'.

B. Athletics 1500m runner

Fitness components to be assessed – aerobic fitness, anaerobic fitness, speed and flexibility. Assessment should take the form of time-trials or races over specific distances, selected on the basis of logical validity. Test results to be compared with the athlete's previous performances and expectations of performers of their level.

Test 1 – performed at the end of December/January following the phase of training which focuses upon aerobic fitness, endurance and stamina. Aerobic fitness assessed via a 3km performance run.

Test 2 – performed at Easter following the phase of training which focuses upon the further development of aerobic fitness and anaerobic fitness via interval training. Aerobic fitness assessed via a 3km performance run and anaerobic fitness assessed via a 400m performance run.

Test 3 – performed at the beginning of the competitive season, following a phase of training which has focused upon speed whilst maintaining the aerobic and anaerobic endurance components of fitness. Aerobic fitness assessed via a 3km performance run, anaerobic fitness assessed via a 400m performance run and sprinting speed assessed via an 80m sprint off a rolling start at 1500m race pace. Additional fitness monitoring is achieved by recording times during training sessions and in races throughout the year.

The role of fitness testing & selecting and using fitness tests.

KENT SPORTS DEVELOPMENT UNIT **Sports**sheet

Sportssheet SERIES

Recommended reading and other sources of information

ACSM's guidelines for exercise testing and prescription. American College of Sports Medicine (2007). 7th ed. Phil: Lippincott Williams & Wilkins.

Sport and Exercise Physiological Testing Guidelines: Volume 1: Sport Testing. British Association of Sport and Exercise Sciences (2007), Oxon: Routledge.

A Guide to Field Based Fitness Testing. NCF (1995) Leeds: National Coaching Foundation.

Resources available from Sports Coach UK

Abdominal curl conditioning test
Multistage fitness test

For information on accredited physiological testing laboratories contact:

British Association of Sport and Exercise Sciences, 14 Cardigan Road, Headingley, LEEDS, LS6 3BJ, Tel: 0113 289 1020

Other useful contacts

Kent Sports Development Unit 01622 605054 / 605055

Sports Coach UK 0113 274 4802

Coachwise 0113 231 1310

Acknowledgements:

Written by Professor Steve Bird, Kent Sport Science Support Programme, Canterbury Christ Church University 2001. Amended by Daniel Tolhurst Canterbury Christ Church University 2008.

Kent Sport, Leisure & Olympic Service is working in partnership with University of Kent, Canterbury Christ Church and University of Greenwich to provide sport science support for performers and coaches in Kent.

If you require this publication in another format please contact the Kent Sports Development Unit on 01622 605054

This publication was produced in an environmentally friendly way using non-bleached paper from sustainable forests and up to 50% recycled paper.