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FITNESS TESTING AND THE PHYSICAL PROFILING OF PLAYERS

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SA RUGBY

ABSA

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Providing coaches, referees, players, and administrators with the knowledge, skills, and leadership abilities to ensure that safety and best practice principles are incorporated into all aspects of contact rugby.

INTRODUCTION

The physical demands of rugby vary depending on the playing position. For example, forwards require more strength and size to enable them to contest for the ball while backline players need to be more agile and have speed to carry the ball past the opposition (Duthie et al, 2003). Forwards spend more time competing for the ball while backs spend more time involved in intense running (Duthie et al, 2003). A variety of tests have been designed to test the range of fitness characteristics of the different playing positions. Knowledge of the performance in these various tests serves several purposes:

- Goals can be set for the players
- Weaknesses can be identified in the fitness profile of each player
- Talent identification
- Fitness trends accompanying the development of the game can be monitored
- Risk of injury can be identified

The next section shows an example of a consent form which the players should complete before they are involved in any testing programme, followed by a detailed description of the tests.

REFERENCES

Duthie, G., Payne, D and Hooper, S. (2003). Applied Physiology and the Game Analysis of Rugby Union. Sports Med 33(13): 973 – 991

CONSENT FORM

I (print name) _____ hereby consent to participating in the physiological assessment on the following terms:

I have been informed about the physiological assessment procedures and understand what I will be required to do.

I understand that I will be partaking in physical exercise, some of which is at maximal intensity. I understand that there is always a risk of injury associated with high-intensity exercise.

I understand that I can withdraw my consent, freely and without prejudice, at any time.

I have told the testing personnel about any illness or physical defect I have that may contribute to the level of risk.

I understand that the information obtained from the test will be treated confidentially, with my right to privacy assured. However, the information obtained may be used for statistical analysis or scientific purpose with my right to privacy retained.

I release the testing personnel from any liability for any injury or illness that I may suffer while undertaking the physical assessment, or subsequently occurring in connection with the assessment, or that is to any extent contributed to by it.

I accept however that the testing personnel will take every precaution to ensure that no incidents will occur.

Participant signature_____Date_____

Parent/Guardian name (if under the age of 18)_____

Parent/Guardian signature_____Date_____

Witness _____Date_____

PRACTICAL GUIDELINES FOR FITNESS TESTING

Only qualified personnel should test players. The testing should be planned well in advance, so that it can be structured into the player's training programme. The player must not undertake any intensive training or competition for 48 hours prior to testing.

The order in which the tests are conducted should be standardised and recorded as a reference for future testing. The players need to become familiar with the protocols and the prescribed tests. The players should not be expected to train on the same day as they are being tested. Some of the tests require a maximal effort and therefore training after a full testing session may lead to excessive fatigue or an increased risk of injury. The protocol below is designed in a specific order. It is important to adhere to this order and to do the tests exactly as they are described. Failure to do so will increase the player's risk of injury and also decrease the accuracy of the results.

1. All players should be interviewed during a consultation prior to being tested, in order to achieve the following:
    a. To establish whether the player has an injury that could prohibit him from being tested, or which could be aggravated by testing.
    b. To establish whether they are familiar with the testing protocol. A player that is not familiar with the testing protocol may underperform in a test.
    c. To establish the periodisation scheme of the player. One may need to be selective about which tests to perform, depending on the stage of training and when the player will next compete.
    d. To establish which tests the player has previously completed and to explain why the current tests may provide further information.
    e. To gather information about the player's current training regime in order to compile a new training programme.

2. Which tests in the protocol should be used and in what order?
    a. The protocols act as a guideline for testing procedure and testing order. All tests described in the protocol need not be performed. The tests performed will depend on the information gathered by the tester during the consultation.
    b. The order in which the tests are performed is important for validity and reliability reasons, as well as to reduce the risk of injury.

3. Guidelines for the ordering of tests:
    a. Consultation: This is always the first step in the process and it empowers the tester to make the correct decision about which tests to complete. It also allows the tester to inform the group or individual on the process to be followed. The players must understand why they are being tested and what the testing involves.
    b. Anthropometry: The player should not perform any physical activity prior to the measurements of body composition. This test should always take place first, and directly after the consultation.
    c. Flexibiltiy: The flexibility tests described are all performed in a "cold" state. Therefore, these tests, if they are to be performed, should be done after anthropometry. Please note that when a player stretches "cold", they stretch until the muscle is tight, and not until they feel pain.
    d. Speed/power: Power tests are usually performed first, followed by speed, agility, strength, muscle endurance and, finally, cardiorespiratory or repeat sprint tests. A speed test, for example, should be performed after a thorough warm-up but it should not be performed after a multistage shuttle run (bleep) test. If an athlete completes the multistage shuttle run prior to the speed test, then his speed performance will be negatively affected. The vertical jump test may be performed prior to the sprint test.
    e. Muscle strength: Muscle strength (1-10RM) tests are always completed prior to muscle endurance tests but after the speed and power tests. A minimum break of 5 minutes is recommended between muscle strength and muscle endurance tests.
    f. Cardiorespiratory endurance/Repeat sprint ability: The bleep test or the 5m repeat sprint test are usually completed at the end of a test battery. A player should not complete both these tests on the same day. Both tests are maximal and exhausting and therefore may cause muscle fatigue, which lasts for several hours. If one completes both tests on the same day, the risk of injury is increased.

4. What tests are performed on different age groups?

The following table has been set up to provide general guidelines for which tests are safe to be performed with different age groups. These are only guidelines and each professional needs to assess the players and use discretion to decide on the appropriate testing battery. It is not necessary to complete all the tests in the battery, but only the tests that are appropriate. For example, one would not complete a 1RM and 10RM bench press, as one is able to predict 1RM from a 10RM performance. Certain players, depending on their levels of experience and injury status, may not be able to perform one or more of the tests, even if the tests are age-appropriate.

TYPE OF TEST	12-13 Years	14-15 Years	16-17 Years	18+ Years
ANTHROPOMETRY	✔	✔	✔	✔
FLEXIBILITY	✔	✔	✔	✔
SPEED	✔	✔	✔	✔
AGILITY	✔	✔	✔	✔
POWER				
• Vertical jump	✔	✔	✔	✔
• Broad jump	✔	✔	✔	✔
STRENGTH				
• 1 RM Bench press			✔	✔
• 5-10 RM Bench press		✔	✔	✔
• 1 RM Parallel squat				✔
• 5-10 RM Parallel squat				✔
MUSCLE ENDURANCE				
• Pull ups (with movement)		✔	✔	✔
• Flexed arm hang (isometric hold)	✔			
• Push ups	✔	✔	✔	✔
• Sit ups (2min)		✔	✔	✔
• Sit ups (1min)	✔			
Cardiorespiratory fitness				
• Multi-stage shuttle run (bleep test)	✔	✔	✔	✔
• 3 km time trial	✔	✔	✔	✔
Repeat sprint ability				
• 5m shuttle run	✔	✔	✔	✔

ANTHROPOMETRIC EVALUATION

Definition

Anthropometry is the science of measuring the physical parameters of the human body. Anthropometry is often used to evaluate a player's size, shape, body proportions, body composition and degree of asymmetry between the dominant and non-dominant limbs. This information can be useful in designing intervention programmes as well as tracking progress. It is important that the anthropometrical measurements are completed according to the specified descriptions. A qualified person needs to

perform the measurements and these should be completed by the same person during successive measurements to ensure repeatability.

Description of measurements

The aim of this section is to describe each procedure in sufficient detail, including the calculation of the derived values, to ensure a high degree of consistency between measurers.

BODY MASS

Purpose:

Body mass is an important variable as it gives an indication of the player's appropriateness for a particular playing position and also indicates whether or not a player is adapting to a training programme. Furthermore, interpreted in the context of the other variables body mass can also be useful for talent identification.

Equipment:

Body mass should be recorded on a calibrated scale able to record to the nearest 100g.

Procedure:

The player should be weighed in underpants and without shoes, preferably before a large meal. Players tested regularly should be weighed at the same time of day for each test.

Scoring:

Body mass should be recorded to the nearest 100g.

STATURE (HEIGHT)

Purpose:

This measurement is recorded as the height from the floor to the vertex of the head. The vertex is defined as the highest point on the skull when an imaginary line between the lower margin of the eye socket and the upper margin of the zygomatic bone is parallel to the ground.

Equipment:

Stadiometer

Procedure:

The player should stand barefoot with the arms at the sides. The heels, buttocks, upper back and head should be in contact with the wall. Prior to measurement, the subject should be instructed to look ahead and take a deep breath.

Scoring:

The measurement should be recorded to the nearest mm.

(Measuring error for standing height < 2 mm)

SKINFOLD THICKNESS

Method

The skinfold-calliper reading is a measurement of the compressed thickness of a double layer of skin and the underlying subcutaneous tissue, which is assumed to be adipose tissue. The skinfold thickness is measured by grasping a fold of skin and the underlying subcutaneous tissue between the thumb and forefinger, 1 – 2 cm above the site that is to be measured. The fold is pulled away from the underlying muscle and the jaws of the callipers are placed on either side of the site, at a depth of approximately 1 cm. The skinfold is held firmly throughout the application of the calliper and the reading is taken when the needle becomes steady after the full pressure of the calliper jaws has been applied. The callipers must be

applied at right angles to the fold at all times. All measurements are recorded on the player's right side except for the abdominal skinfold, which is recorded on the player's left side. The measurement is recorded in millimetres.

(Measuring error for skinfold thickness < 1.5 mm)

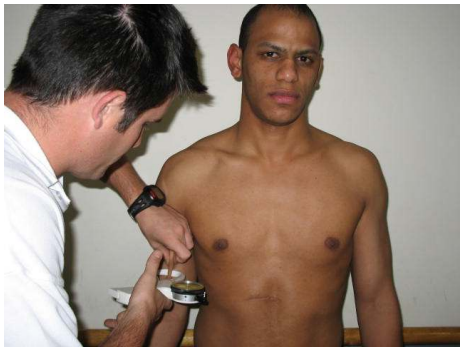
SKINFOLD SITES

Triceps

Measured from the back on the posterior surface of the arm, midway between the top of the shoulder (acromion process) and the elbow (olecranon process). The upper limb should hang loosely at the side, with the player in a standing position.

Biceps

Measured from the front on the anterior surface of the arm, midway between the top of the shoulder and the elbow. The player stands in the same position as for the triceps measurement.



Subscapular

Measured just below the inferior angle of the scapula, with the fold in an oblique plane descending laterally (outwards) and downwards at an angle of approximately 45° to the horizontal.

Supra-iliac

Measured 5 cm above the iliac crest with the fold oblique, descending medially (inwards) and downwards at an angle of about 45° to the horizontal. The player should stand erect with the upper limbs at the sides and the abdominal muscles relaxed.

Calf

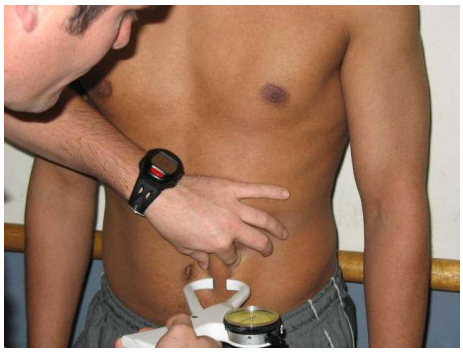
Measured on the medial surface of the calf at the level of the greatest calf circumference. The player's weight must be placed on the opposite leg.

Thigh

Measured at the mid-point on the anterior surface of the thigh, with the fold parallel to the long axis of the thigh. The player's weight should be on the opposite leg so that the knee joint of the measured leg forms an angle of approximately 120°. The mid thigh point can be established by measuring the distance between the gluteal fold and the lateral epicondyl. This distance is the halved to establish the distance up the anterior surface thigh, where the measurement is taken.

Abdominal

Measured in a vertical plane 5 cm to the left of the subject's umbilicus



GIRTH MEASUREMENTS

These measurements are recorded to the nearest cm. The measuring error should be less than 1 cm.

GIRTH MEASUREMENT SITES

Calf

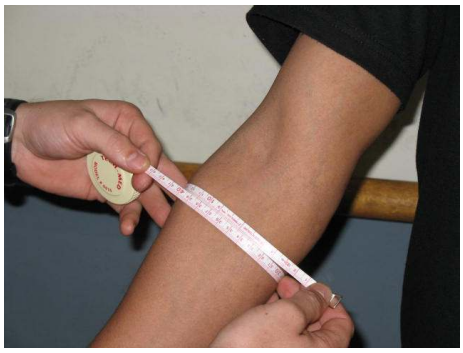
Measured at the greatest circumference of the calf, with the player standing erect, legs slightly apart and with the weight distributed evenly between legs.

Mid-thigh

Measured at the level at which the thigh skinfold was measured. Weight must be distributed evenly on both feet.

Forearm

Measured at the maximal girth of the forearm when the arm is hanging relaxed at the side.



BODY FAT

There is a tendency in laboratories around the world to move away from expressing body fat as a percentage, and towards expressing body fat as a sum of skinfolds (mm). This is because the use of skinfold thicknesses to predict body fat percentage is a "doubly-indirect" procedure (Martin and Drinkwater, 1991) and therefore has inherent inaccuracies. For example, there are many assumptions associated with measuring skinfolds and it is assumed that the densities of the fat and fat-free mass are constant. These assumptions are not always met. It is recommended that the sum of skinfolds (7 sites) be used if the players are going to be monitored on a regular basis throughout the season. Sum of skinfolds and body fat percentage can be measured if the assessment is done on one occasion, or if it is necessary to calculate the target mass of the athlete.

SUM OF SKINFOLDS

Body fat is described as the sum of the following skinfolds:

- biceps
- triceps
- subscapular
- suprailiac
- abdominal
- thigh
- medial calf

BODY FAT PERCENTAGE

The Durnin and Womersley technique should be used to estimate body fat percentage (Durnin and Womersley, 1974). This is a general equation with limited population specificity since it was developed from a heterogeneous group of varying ages (n = 481). This technique does however seem to over-estimate body fat percentage in physically active individuals who are older than 30 years. To prevent an overinterpretation of results, the body fat percentages should always be expressed to a rounded whole number and as a value ± 1%.

The calculation of body fat % involves measuring 4 skinfold sites: triceps, biceps, subscapular and suprailiac.

Measure the 4 skinfold thicknesses (biceps, triceps, subscapular and suprailiac), and substitute the log of their sum into one of the following equations:

Males

Age (yrs)

- 17 D = 1.1533 - (0.0643 X L)
17 - 19 D = 1.1620 - (0.0630 X L)
20 - 29 D = 1.1631 - (0.0632 X L)
30 - 39 D = 1.1422 - (0.0544 X L)
40 -49 D = 1.1620 - (0.0700 X L)
50 + D = 1.1715 - (0.0779 X L)

Females

Age (yrs)

- 16 D = 1.1369 - (0.0598 X L)
16 - 19 D = 1.1549 - (0.0678 X L)
20 - 29 D = 1.1599 - (0.0717 X L)
30 - 39 D = 1.1423 - (0.0632 X L)
40 - 49 D = 1.1333 - (0.0612 X L)
50 + D = 1.1339 - (0.0645 X L)

Where

D = predicted density of the body (g/ml)

L = log of the total of the 4 skinfolds (mm)

Then calculate the predicted percent body fat by substituting into the following formula (Brozek et al, 1963):

Predicted % body fat = 100(4.570/D - 4.142)

FURTHER DERIVATIONS INVOLVING BODY FAT

Fat mass (kg) = body mass (kg) X %fat

Fat-free mass (kg) = (Body mass (kg)) - (fat mass (kg))

Target mass (kg) = Fat-free mass

/((100-TF%)/100)

where TF% = target % body fat

- this should be used with caution because of the many assumptions associated with the calculation.

MUSCLE MASS

The following measurements are needed for the anthropometric assessment of muscle mass (Martin et al, 1990):

- stature (cm)
- mid-thigh girth (cm)
- mid-thigh skinfold (mm)
- calf girth (cm)
- calf skinfold (cm)
- forearm girth (cm)

The technique was developed from measurements conducted on cadavers.

The equation is as follows:

Muscle mass (g) = $S(0.0553CTG^2 + 0.0987FG^2 + 0.0331CCG^2) - 2445$

Where:

S = stature

CTG = corrected mid-thigh girth

FG = forearm girth

CCG = corrected calf girth

CTG = TG - π(mid-thigh skinfold/10)

CCG = CG - π(calf skinfold/10)

REFERENCES

Brozek, J., Grande, F., Anderson, J.T. and Keys, A. (1963). Densitometric analysis of body composition: revision of some quantitative assumptions. Annuls New York Academy of Sciences, 110, 113-140.

Durnin, J.V.G.A. and Womersley, J. (1974). Body fat assessed from the total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. British Journal of Nutrition, 32, 77-97.

Martin, A.D., Spenst, L.F., Drinkwater, D.T. and Clarys, J.P. (1990) Anthropometric estimation of muscle mass in men. Medicine and Science in Sports and Exercise, 22, 729-733.

Martin, A.D. and Drinkwater, D.T. (1991). Variability in the measures of body fat: assumptions or technique? Sports Medicine ,11, 277-288.

Measurement	Body fat %	Sum of skinfolds	Muscle mass
Mass	✔		
Stature			✔
Age	✔		
Skinfolds			
Triceps	✔	✔	
Biceps	✔	✔	
Subscap	✔	✔	
Suprail	✔	✔	
Calf		✔	✔
Thigh		✔	✔
Abdomen		✔	
Girths			
Calf			✔
Mid-thigh			✔
Forearm			✔

Measurements for body composition procedures

FLEXIBILITY

Definition

The term flexibility is used to describe the range of motion around a joint, or series of joints (Maud and Cortez – Cooper, 1995). The purpose of this section is to provide range of motion (ROM) tests that use static evaluation techniques . Flexibility is not a specific performance-related variable, but may be important in injury-prevention.

Rules for the measurement of flexibility

- Ensure that the player's body position during testing is according to the position specified in the different protocols. A slight change in the position of the knee or pelvis may increase scores by 20 – 30%.
- The clothing worn by the player should allow freedom of movement. In addition, the tester must be able to observe all anatomical landmarks during movement.
- Repeat testing must be performed at the same time of day to avoid the effects of circadian variations on flexibility (Reilly, 1981).
- A player should not be warmed up prior to stretching. This is to standardise the procedure. When a player stretches, he should only stretch until the muscle is tight and not until he feels pain.

Description of measurement

SIT AND REACH TEST

Purpose:

The sit and reach test is used to determine the joint range of motion and flexibility of the muscles around the hip joint (the test simultaneously examines the flexibility of the lower back and hamstrings). The reliability of the test has been documented previously (Johnson and Nelson, 1979).

Equipment:

A sit and reach box is required. The "zero" point of the box should be at 26 cm.

Procedure:

For this test, the player sits on the floor with knees extended (straight), ankles flexed and bare feet against the vertical edge of the sit and reach box. The player then flexes (bends) at the hip and reaches forward, with both hands together, towards his toes. The player is encouraged to flex maximally at the

hip joint without flexing the extended knees. The furthermost point reached by both index fingers along a ruler fixed along the top of a box, is taken as the score. The best of three attempts is recorded as the score in centimetres (cm).

Scoring:

The point directly above the vertical edge that the foot is resting against is recorded as zero cm. The sit and reach box must have the zero point set at 26 cm on the ruler that runs along the top of the box.

Figure 1.1 Sit and reach initial test position

Figure 1.2. Player reaches forward, his legs must remain straight

STRAIGHT LEG RAISE TEST (HAMSTRING FLEXIBILITY)

Purpose:

The purpose of this test is to measure the player's hamstring flexibility in both limbs.

Equipment:

Goniometer and plinth

Procedure:

The player lies supine on a bed, while one leg is passively rotated about the hip joint as far as possible with the knee fully extended. This test requires two testers. One tester extends the leg and the other tester measures the angle reached, using a goniometer. The tester moving the leg needs to place one hand in front, but slightly below the knee, and the other at the base of the ankle (heel), forcing the leg into full extension prior to lifting the leg (the leg must be kept in full extension, without the pelvis lifting off the plinth, throughout the movement).

The fulcrum of the goniometer is held over the greater trochanter, while the moving arm is aligned with the midline of the femur, using the lateral epicondyle as a reference point. The stationary arm of the goniometer is aligned with the lateral midline of the pelvis (adapted from Maud and Cortez-Cooper,1995). Measure the angle of displacement from the horizontal. The opposite leg is held firmly by a separate tester or by using a strap, so that there is no flexion at the hip joint. The procedure is repeated for both legs.

Scoring:

Two separate trials are performed with the mean of the two recorded as the hip flexion score. The angle of displacement from the horizontal is measured by the goniometer.

Illustration showing athlete and tester positioning for the Straight leg raise test (Hamstring flexibility)

Figure 2.1 Straight leg raise test position

Figure 2.2. Placement of goniometer

MODIFIED THOMAS TEST

Purpose:

The modified Thomas test is used to obtain measures of flexibility for the iliopsoas and quadriceps (Harvey,1998).

Equipment:

Goniometer and plinth

Procedure:

For the modified Thomas test, the player sits on the end of the plinth. The player then rolls back onto the plinth while pulling both knees to the chest. This is to ensure that the lumbar spine is flat on the plinth and the pelvis is posteriorly rotated. The player then holds the contra-lateral hip in maximum flexion with the arms, while the limb to be tested is lowered towards the floor

Two angles are measured (using a goniometer) for each limb:

The length of the iliopsoas is determined by measuring the angle of hip flexion. The stationary arm of the goniometer is aligned with the lateral midline of the pelvis. The moving arm is aligned with the midline of the femur using the lateral epicondyle as a reference point (Fig 3.1).

The length of the quadriceps is determined by measuring the knee flexion angle. The stationary arm of the goniometer is aligned with the lateral midline of the thigh, using the greater trochanter as a reference point. The fulcrum is placed over the lateral epicondyle of the femur. The moving arm is aligned with the lateral midline of the fibula, using the lateral malleolus as a reference point (Fig.3.2).

Scoring:

The largest angles of displacement are measured by the goniometer.

BODY POSITION FOR THE MODIFIED THOMAS TEST

Illiopsoas measurement

Figure 3.1 Illiopsoas measurement during Modified Thomas test

Rectus femoris measurement

Figure 3.2. Quadriceps flexibility measurement during Modified Thomas Test

REFERENCES

Harvey, D. (1998). Assessment of the Flexibility of elite athletes using the modified Thomas test. British Journal of Sports Medicine. 32, 68-70.

Johnson BL and Nelson JK. (1979) Practical measurements for evaluation in physical education. Burgess, Minneapolis. 78-79.

Maud, P.J. and Cortez-Cooper, M. (1995). Static techniques for the evaluation of joint range of motion. In Physiological Assessment of Human Fitness. (Ed. Maud P.J and Foster C) Champaign, Illinois. Human Kinetics.

Reilly, T. (1981). The concept, measurement and development of flexibility in sports fitness and sports injuries.(Reilly,T.,ed) Faber and Faber London.

SPEED

Definition

Speed is displacement per unit time. The aim is to measure the time it takes a subject to complete a specified distance.

Description of measurements

SPEED (10M AND 40M SPEED)

Purpose:

The purpose of these tests is to determine the player's maximum sprint speed and the ability to accelerate from a stationary position.

Equipment:

Photo-electric sensors, electronic sprint timer, marking cones and tape measure.

Procedure:

Players must warm up thoroughly before this test, as they are required to produce an all-out effort. It is strongly recommended that each player performs a minimum of 10 minutes of sub-maximal running, followed by an appropriate stretching regimen, and some acceleration sprints, building up to full pace. For this test, an electronic sprint timer, with photo-electric sensors, is set at chest height and placed at 10m and 40m intervals from the start line. The player is instructed to position himself, in a crouched start

position, 30 cm from the start line (this line must be clearly marked). The first set of light sensors are placed at the start line, the second at 10m and the third at 40m. The player sprints maximally for 40m through the sensors. The player completes two maximal effort runs separated by a minimum of 5 minutes' recovery period. If photo-electric cells are unavailable then a hand-held timer should be used.

Scoring:

Record times for 10m and 40m .

AGILITY

Definition

Agility can best be described as the ability to accelerate, decelerate and change direction at maximal speed.

Description of measurements

ILLINOIS-TEST

Purpose

The purpose of this test is to measure the player's speed and agility. The test is set up as shown below:

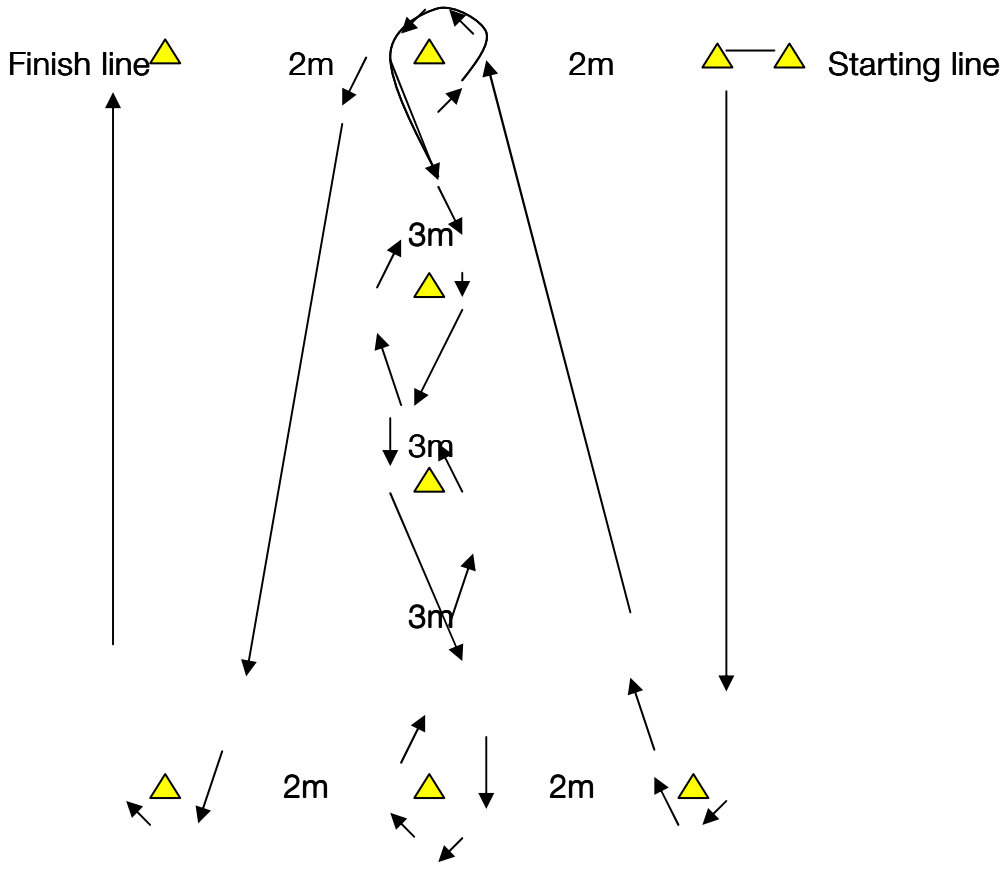


Figure 5. Illinois Agility Test (Adapted from Getchell, 1979)

Equipment

Cones, whistle, tape-measure and photocells if possible, otherwise hand timing will suffice.

Procedure

The player lies in the prone position with his chin touching the surface of the starting line. The first light sensor is placed at the start line, 50 cm above the ground. The light sensor will be activated as the subject moves from the prone position. The second light sensor is placed at the finish line. A whistle sets off the player, who jumps up and accelerates towards and around the opposite cone. He then runs towards the starting line's middle cone, zig-zags through the cones downward and again upwards, sprints to the last cone on the far side and finishes at the finish line. If a player is tested on a grass surface then boots must be used. No starting blocks are allowed. If indoor testing is completed then running shoes should be used. If photo-electric cells are unavailable then a hand-held timer should be used.

Scoring

The player gets two chances, with the faster time taken and recorded in seconds.

REFERENCES

Getchell,B.(1979). Physical fitness: A way of life, 2nd ed. John Wiley and sons, Inc. USA.

POWER

Definition

Power is the ability to complete maximal work in the shortest amount of time. Measurements of power attempt to describe a player's explosiveness.

Description of measurements

VERTICAL JUMP

Purpose

This test measures the player's leg power.

Equipment

- A smooth wall with a ceiling high enough to measure maximum jump height.
- Measuring device, e.g. stick, tape measure
- Chalk

Procedure

The first step is to measure the player's standing height. The player stands side on with the dominant shoulder facing the wall. The player then reaches up with the dominant arm and the standing height is measured at the point of their fingertips. The athlete is then ready to attempt the first jump attempt. The player is allowed to bend (flex) the knees and swing the arms prior to the jump. The player is not allowed a run up or do a shuffle step prior to the jump. The player is allowed a maximum of two efforts after a thorough warm-up. At the highest point of the jump the player reaches up and touches the wall, making a chalk mark. The player's vertical jump score is measured as the distance between the standing height and the jump height.

Scoring

The standing height is subtracted from the jump height and recorded as the vertical jump score. The highest value (cm) is recorded.

Figure 6.1 Standing height is measured first

Figure 6.2. The player flexes the knees in preparation to jump

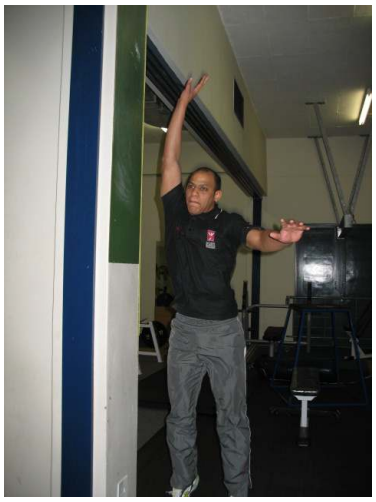


Figure 6.3. The player jumps, touching the wall

STANDING BROAD JUMP

Purpose

This test measures explosive leg power over a horizontal distance. The player jumps forward from a two-footed take-off position, flexing at the hip, knee and ankle joints prior to take-off. The aim of the jump is to obtain as much horizontal distance as possible. The better of two jumps is recorded. Protective shoes (trainers) should be worn if a hard surface is used.

Procedure

The player stands with his feet comfortably apart, behind a demarcated line. The player is allowed to bend (flex) the knees and swing the arms prior to the jump. The player is not allowed a run-up or a shuffle step prior to the jump. The player is allowed a maximum of two efforts after a thorough warm-up.

Equipment

- Straight line/rope
- Measuring tape and a suitable area for the execution of the test.

Scoring

The maximum distance (cm) from the take-off line to the back of the heel closest to the take-off line is recorded.

Figure 7.1. The player flexes his knees, ankles and hips in preparation to take off. The player is also allowed to swing his arms.

Figure 7.3. Landing

MUSCLE STRENGTH

Definition

Testing of muscle strength refers to the external force that can be generated by a specific muscle or group of muscles.

Description of measurements

The testing of muscle strength involves movement of the muscles within the body to produce a force against an external load or object. When completing strength tests, a player must be familiar with the equipment and procedures. A player must have performed the specific lift on several occasions and trained with the lifting technique prior to attempting a maximum lift. One of the most common measures of strength involves lifting the heaviest weight possible and completing up to 10 repetitions. The weight and number of repetitions can then predict the 1 repetition maximum (1 RM). This value is useful in prescribing loads for training and for evaluating changes in strength.

A formula to predict a 1RM for the squat and bench press was created by Wathan (1994). A table for predicting 1RM and training loads is presented in appendix A. The equation is as follows:

1RM = 100 x Weight lifted/(48.8+53.8 x EXP(-0.075 x Number of repetitions performed)).

Maximal strength tests, if performed incorrectly, carry a high risk of injury. The predicted 1RM from 3-10 repetitions has a lower risk of injury than a measured 1RM. A spotter is required for all 1-10 RM tests.

The following steps should be followed for 1 RM testing:

1. Complete a light warm-up set of 10 repetitions at 40 – 50 % of the player's estimated 1 RM
2. Complete a 4-minute light stretching routine
3. Increase the weight to 70-80% of the estimated 1RM, completing three repetitions
4. Complete a 4-minute rest period before the resistance is again increased to a 100% estimate of his 1 RM
5. If step 4 was successful, complete a minimum 4-minute rest period before increasing the resistance (used in step 4) by 2.5-5%. If step 4 is not successful, decrease the weight used in the unsuccessful attempt by 2.5-5% and let the player rest for a minimum of 4 minutes, prior to attempting a lesser weight.
6. The maximum weight lifted is recorded as the 1 RM.

The following steps should be followed for 3-10 RM testing:

1. Complete a light warm-up set of 6 repetitions at 40 – 50 % of the player's estimated 1 RM
2. Complete a 4-minute light stretching routine
3. Increase the weight to 70-80% of the estimated 3-10 RM, completing three repetitions
4. Complete a 4-minute rest period before the resistance is again increased to a 100% estimate of his 10 RM
5. If step 4 was successful, complete a minimum 4-minute rest period before increasing the resistance (used in step 4) by 2.5-5%. If step 4 is not successful, decrease the weight used in the unsuccessful attempt by 2.5-5% and let the player rest for a minimum of 4 minutes, prior to attempting a lesser weight.
6. The maximum weight lifted is recorded as the 3-10 RM.

Note: The software program will automatically calculate 1RM values for a 3-10 RM test.

BENCH PRESS

Purpose:

The purpose of these tests is to determine the player's maximal muscle strength of the upper body.

Equipment:

- Olympic bar
- Weights
- Bench press bench

- Three testing personnel for spotting

Procedure:

For this exercise, the player lies supine on a bench with his/her feet flat on the floor and his/her hips and shoulders in contact with the bench. Hand spacing is usually 1.5 times the player's biacromial width. The player starts this lift by lowering the bar, in a controlled manner, to the centre of the chest, touching the chest lightly (no bouncing the bar on the chest) and then extending upwards until the arms are in a fully locked position. The player is advised to inhale when lowering the bar and to exhale when pressing it. A player should never complete a maximum lift without a spotter.

There are several reasons for disqualifying a lift, and these include:

- Lifting the buttocks off the bench during the movement
- Bouncing the bar off the chest
- Uneven extension of the arms
- Touching of the bar by the spotter.

Scoring:

The maximum amount of weight that can be lifted for 1-10 repetitions.

1-10 RM Bench press (absolute) – (kg)

The 1-10 RM Bench press (relative) is calculated as: 1RM/(bodyweight$^{0.57}$) (the athlete with the largest numerical index is considered the strongest body mass-adjusted lifter) (Dooman and Vanderburgh, 2000)

Figure 8.1. Bench Press test start position (note position of spotter)

Figure 8.2. The bar is lowered to the chest (note position of spotter)

PARALLEL SQUAT

Purpose:

To assess the maximum muscular strength of the leg musculature.

Equipment:

- Squat rack
- Olympic bar
- Weights

Procedure:

For this test, the player stands erect with feet placed 5-10 cm wider than shoulder width and toes pointing slightly outwards. The bar is allowed to rest on the middle of the trapezius muscle of the upper back while the player grips the bar with both hands positioned 10-15 cm from the shoulders. The player then performs a controlled squat until an angle of 90 degrees is reached at the knee joints. The player then extends the knees to fully return to the starting position. Players are instructed to keep their heads up in the neutral position throughout the entire movement. The maximum weight pushed for a 1-10 RM must be established. A player should never complete a lift without a spotter.

There are several reason for disqualification of a lift, including:

- More than one recovery attempt
- Touching of the bar by the spotter
- Shifting or movement of the feet or hands during the lift

Scoring:

The amount of weight for the 1-10 RM is recorded

1-10 RM parallel squat (absolute) – (kg)

1-10 RM full parallel (relative) – 1RM/(bodyweight$^{0.60}$) (the athlete with the largest numerical index is considered the strongest body mass-adjusted lifter) (Dooman and Vanderburgh, 2000)

Figure 9.1. The player descends to 90 degrees (note position of spotter). A squat rack is required to perform this test safely

REFERENCES

Dooman,C.S and Vanderburgh,P.M. (2000). Allometric modeling of the bench press and squat: who is the strongest regardless of bodymass? Journal of Strength and Conditioning research, 14, 32-36.

Wathan, D. Load assignment. In: Essentials of strength training and Conditioning. (1994) . T.R. Baechle, ed. Champaign, IL: Human kinetics, pp. 435-439.

MUSCLE ENDURANCE

Definition

Muscle endurance is the ability of a specific muscle group to contract repetitively or to hold a single contraction to fatigue.

Description of measurements

PULL UPS (MAXIMUM NUMBER)

Purpose:

The objective of this test is to measure the player's upper body endurance. This test is applicable to those players who are 14 years and older. Players younger than 14 are advised to complete the flexed arm hang (isometric hold) version of the test.

Equipment:

- Pull-up bar
- Rubber gripping/towel to ensure a secure grip on the bar

Procedure:

An underhand grip is used with hands placed 10-15 cm apart. The player must start from a hanging position (arms fully extended). The player's chin must reach above the bar on the ascent with arms fully extending (straightening) on the descent. A repetition is not valid if these requirements are not fulfilled. The player must pull his knees up in front (of the body) during the movement in order to avoid arching the back. This is a maximal effort test with the player continuing until he can no longer lift his chin to the bar.

Scoring:

The maximal amount of valid pull-ups completed from an extended arm position to where the chin touches the bar and back down.

Starting position Upward movement

Figure 10. Underhand pull-ups

FLEXED ARM HANG (MAXIMUM ISOMETRIC HOLD) 12-13 YEAR OLDS

Purpose:

The objective of this test is to measure the athlete's upper body endurance.

Equipment:

- Pull-up bar
- Rubber gripping/towel to ensure a secure grip on the bar
- Stopwatch

Procedure:

An underhand grip is used with hands placed 10-15 cm apart. The player must start from a hanging position, from where they are helped into a position where the elbows are flexed to 90 degrees. The test starts when the tester releases the player. The aim of test is to see how long the player can maintain a 90-degree elbow position. The test ends (timer is stopped) when the player can no longer maintain a 90-degree angle at the elbow joint. A maximal 10 degrees of error movement is allowed.

Hold position

Figure 11. 90-degree elbow flexion position for the maximal isometric hold

Scoring:

Record the number of seconds that the athlete can maintain 90 degrees of flexion of the elbow joint.

PUSH UP TEST (1 MINUTE)

Purpose:

The aim of this test is to measure the player's upper body strength and endurance

Equipment:

- Stopwatch
- Gymnastic mat

Procedure:

The player assumes a position where his thumbs are 0-5 cm wider than shoulder width. Keeping the back and body straight, the player descends to the tester's fist, placed below the sternum and then ascend until elbows are fully extended (straightened). If the player does not adhere to these specifications, the repetition is not counted.

Scoring:

The number of push-ups performed in one minute is recorded.

Starting position Finishing position

Figure 12. Push-up Test

SIT-UPS (1-2 MINUTES)

Purpose:

To assess the muscular endurance of the abdominal muscles and hip flexors.

Equipment:

- Stopwatch
- Gymnastic mat

Procedure:

Sit-ups are performed with knees bent, feet fixed (on sit-up bench or held by partner). The hands should touch the ears and elbows should touch the knees at the end of the curl up. The player should then descend in a controlled manner. The tester's hand is placed palm side up on the bench, such that the wrist makes contact with the player's spine in line with the inferior border (bottom) of the scapulae (shoulder blade).

If the hands are taken off the ears, the elbows do not touch the knees, or the back does not touch the tester's hand, the sit up is not counted.

Scoring:

The duration of the test depends on the age of the player. Players between the ages of 12-13 years complete sit ups for 1 minute, whereas players 14 years and older complete sit-ups for 2 minutes. The player may rest within the 1-2 minute period as desired. The time is not paused during a rest.

Start Finish

Figure 13. Sit-ups

CARDIORESPIRATORY FITNESS

Definition

Cardiorespiratory fitness is the ability to perform continuous exercise, using large muscle groups. The intensity of this exercise may be moderate to high for a prolonged period. This type of activity places demands on the respiratory, cardiovascular and skeletal muscle systems. Cardiorespirotary fitness is important for health and sports performance.

Description of measurements

20M MULTISTAGE SHUTTLE RUN

Purpose:

To assess the cardiorespiratory (running) capacity of the player.

Equipment:

- Audiocassette, portable cassette/CD player
- 20m marked distance on a flat surface (tape measure)
- Cones

Procedure:

This progressive multistage shuttle run is based on the protocol of Lèger et al. (1988). A 20 m distance is measured out and marked on the floor. The player runs between these two lines. The player should attempt to complete each 20 m distance (lap) and turn according to the pace determined by the

recorded sound signal. One foot must touch the marked line by the time the signal sounds. Players may not run wide circles; each player must place one foot just over the line and then turn immediately to face the opposite direction. The timing between signals starts off slowly but becomes progressively faster with each passing minute. The player is allowed to voluntary withdraw when he is unable to maintain the pace dictated by the sound. The player can also be withdrawn from the test if he fails to complete the 20m distances in time for 2 consecutive laps. The score is taken at the last completed lap.

Scoring:

Measured as number of successfully completed shuttles of 20 m. This can be converted to give an approximation of the player's VO2 max.

3 KM TIME TRIAL

Purpose:

To assess the cardiorespiratory (running) capacity of the player.

Equipment:

- Stopwatch
- Track, field or measured road run

Procedure:

The players start the test on the signal of the tester and complete the 3km as quickly as possible. Players are allowed to walk but the objective of the test is to finish the distance as quickly as possible.

Scoring:

The time is recorded in minutes and seconds.

REFERENCES

Lèger, L.A., Mercier, Gadovry and Lambert J. (1988). The Multistage 20 m shuttle run test for aerobic fitness. Journal of Sports Sciences 6, 93 - 101.

REPEAT SPRINT ABILITY

Definition

Fitness in sports such as rugby, soccer and hockey is determined by the player's ability to resist fatigue in short duration, high-intensity (>90% maximum heart rate) and intermittent (rest of 30 seconds) exercise. The 5 m shuttle run test simulates this type of exercise. This test also measures the local muscle endurance of the legs and lower back, as well as agility.

Description of measurements

5M SHUTTLE RUN

Purpose:

The purpose of this test is to measure the player's repeat sprint ability, local muscle endurance of the legs and lower back, as well as agility.

Equipment

Six cones, tape measure, non-slippery surface, 2 stopwatches, whistle. Two testing persons are required for this test and the ratio of participants at any one time to tester should be no more than 2:1. Therefore, if six players perform the test simultaneously, at least 3 testing personnel are required to make accurate assessments of distance covered by individuals.

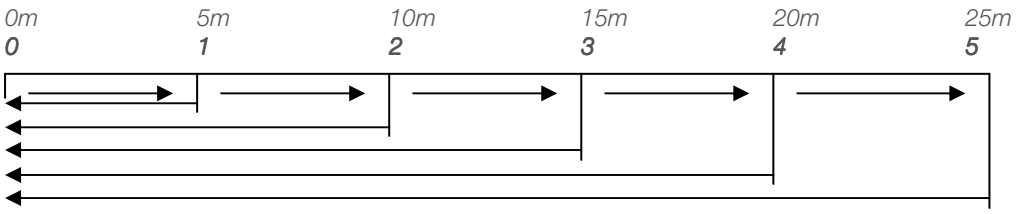


Figure 12. Repeated sprint test

Procedure:

Mark out the running course as shown above in 5m intervals. In addition, place down smaller markers every 2.5m to increase the accuracy of recording the distance reached during each shuttle. The player starts the test at point 0, and upon an auditory signal (whistle), sprints to cone 1, touching the base of the cone with the hand and, returning to point 0, touching the base, and then sprinting to point 2. The player continues in this manner, sprinting to the remaining beacons (3, 4 and 5) and making sure to return to the beacon (0) between each outward shuttle. A whistle is blown after 30 seconds, indicating

the end of the first repetition. The player is then allowed 35 seconds' rest, while the player's distance is recorded. The distance measured is taken from the position of the front foot of the player as the whistle is blown.

During the recovery period, the players make their way back to the starting point (0) and upon completion of the 35th second they begin the next set of shuttles. They need to complete six 30-second runs, with the distance for each run recorded. The aim of the test is to cover as much distance as possible in the six runs. Each run should be completed at about 90% pace. Any player who has a history of lower back pain or injury should not complete this test.

The following parameters are measured:

- The maximum distance (m) covered by the player during any single shuttle-run
- The total distance (m) covered in six repetitions

Scoring:

See Appendix C for a data collection and reference score sheet

AUTHOR'S BIOGRAPHY

Justin Durandt is currently the manager of the Discovery High Performance Centre at the Sport Science Institute of South Africa. Justin has had the privilege of being the conditioning specialist for the national cricket, soccer, Hockey and Olympic teams. In addition he has trained the WP Currie cup team and the SAU19 rugby team at three world cups.

REFERENCES

Boddington, M.K., Lambert, M.I., St Clair-Gibson, A and Noakes, T.D. (2001) Reliability of a 5-m shuttle test. Journal of Sports Sciences, 19, 223 – 228.

APPENDIX A

Table for estimating training loads and 1RM

Max Reps (RM)	1	2	3	4	5	6	7	8	9	10	12	15
% 1RM	100	95	93	90	87	85	83	80	77	75	67	65
Load (lb or kg)	10	10	9	9	9	9	8	8	8	8	7	7
	20	19	19	18	17	17	17	16	15	15	13	13
	30	29	28	27	26	26	25	24	23	23	20	20
	40	38	37	36	35	34	33	32	31	30	27	26
	50	48	47	45	44	43	42	40	39	38	34	33
	60	57	56	54	52	51	50	48	46	45	40	39
	70	67	65	63	61	60	58	56	54	53	47	46
	80	76	74	72	70	68	66	64	62	60	54	52
	90	86	84	81	78	77	75	72	69	68	60	59
	100	95	93	90	87	85	83	80	77	75	67	65
	110	105	102	99	96	94	91	88	85	83	74	72
	120	114	112	108	104	102	100	96	92	90	80	78
	130	124	121	117	113	111	108	104	100	98	87	85
	140	133	130	126	122	119	116	112	108	105	91	92
	150	143	140	135	131	158	125	120	116	113	101	98
	160	152	149	144	139	136	133	128	123	120	107	104
	170	162	158	153	148	145	141	136	131	128	114	111
	180	171	167	162	157	153	149	144	139	135	121	117
	190	181	177	171	165	162	158	152	146	143	127	124
	200	190	186	180	174	170	166	160	154	150	134	130
	210	200	195	189	183	179	174	168	162	158	141	137
	220	209	205	198	191	187	183	176	169	165	147	143
	230	219	214	207	200	196	191	184	177	173	154	150
	240	228	223	216	209	204	199	192	185	180	161	156
	250	238	233	225	218	213	208	200	193	188	168	163
	260	247	242	234	226	221	206	208	200	195	174	169
	270	257	251	243	235	230	224	216	208	203	181	176
	280	266	260	252	244	238	232	224	216	210	188	182
	290	276	270	261	252	247	241	232	223	218	194	189
	300	285	279	270	261	255	249	240	231	225	201	195
	310	295	288	279	270	264	257	248	239	233	208	202
	320	304	298	288	278	272	266	256	246	240	218	208
	330	314	307	297	287	281	274	264	254	248	221	215
	340	323	316	306	296	289	282	272	262	255	228	221
	350	333	326	315	305	298	291	280	270	263	235	228
	360	342	335	324	313	306	299	288	277	270	241	234
	370	352	344	333	322	315	307	296	285	278	248	241
	380	361	353	342	331	323	315	304	293	285	255	247
	390	371	363	351	339	332	324	312	300	293	261	254
	400	380	372	360	348	340	332	320	308	300	268	260

Max Reps (RM)	1	2	3	4	5	6	7	8	9	10	12	15
% 1RM	100	95	93	90	87	85	83	80	77	75	67	65
Load (lb or kg)	410	390	381	369	357	349	340	328	316	308	274	267
	420	399	391	378	365	357	349	336	323	315	281	273
	430	409	400	387	374	366	357	344	331	323	288	280
	470	447	437	423	409	400	390	376	362	353	315	306
	480	456	446	432	418	408	398	384	370	360	322	312
	490	466	456	441	426	417	407	392	377	368	328	319
	500	475	465	450	435	425	415	400	385	375	335	325
	510	485	474	459	444	434	423	408	393	383	342	332
	520	494	484	468	452	442	432	416	400	390	348	338
	530	504	493	447	461	451	440	424	408	398	355	345
	540	513	502	486	470	459	448	432	416	405	362	351
	550	523	512	495	479	468	457	440	424	413	369	358
	560	532	521	504	487	476	465	448	431	420	375	364
	570	542	530	513	496	485	473	465	439	428	382	371
	580	551	539	522	505	193	481	464	447	435	389	377
	590	561	549	531	513	502	490	472	454	443	395	384
	600	570	558	540	522	510	498	480	462	450	405	390

Baechle, T.R., Earle, R.,Wathen D. (2000) In: Essentials of strength training and Conditioning. Champaign, IL: Human kinetics, pp. 410-411.

APPENDIX B

Table for estimating the VO_2 Max from the modified shuttle run test

Level	Shuttle	Predicted VO_2 Max	Ind Shuttle Count
4	2	26.8	25
4	4	27.6	27
4	6	28.3	29
4	9	29.5	32
5	2	30.2	34
5	6	31.8	38
5	9	32.9	41
6	2	33.6	43
6	4	34.3	45
6	6	35.0	47
6	9	36.4	50
7	2	37.1	52
7	4	37.8	54
7	6	38.5	56
7	8	39.2	58
8	2	40.5	62
8	4	41.1	64
8	6	41.8	66
8	8	42.4	68
8	10	43.3	70
9	2	43.9	72
9	4	44.5	74
9	6	45.2	76
9	8	45.8	78
9	11	46.8	81
10	4	48.0	85
10	6	48.7	87
10	8	49.3	89
10	11	50.2	92

Level	Shuttle	Predicted VO_2 Max	Ind Shuttle Count
11	2	50.8	94
11	4	51.4	96
11	6	51.9	98
11	8	52.5	100
11	12	53.7	104
12	2	54.3	106
12	4	54.8	108
12	8	56.0	112
12	10	56.5	114
12	12	57.1	116
13	2	57.6	118
13	6	58.7	122
13	8	59.3	134
13	10	59.8	126
13	13	60.6	129
14	4	61.7	133
14	6	62.2	135
14	8	62.7	137
14	10	63.2	139
14	13	64.0	142
15	2	64.6	144
15	4	65.1	146
15	6	65.6	148
15	8	66.2	150
15	10	66.7	152
16	2	68.0	157
16	4	68.5	159
16	6	69.0	161
16	8	69.5	163
16	10	69.9	165
16	12	70.5	167
16	14	70.9	169

APPENDIX C

Data collection and reference score sheet for the 5m shuttle run

1. Data collection sheet (example)

Name	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Total Distance
Dalton	5B2	5	5	5B4½	4F4	4F3	
	135.0 m	125.0 m	125.0 m	122.5 m	120.0 m	115.0 m	742.5m

2. Score sheet

0		5m		10m		15m		20m		25m
0	↔	1	↔	2	↔	3	↔	4	↔	5

EXAMPLES:

1. Reference number = 5B2

   Where:

   5 = Beacon number

   B = Turned back

   2 = Number of beacons passed after turning back

   Distance = 135 m

2. Reference number = 4F4

   Where:

   Beacon number = 4

   F = has reached beacon 4, turned and reached beacon 0, turned and

   4 = reached beacon 4

m	*Reference*
5	1
10	1B1
15	1F1
20	2
25	2B1
30	2B2 (Reached beacon 2, turned and made it back to beacon 0.)
35	2F1
40	2F2
45	3
50	3B1
55	3B2
60	3B3
65	3F1
70	3F2 (Reached beacon 3 , turned and made it back to beacon 0, turned and was at beacon 2 on the blow of the whistle.)
75	3F3
80	4
85	4B1
90	4B2
95	4B3
4B4	
105	4F1
110	4F2
115	4F3
120	4F4
125	5
130	5B1
135	5B2
140	5B3
145	5B4

APPENDIX D

Individual score sheets

APPENDIX E

Team score sheets