Introduction

The game of netball is an international sport based on throwing and catching. It is played by two teams of seven players and takes place over four 15 min quarters. It is played on a court (double sprung wooden timber) measuring 30.5 m long by 15.25 m wide. The court is divided into three thirds measuring 10.17 m each. The area of the court accessible to each player is determined by the player position. Given the confined court area, players are constantly involved in offensive and defensive maneuvers.

The objective of the game is to advance the ball down the court and have the two shooting players (goal shooter and goal attack) score goals from within a defined area (goal circle) by throwing the ball through a ring that is attached to a 3.05 m (10 feet) high post. Netball is the most popular women’s sport in Australia with an estimated one million players nationwide. At an international level, it is played in more than 40 countries. Australia has claimed the World Championship title in 10 of the 13 World Netball Championships held since 1963.

Netball, like many team games, requires players to perform game-related skills with the ball (e.g., throwing, catching, shooting, offensive and defensive rebounds) as well as game-related activity without the ball (e.g., jumping, lunging, defending). These skills are performed in combination with movement patterns of various intensities and duration. Success in netball at an elite level requires players to possess an exceptional level of skill in combination with high levels of aerobic and anaerobic fitness. Netball has been described as a game reliant on rapid acceleration and sudden and rapid changes in direction in combination with jumping or leaping movements (Otago 1983). It is an interval-type game involving a combination of short work intervals (e.g., sprints, jumps, shuffling movements) interspersed with short recovery periods (e.g., jogging, shooting, and passive defense). Aerobic conditioning has been identified as a major contributor to performance (Allison 1978; Woolford and Angove 1992).
Studies of movement patterns and work intensities of netball players provide valuable information relating to the key physical qualities related to the game. All of these qualities should be considered in the physical preparation and conditioning of netball players. Key activity patterns and motion variables for netball include the following:

- The average work to rest ratio is 1:3 (Davidson and Trewartha 2008; Loughran and O’Donoghue 1999; Otago 1983).
- There is a greater work to rest ratio for center players as opposed to goalkeepers and goal shooters (Davidson and Trewartha 2008).
- Center players spend less time per standing and walking event but greater amount of time per jog and sprint events relative to all other positions (Davidson and Trewartha 2008; Loughran and O’Donoghue 1999; Steele and Chad 1992).
- On average, center players cover approximately 8 km during a game compared with 4.2 km covered by goalkeepers and goal shooters (Davidson and Trewartha 2008).
- The majority of work periods are less than 10 s (Otago 1983), and the average time spent per activity is typically less than 5 s (Steele and Chad 1992).
- On average, players change direction every 4 s (Davidson and Trewartha 2008).
- Mean sprint duration is approximately 1.4 s (Allison 1978; Davidson and Trewartha 2008; Loughran and O’Donoghue 1999); sprint events equate to a quarter of the total distance covered by center players (Davidson and Trewartha 2008).

This document contains guidelines for assessing the physiological abilities of netball players. The tests are those currently used by Australian national squads (e.g., National team, under 21 squad, under 19 and under 17 talent squads) and include field tests and strength tests.

The field tests have been selected to measure some of the major physical abilities required for playing netball, namely, acceleration, agility or footwork, jumping ability, and endurance. Resistance training is an important component of the netball player’s physical preparation, and the selected strength tests enable basic diagnosis of strength and changes related to training. The field tests and strength tests are two separate procedures and should be conducted on separate occasions.

Athlete Preparation

Standardized pretest preparation is recommended to enable reliable and valid physiological data to be obtained. Refer to the AIS Pretest Preparation document for specific information relating to athlete and environment preparation.

Frequency of tests -

In general, field tests and strength tests should be carried out at the end of each appropriate macrocycle to help determine the effectiveness of the program completed and structure of the next program to be implemented.

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Test Conditions/Environment -
- The tests should be carried out at the same time of day for each testing session.
- Testing should not be conducted in extreme environmental conditions, particularly hot and humid conditions and extreme cold conditions. Although it is sometimes impossible to control the environmental conditions for field testing it is possible to test at times of the day that are the least extreme.
- The time of day, temperature (°C) and relative humidity (%) should be recorded.

Recommended Test Order

It is important that the field and strength tests are completed in the same order to control the interference between tests. This order also allows valid comparison of different test occasions. Generally strength tests are completed on a day following the field-based tests, although this is not always practical. The order of testing within the strength testing session should be decided in consultation with the strength and conditioning specialist conducting the assessments.

The order is as follows:

<table>
<thead>
<tr>
<th>DAY</th>
<th>TESTS</th>
</tr>
</thead>
</table>
| 1   | Anthropometry  
20 m sprint  
5-0-5 agility / Planned agility  
Vertical jump  
Yo-Yo intermittent recovery |
| 2   | Muscular strength |

Please Note: The 5-0-5 agility test is used as a generic test of agility. The planned agility test can also be used, but it is not a standard National test and is optional for the testing of National squads/teams.

The reactive agility test is not included in the regular testing battery for netball. This test requires specialized equipment and a detailed setup; testing is usually only conducted annually and occurs on a separate day from the rest of the regular testing battery.
Equipment Checklist

Anthropometry:
[ ] Stadiometer (wall mounted)
[ ] Balance scales (accurate to +/- 0.05 kg)
[ ] Anthropometry box
[ ] Skinfold calipers (Harpenden skinfold caliper)
[ ] Marker pen
[ ] Anthropometric measuring tape
[ ] Recording sheet
[ ] Pen

20 m Sprint Test:
[ ] Electronic light gate equipment
[ ] Measuring tape
[ ] Field marking tape
[ ] Marker cones
[ ] Recording sheet
[ ] Pen

5-0-5 Agility Test:
[ ] Electronic light gate equipment
[ ] Measuring tape
[ ] Field marking tape
[ ] Witches hats
[ ] Recording sheet
[ ] Pen

Planned Agility Run:
[ ] Electronic light gate equipment
[ ] Measuring tape
[ ] Field marking tape
[ ] 5x obstacles / poles
[ ] Recording sheet
[ ] Pen

Vertical Jump Test:
[ ] Yardstick © jumping device (e.g. Swift Performance Yardstick)
[ ] Measuring tape
[ ] Field marking tape
[ ] Recording sheet
[ ] Pen

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Yo-Yo Intermittent Recovery Test:
[ ] Measuring tape
[ ] Witches hats
[ ] Sound box or CD player
[ ] Yo-Yo Intermittent Recovery Test CD
[ ] Recording sheet

Muscular Strength Tests:
[ ] Squat rack with safety bars
[ ] Olympic bench press
[ ] Barbell (Olympic 20kg)
[ ] Weight plates (2.5-25kg increments)
[ ] Recording sheet
[ ] Pen

Test Protocol - Anthropometry

Rationale -
Height, body mass, and sum of seven skinfolds provide objective measures of the athlete’s body structure. These measurements are important in quantifying differential growth and training influences (Ross and Marfell-Jones 1987). In particular, skinfold measurement can be used to monitor and understand the effect of diet and training intervention on body composition. For example, skinfold measurements may be used to determine whether changes in body mass are due to changes in body fat levels or lean body mass (Norton et al. 1994). Furthermore, increased body fat levels may have an adverse effect on netball performance because excess fat has no functional role in activities on the court and can be regarded as dead weight. Excess fat will decrease acceleration and is detrimental to the player’s ability to rebound or leap for the ball (Norton et al. 1994). The development of anthropometric profiles of elite netballers is also of importance. Analysis of such information highlights the physical requirements of particular netball positions (Bale and Hunt 1986).

Test Procedure -
Measurement of height, body mass and skinfolds should be carried out prior to field testing protocols. Skinfolds are recorded over seven sites (triceps, biceps, subscapular, supraspinale, abdominal, front thigh and medial calf). The individual skinfold measures as well as the sum of the seven sites should be reported. Refer to anthropology protocols outlined in AIS Surface Anthropometry document, for a detailed description of all anthropometric test procedures. Although the description of skinfold measurement procedures seems simple, a high degree of technical skill is essential for consistent results. It is therefore important that these measurements be taken by an experienced tester who has been trained in these techniques. It is also important that the same tester conduct each re-test to ensure reliability.

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Data Analysis -
Anthropometric data can be used for serial monitoring (within-subject) of changes in body composition of individual players across the course of a competitive season. In the younger age groups, body mass and stature are the only anthropometric measures used for between-subject comparisons within the national talent identification pathway.

Normative Data -
The anthropometry of netball players can be influenced by player position, age group and competitive level. Normative data for national squads are presented in the table below.

<table>
<thead>
<tr>
<th>Squad/Level</th>
<th>Height (cm)</th>
<th>Body Mass (kg)</th>
<th>( \sum^7 ) Skinfolds (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U21</td>
<td>181.5 ± 4.1</td>
<td>73.7 ± 5.4</td>
<td>99.8 ± 21.7</td>
</tr>
<tr>
<td></td>
<td>(170.5-186.6)</td>
<td>(64.8-91.9)</td>
<td>(62.6-169.9)</td>
</tr>
<tr>
<td>National Team</td>
<td>182.4 ± 6.2</td>
<td>72.6 ± 8.0</td>
<td>82.9 ± 17.5</td>
</tr>
<tr>
<td></td>
<td>(170.0-196.0)</td>
<td>(58.6-92.4)</td>
<td>(46.4-136.6)</td>
</tr>
</tbody>
</table>

Source: AIS Netball and National team database 2010; U21 (n=46, age 17-21 yr); National Team (n=30, age 20-33 yr)

Test Protocol - 20 m Sprint

Rationale -
Although netballers rarely sprint at maximal speed during the game, a large number of efforts involve acceleration from a jog, shuffle, or stationary position (Steele and Chad 1992). These running efforts average less than 2 s, but the acceleration involved in making position, evading an opponent, or intercepting a pass is an important requirement of the game. Therefore, the ability of the netballer to accelerate is best indicated by the times to 5 and 10 m, with 20 m being the maximal distance any player might travel.

Test Procedure -
For netball, the sprint test is conducted over 20 m, with intermediate distances of 5 and 10 m. Ideally, the 20 m sprint test should be conducted on a wooden floor which is used for indoor court play. It is important to ensure that the surface used is consistent for each test - results can be affected by dust or dirt on the floor boards or the use of a different playing surface. Athletes must warm up adequately in preparation for the sprint and agility tests. A poor warm-up may result in unreliable or slower results. The warm-up should include a period of easy running and several maximal sprints and start efforts (e.g., 10 min of easy running and stretching, approximately six “stride-throughs” over 30 m building in intensity from 85% to 100% maximum with jog recovery and four sprints from a stationary start over 10 m building in intensity from 90% to 100%). A minimum of 2 min recovery should be given between each sprint trial.

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i. Measure specified distances with the measuring tape, checking that there are no twists in the tape when laid out. It is useful, where possible, to use a lane marker or sideline (straight line) to lay the measuring tape along.

ii. Mark each interval (i.e., 5, 10, 20 m) with masking tape including a start line (0 m) and a finishing line (20 m).

iii. Place two cones approximately 4 m after the last set of light gates.

iv. Set the light gates at the appropriate intervals (0, 5, 10, and 20 m).

v. Set the light gates on the start line at a lower height to ensure capture of the start. Other light gates should be set at approximately torso height and approximately 1.5 to 2.0 m apart.

vi. Purge the timing module memory and then set the correct number of splits.

vii. The starting position is with front foot toe just touching the start line (0 m), heel up on back foot, body mass over the front foot, and shoulders and hips square in a crouched “ready” position.

viii. Once the athlete is in the ready position, all subsequent movement must be in a forward direction (i.e., no rocking is allowed).

ix. The athlete may start in their own time once they have been advised that the system is ready.

x. The athletes should be instructed to sprint as fast as possible, ensuring that they don’t decelerate until they have passed the cones set 4 m after the final gate.

xi. Record split times (at 5 and 10 m) and final time (20 m) for three trials to the nearest 0.01 s.

xii. Allow at least 2 min active recovery or rest between sprint trials.

xiii. Use the best time for each split and final time as the final result, even if these times come from different trials.

**Data Analysis**

The assessment of maximal 20 m sprint time can assist the practitioner in monitoring within-athlete changes in netball relevant speed and the ability of the athlete to accelerate from a stationary start. The assessment of changes after specific training interventions can assist in determining the appropriateness of the training program.

**Normative Data**

Normative data for the 20 m sprint for under 17, under 19, under 21 and National squad netball players are presented in the table below.
Sprint data for U17, U19, U21 and National squad netball players
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Squad/Level</th>
<th>5 m time (s)</th>
<th>10 m time (s)</th>
<th>20 m time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U17 TID</td>
<td>1.25 ± 0.09 (1.09-1.50)</td>
<td>2.07 ± 0.10 (1.84-2.43)</td>
<td>3.52 ± 0.16 (3.15-4.15)</td>
</tr>
<tr>
<td>U19 TID</td>
<td>1.24 ± 0.08 (1.10-1.52)</td>
<td>2.06 ± 0.09 (1.87-2.40)</td>
<td>3.51 ± 0.14 (3.21-3.99)</td>
</tr>
<tr>
<td>U21</td>
<td>1.21 ± 0.07 (1.03-1.36)</td>
<td>2.03 ± 0.09 (1.46-2.25)</td>
<td>3.45 ± 0.14 (3.14-3.74)</td>
</tr>
<tr>
<td>National Team</td>
<td>1.22 ± 0.08 (1.04-1.39)</td>
<td>2.03 ± 0.10 (1.78-2.25)</td>
<td>3.46 ± 0.16 (3.07-3.92)</td>
</tr>
</tbody>
</table>

Source: AIS Netball database 2010; U17 TID (n=118); U19 TID (n=76); U21 (n=45); National Team (n=55)

Test Protocol - 5-0-5 Agility Test

Rationale -
The basic movement patterns of netball requires athletes to perform sudden changes in direction in response to the flight of the ball or movement of their opponents or teammates. The 5-0-5 agility test is a relatively simple test that measures the time for a single rapid change of direction over a short “up and back” course with a running start. The test has been validated in the context of a team game (Draper and Pyke 1988) and is designed to minimize the influence of velocity while accentuating the effect of acceleration immediately before, during, and after the change of direction.

Test Procedure -
i. A metal tape measure and marking tape are used to mark out the points of the course as per the figure below.
ii. Light gates are set at 5 m approximately torso height and 1.5 to 2.0 m apart.
iii. The starting position is with front foot toe to the start line.
iv. After a signal that the light gates are ready, the athlete can start in their own time.
v. The athlete should sprint from the start line through the light gates to the zero line, where they are required to turn and accelerate off the line, back through the light gates. One foot must be on or over the zero line at the turn for it to be a valid trial.
vi. The athlete may slow down only after passing through the light gates for the second time.
vii. The time taken to cover the 10 m distance is recorded to the nearest 0.01 s.
viii. The athlete completes three trials turning on their preferred foot. Alternatively, three trials on both sides may be given.
ix. The fastest time is recorded as the best score.

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Data Analysis -
Typically athletes who perform this test turning on both sides find they are faster on one side than the other. To improve imbalances between left and right sides and where the 5-0-5 test result is slow, it is recommended that athletes be given footwork drills, agility drills with and without the ball, and some acceleration and deceleration training.

Normative Data -
Normative data for the 5-0-5 agility test for under 17, under 19, under 21 and National squad netball players are presented in the table below.

5-0-5 agility test data for U17, U19, U21 and National squad netball players (mean ± SD; range)

<table>
<thead>
<tr>
<th>Squad/Level</th>
<th>5-0-5 Time Right (s)</th>
<th>5-0-5 Time Left (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U17 TID</td>
<td>2.51 ± 0.09 (2.32-2.73)</td>
<td>2.52 ± 0.11 (2.31-2.91)</td>
</tr>
<tr>
<td>U19 TID</td>
<td>2.48 ± 0.07 (2.32-2.66)</td>
<td>2.49 ± 0.09 (2.28-2.73)</td>
</tr>
<tr>
<td>U21</td>
<td>2.45 ± 0.08 (2.33-2.64)</td>
<td>2.45 ± 0.08 (2.31-2.66)</td>
</tr>
<tr>
<td>National Team</td>
<td>2.42 ± 0.09 (2.20-2.59)</td>
<td>2.43 ± 0.09 (2.28-2.64)</td>
</tr>
</tbody>
</table>

Source: AIS Netball database 2010; U17 TID (n=95); U19 TID (n=77); U21 (n=45); National Team (n=50)
Test Protocol - Planned Agility Test

Rationale -
The basic movement patterns of netball players involve numerous sideways movements, sudden changes in direction, and quick stops and starts. A player will perform shuffling or sideways movement of the body at speed and full effort between 100 and 300 times a game depending on the playing position (Steele and Chad 1992). The 5-0-5 agility test was used for the assessment of agility in all national and state level programs up until 2010, after which the current planned agility test protocol was introduced. The planned agility test involves maximal effort trials around a predetermined course of cones consisting of three left and two right 90° turns. This has been used extensively in the assessment of agility in Australian Football players (Pyne et al. 2005).

Test Procedure -
i. Two sets of light gates are required, one at the start and one at the finish. The poles (obstacles) are typically made from PVC pipe with a circumference of ~35 cm and are ~1.5 m high. Field marking tape should be placed on the floor at two corners of the obstacle so it can be accurately re-positioned if it is knocked over.

ii. Athletes start from a stationary, upright position with the front foot on the 0-m point, in line with the start gate. Athletes weave in and out of the obstacles/poles as per the figure below and should avoid moving them in any way. If this occurs, or a pole is knocked over completely, the trial is stopped and the athlete must start again (after a brief rest).

iii. Athletes should complete a short warm-up of light running, dynamic stretching and some run throughs. After instruction, athletes should have a practice trial at 50% effort to familiarise themselves with the course.

iv. Three 100% maximal effort trials are recorded and the best time (seconds reported to two decimal places) taken as the score. Allow 2-3 minutes recovery between trials.

Schematic diagram of the planned agility run
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Data Analysis -
Similar to the assessment of maximal 20 m sprint time, monitoring within-athlete change of direction ability can assist the practitioner in determining the appropriateness of conditioning stimuli. In addition to monitoring athletes’ ability to negotiate a predetermined agility course in minimal time, the practitioner should consider assessing reactive agility and decision-making time (see following section on assessment of reactive agility). Athletes who are slow on the agility run should be given footwork drills, agility drills with and without the ball, and some acceleration and deceleration training.

Normative Data -
Planned agility test normative data for under 17 and National squad netball players are presented below.

<table>
<thead>
<tr>
<th>Squad/Level</th>
<th>Planned Agility Test (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U17 TID</td>
<td>9.05 ± 0.26 (8.6-9.5)</td>
</tr>
<tr>
<td>National Team</td>
<td>8.92 ± 0.34 (8.3-9.7)</td>
</tr>
</tbody>
</table>

Source: AIS Netball database 2010; U17 TID (n=95); National Team (n=50)

Please Note: The planned agility test is not a standard National test and is optional for the testing of National Netball squads/teams.

Test Protocol - Reactive Agility Test

Rationale -
The reactive agility test combines both planned and reactive movements to sport-specific stimulus. This reflects the actual game of netball, because the majority of footwork patterns initiated by the players (particularly defensive players) are triggered by an opponent’s movement. It is the aim of this test to measure the movement speed of players performing a defensive agility movement when the movement is (a) planned and (b) in reaction to a sport-specific stimulus. The additional measures of movement direction accuracy and movement initiation time are recorded within the sport-specific display condition.

This test requires specialized equipment, including a custom-designed software package developed by the Australian Institute of Sport (AIS). An overview is presented here; however for more detail readers are referred to the AIS Perceptual–Cognitive and Perceptual–Motor Contributions document.
Setup -

- The figure below shows the dimensions and setup of the reactive agility test. To begin, use a tape measure and field marking tape to place a mark 5 m in front of the projection screen to indicate the position of the projector. Place another mark 3 m directly behind the projector to indicate where timing gate 2 will be placed. Place a third mark 1 m directly behind the 2nd mark indicating the line of the defensive shuffle. Extend this mark 2 m to the left and 2 m to the right to indicate the start and end points of the defensive shuffle.

- Assemble 4 sets of timing gates on tripods with the bottom segment extended only. Set up the gates as shown in the figure below. Gate 1 is positioned at the start of the defensive shuffle (to the right hand side of the projector looking at the screen). Gate 2 is positioned at the mark 1 m in front of the defensive shuffle line, gate 3 is positioned 4.1 m diagonally left of the cone marking the point of change of direction (looking at the screen), and gate 4 is positioned 4.1 m diagonally right of the cone marking the point of change of direction.

- Connect gate 4 to gate 2, gate 2 to gate 1, and gate 1 to gate 3. Connect the timing gate control box to gate 4.

- Connect the timing gate control box to the computer.

- Once the data projector is positioned as per the setup diagram, mount the projection screen on the wall. Adjust the position and focus of the projector so that the image is displayed clearly on the projection screen and ensure that the resultant video image size is as realistic as possible (i.e., height and width). To do this, zoom the projector out as far as possible and then focus.

- Set up a digital camera behind the defensive shuffle line, directly in line with the projector. The camera should be placed on a tripod set at the lowest possible height. Ensure that the camera has the closest, unobstructed view of the test screen and the athlete’s lower body and feet as possible. Place a labeled, blank tape in the camera and set the camera to stand-by mode.

![Schematic diagram of the reactive agility test](https://humankinetics.com/coaching)
Test Procedure -

- Prior to the commencement of testing, inform the athlete of the test protocol. There will be 2 test conditions—reactive agility test condition and planned agility test condition. The reactive agility test condition will be performed first, followed by the planned agility test condition.
- At the commencement of testing, switch the camera into the record mode. Get the athlete to face the camera and say her name and the date of testing. There is no need to record practice trials or the test trials of the planned test condition. It is only necessary to record the test trials of the reactive test condition.

Reactive Test Condition -

- The test requires athletes to shuffle (sidestep) for 4 m to her left and then 2 m to her right, while facing forward. The athlete then sprints forward for 1 m before changing direction and running for 4.1 m in a straight sprint on a 45° angle. When the athlete begins the sidestepping movement, this triggers the video to play a near-life-size video image of an opponent passing the ball, which indicates whether the participant has to run to the right or the left direction.
- The player performs 2 practice trials and 12 test trials.
- When the athlete is ready to begin the test trials, turn the camera into record mode.
- Before the commencement of each trial, the timing gates must be armed. To do this the athlete must pass through timing gate 1 from the left of the gate (looking at the screen) to the starting position on the right of the gate. It is essential that this is done quickly and cleanly so that the gate beeps once only. The most effective way of arming the gate is to instruct the athlete to hold their arms straight up above their head and to jump through quickly. If the gate beeps more than once, you must begin the trial again.
- Arming the gates will begin the timer on the timing gate control box and the timing for display of the video image on the projection screen.
- After arming the gates, the athlete should commence the test as soon as possible. Facing the screen, the athlete should begin the sidestep shuffle to the left through timing gate 1 to the end of the 4 m defensive shuffle line.
- When the athlete reaches the end of the defensive shuffle line, she remains facing the screen but changes direction and side-shuffles back along the line to the right. At the mark on the halfway point of the defensive shuffle line, the athlete sprints forward through timing gate 2. Upon passing through timing gate 2, the athlete must respond as though she were about to receive the pass viewed on the screen and sprints diagonally left or right through timing gate 3 or 4. Remind the athlete that it is important to continue sprinting until she has passed through the final gate and not to slow down until after the final gate has been cleared.
- Record the trial number, the direction of movement, and whether the trial was correct or incorrect on the athlete’s manual data sheet.
- Perform the second trial in the same way, ensuring to arm the timing gates.
- Repeat the procedure as above for 12 test trials. Remember to reset the timing gates between trials and to record all of the trials on the manual data sheet.
Planned Test Condition -
- The planned condition is designed to replicate agility tests where the direction of travel is known to the subject before commencing the test. In this case the player is required to move around a cone that is situated 50 cm from the end of the 1 m sprint and 25 cm to either the right or the left of the center line (dependent on which way the subject was required to run).
- The test is performed in a similar way to the reactive test condition, and setup is the same. However, the projector is not necessary for the planned test condition.
- During the directional sprints, the athlete always runs to the left and through timing gate 3 for the first 6 trials, and the athlete always runs to the right and through timing gate 4 for the final 6 trials (i.e., the direction of movement is planned). To ensure that the athlete does not cut corners as she passes through timing gate 2, she must pass the cone situated 50 cm in front of timing gate 2 before turning in the predetermined direction.
- Perform 1 practice trial for each direction followed by 6 trials to the left and 6 trials to the right.
- Proceed as for the reactive agility test, remembering to reset the timing gates and record the trials on the manual data sheet following each individual trial.
- There is no need to film the planned test condition trials.

Data Analysis -
Outcome measures from the reactive agility test include the following:
- Shuffle time (seconds)—time taken from the start of the test until the completion of the shuffle movement (from gate 1 until gate 2).
- Sprint time (seconds)—time from the end of the shuffle until the completion of the test. This measures the athlete’s straight sprinting ability (from gate 2 until either gate 3 or 4, depending on left or right movement direction).
- Total time (seconds)—the addition of the shuffle and sprint time components.
- The shuffle and sprint time components are also separated into left and right changes of direction.
- Decision-making time (meters per second)—defined as the first initiation of a movement toward the required direction of travel relative to the moment of ball release from the athlete passing in the video image. Typically the athlete’s heel is the first signal of a change in movement direction. A negative score indicates anticipation of the pass direction.

For a more detailed discussion surrounding the interpretation and practical recommendations resulting from the reactive agility test for netball, please refer to the AIS Perceptual–Cognitive and Perceptual–Motor Contributions document.
Test Protocol - Vertical Jump

Rationale -
The vertical jump test is selected as the method for evaluating both explosive leg power and jumping ability. The test is easily performed in the field and requires limited equipment, and substantial sport-specific normative data are available.

Test Procedure -
Standing Reach Height:
i. The athlete should stand with their feet together side-on to the Yardstick jumping device.

ii. Keeping the heels on the floor and looking straight ahead, the athlete reaches upward with their dominant hand as high as possible, fully elevating the shoulder to displace the vanes (e.g., vane 25 is displaced 25 cm).

iii. This is recorded as the standing reach height in centimeters.

iv. The absolute standing reach height from the floor may be calculated as the pole setting height (i.e., the height the zero vane is from the floor; either 160, 170, 180, 190, 200, or 210 cm) plus the highest vane displaced. Record this measure in centimeters.

Vertical Jump Height:
i. Move several of the lower vanes away before instructing the athlete to stand close to the Yardstick for their jump.

ii. The athlete uses an arm swing and countermovement to jump as high as possible in order to displace the vanes at the height of the jump.

iii. The takeoff must be from two feet with no preliminary steps or shuffling; however, feet can be comfortably apart.

iv. The athlete performs at least three trials and may continue as long as improvements are being made. The best trial, that is, the highest vane displaced, is recorded as the jump height.

v. The difference between jump height and standing reach height is calculated to give the relative vertical jump result in centimeters.

vi. The absolute jump height from the floor may be calculated as the pole setting height (i.e., the height the zero vane is from the floor; 160, 170, 180, 190, 200, or 210 cm) plus the highest vane displaced (e.g., vane 80 = 80 cm). Record this measure in centimeters.

In addition, the following points apply to the measurement of relative and absolute jump height:
- Reach height must be recorded to help ensure test reliability for relative height.
- The jump measurement device used to conduct the test should be noted.
Data Analysis -
The test provides two jump heights: the relative vertical jump height and absolute jump height. The absolute jump height is the highest point reached or touched when jumping, whereas the relative jump height is the difference between the standing reach and absolute jump height. Absolute jump height provides an objective measure of the specific skill and physical ability to rebound; the height reached indicates an important performance component for goal shooters and defenders. Relative jump height can be used to monitor the effects of strength training programs that target the legs and make comparisons between players.

The vertical jump test result can be affected by the coordination of trunk and arms, and the interpretation of any changes due to strength training may be obscured by changes in the jump action used (Young 1994). It is assumed that the jump action of elite level netballers will not change substantially from test to test; however, junior netballers may improve their vertical jump result due to skill and growth related changes.

Normative Data -
Normative data for the vertical jump tests for under 17, under 19, under 21 and National squad netball players are presented below.

Vertical jump data U17, U19, U21 and National squad netball players
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Squad/Level</th>
<th>Standing Reach Height (cm)</th>
<th>Absolute Jump Height (cm)</th>
<th>Relative Jump Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U17 TID</td>
<td>234.9 ± 8.7 (213-254)</td>
<td>278.8 ± 9.2 (258-300)</td>
<td>43.9 ± 5.0 (31-58)</td>
</tr>
<tr>
<td>U19 TID</td>
<td>235.1 ± 7.3 (216-251)</td>
<td>279.2 ± 7.9 (262-295)</td>
<td>44.1 ± 5.5 (34-65)</td>
</tr>
<tr>
<td>U21</td>
<td>238.5 ± 9.5 (218-263)</td>
<td>284.3 ± 9.8 (262-299)</td>
<td>45.8 ± 5.5 (34-57)</td>
</tr>
<tr>
<td>National Team</td>
<td>237.0 ± 9.5 (217-263)</td>
<td>283.4 ± 9.5 (262-301)</td>
<td>46.4 ± 5.4 (35-56)</td>
</tr>
</tbody>
</table>

Source: AIS Netball database 2010; U17 TID (n=100); U19 TID (n=67); U21 (n=44); National Team (n=55)
Test Protocol - Yo-Yo Intermittent Recovery Test

Rationale -
The contribution of the aerobic energy system to netball play will depend on factors such as playing position, how closely the competing teams are matched, and the distribution or pattern of court play (Chad and Steele 1990; Woolford and Angove 1992). Because athletes may be required to sustain high levels of intensity with little opportunity for substantial recovery, a high level of aerobic fitness is required (Chad and Steele 1990). Furthermore, a high level of aerobic fitness will enable the netballer to play and practice longer at higher intensities. Historically, the multistage fitness test has been used to assess aerobic fitness in netball. In 2009–2010 the multistage fitness test was replaced with the yo-yo intermittent recovery test (IRT). This intermittent test involves a 5 to 15 s exercise period followed by a 10 s active recovery. Over the period of the test, the speed of running is progressively increased. The complete duration of the test may vary between 2 and 15 min. This test is specifically designed to mimic sports involving intensive exercise bursts followed by short recovery periods.

Test Procedure -
It is recommended that this test be completed at the conclusion of the netball testing battery, as fatigue associated with this test may affect performance in the speed and power-type tests.

**Note:** There are two levels for this yo-yo IRT: level 1 and level 2. Currently, the standard testing criteria for netball is level 1. If an athlete is able to run faster than level 1 speed 23, she should perform the level 2 test on the next occasion.

i. Using a measuring tape and marking tape, measure out a 20 m test course as per the figure below.
ii. Place markers 2 m apart at both ends of the 20 m test course (i.e., at start and turning lines).
iii. In addition to marking the 20 m line, measure out a 5 m distance behind the start line.
iv. Place a marker on the recovery line aligned to the middle of the two markers on the start line, as outlined in the figure below. Ensure there is one course setup per athlete being tested.
v. Athletes assume a starting position on the 0 m line.
vi. The Yo-Yo test CD is started.
vii. At the time of the first signal, athletes run forward to the turning line. At the sound of the second signal, athletes arrive and turn at the turning line and then run back to the start line arriving on the next beep. When the start marker is passed, the athletes continue forward at a reduced pace (jogging) toward the 5 m mark, where they then turn around the cone and return to the start line. At this point the athletes stop and wait for the next signal to sound. It is important that the athletes are stationary on the start line before the commencement of each sprint.
viii. Athletes are required to place one foot either on or behind the start or turning lines at the sound of each beep.
ix. Athletes should continue running for as long as possible, until they are unable to maintain the speed as indicated by the CD (or MP3 file).

x. The end of the test is indicated by the inability of an athlete to maintain the required pace for two trials. The first time the start line is not reached, a warning is given; the second time the athlete must withdraw.

xi. When the athlete withdraws, the last level and the number of 2 x 20 m intervals performed at this level are recorded on the appropriate recording sheet. (The last 2 x 20 m interval is included, even if the athlete did not complete it at the right pace.)

xii. The Yo-Yo IRT is effort dependent, so for valid results athletes must attempt to reach the highest level possible before stopping.

xiii. Verbal encouragement should be given to the athletes throughout the test.

xiv. Upon completion of the test, all athletes should be encouraged to perform a warm down.

xv. The final Yo-Yo intermittent recovery speed and interval score obtained by each athlete are used to calculate the total distance covered by the athlete during the test.

Note: If an athlete is able to run faster than speed level 23 on IRT1, they should perform the IRT2 on the next occasion.

Data Analysis -
The yo-yo IRT is effort dependent; thus, for valid results athletes must attempt to reach the highest level possible before stopping. Providing verbal encouragement throughout the test can assist in ensuring this outcome. The results of the yo-yo IRT are primarily used for evaluation of changes in intermittent running endurance capacity rather than prescription of training speeds and estimation of VO$_{2}\text{max}$.

Normative Data -
Yo-Yo IRT normative data for under 17, under 21 and National squad netball players are presented in the table below.

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Yo-Yo test data for U17, U21 and National squad netball players (mean ± SD; range)

<table>
<thead>
<tr>
<th>Squad/Level</th>
<th>Level</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U17 TID</td>
<td>15.7 ± 0.9 (13.4-17.3)</td>
<td>1013 ± 286 (440-1520)</td>
</tr>
<tr>
<td>U21</td>
<td>16.6 ± 1.2 (13.4-18.7)</td>
<td>1320 ± 372 (440-2000)</td>
</tr>
<tr>
<td>National Team</td>
<td>17.2 ± 1.1 (14.3-19.3)</td>
<td>1492 ± 358 (560-2160)</td>
</tr>
</tbody>
</table>

Source: AIS Netball database 2010; U17 TID (n=25); U21 (n=22); National Team (n=27)

Test Protocol - Muscular Strength Tests

Rationale -
Netball play involves explosive actions such as leaping for intercepts, rebounding, and hard changes of direction. These explosive actions require high levels of force to be exerted over a relatively short period of time. Maximal force and rate of force development have been demonstrated to be important to the performance of such activities (Hakkinen et al. 1986; Schmidtbliecher 1992). Furthermore, resistance and plyometric training effectively develop the strength qualities of maximal force and rate of force development, respectively (Hakkinen et al. 1985; Schmidtbliecher 1992). Resistance training, therefore, is an important component of the netball player's physical preparation. The bench press, bench pull, and back squat lifts are used to assess maximal force production capabilities for netball because they test multijoint function, use the major muscle groups of the upper and lower body, and are commonly used training exercises that are familiar to the high-level player.

Test Procedure -
Strength tests should be administered by a coach or instructor who is qualified and experienced in teaching strength training methods. The athlete’s technique should be closely scrutinized during the warm-up, particularly for the squat. Instruction and coaching tips should be given if these are required. If the tester believes that the athlete’s technique is very poor and cannot perform the tests safely, the test should not be conducted. Before leaving the weight training facility, the athlete should perform a number of light sets of each exercise under instruction from the tester. Follow-up technical coaching or testing should be arranged at this time.

For the back squat and bench press tests, the bar should be loaded such that no more than five sets are performed in achieving the 3 repetition maximum (3RM). A minimum of 3 min of recovery should be given to the athlete between sets.
The following general guidelines must be adhered to for all tests:

i. Strength testing should be performed on a separate day from the field tests. Strength and field tests should ideally be separated by 48 h.

ii. Ensure that the athlete has performed an appropriate warm-up. As a minimum, all athletes are required to perform a trial at ~ 90% of specified repetition maximum (RM) for each test. If the athlete is tested for the first time, he or she should perform an initial trial at ~ 90% of weight lifted in training.

iii. Lowering and lifting actions must be performed in a continuous manner. A single rest of no more than 2 s is allowed between repetitions.

iv. A maximum of 5 min recovery between trials is allowed.

v. Minimum weight increments of 2.5 kg should be used between trials. However increments should be guided by ease of each trial.

vi. Ideally, specified repetition maximum (RM) test should be completed within four trials (not including the warm-up).

vii. If the athlete is unable to complete tests as per protocol this fact should be noted on the recording sheet – the test scores should not be included in any mathematical calculations (e.g. mean, TE).

viii. It is recommended that a spotter, other than the supervising coach, be used where necessary.

3RM Squat:
This test requires a high level of technical proficiency and is recommended for athletes with a solid training base. A qualified and experienced strength coach/scientist must supervise this test.

Preparation/Test:

- The safety bars should be set at the highest possible point without affecting the athlete’s range of motion.
- Heel blocks should not be used unless anatomical structures limit the athlete’s range of motion or prevent the exercise from being performed with correct technique. Use of heel blocks should be consistent between tests.
- The use of a weight belt is optional but should be consistent between tests.
- Athlete should assume a natural stance with feet approximately shoulder width apart.
- Bar should be held in a ‘high’ bar position on the trapezius during test. Hands should be held in a comfortable position as close to shoulders as possible.
- During the lowering action knees should travel forward over toes. Heels must remain in contact with the floor at all times during test.
- Athletes are required to lower to a designated depth where crease of hips is level with the top of the knee.
- Recommended assessor position – side on to athlete to facilitate observation of hip/knee angle, back posture and depth.

Technique:

- A valid repetition is one in which the weight is lowered to required depth and then extended to full leg extension with trunk as upright as possible.

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**Technical Violations:**
The following technical violations will result in the trial being invalid and a 2\textsuperscript{nd} trial at the same weight provided:

- Excessive forward or sideways movement during test;
- Loss of controlled spinal position;
- Lifting of heels off the floor;
- Not lowering to required depth;
- Raising of hips prior to shoulder elevation;
- Having greater than 3 s rest between repetitions.

**3RM Bench Press:**
- Initially, athletes may choose the width of grip that they prefer but this should remain consistent over consecutive attempts and tests. In the bottom position, the forearms should be perpendicular to the floor.
- Foot position should be recorded (either both feet on the floor or on the bench).
- Recommended assessor position is 45\textdegree to front of athlete level with hips to facilitate observation of feet, shoulders and buttocks and bar contacting chest.

**Technique:**
- A valid repetition is one in which the athlete lowers the bar to the highest point of the chest (above the bench) in a controlled movement prior to completing the lift to full elbow extension.

**Technical Violations:**
The following technical violations will result in the trial being invalid and a 2\textsuperscript{nd} trial at the same weight provided:

- Failing to make contact with or excessively bouncing the bar off the chest;
- Lifting the shoulders or buttocks off the bench;
- Raising either foot off the bench/ground so that it breaks contact with the floor;
- Excessive deviation of bar from ‘normal’ position (observed in warm-up);
- An uneven bar during the lift (shoulder elevation or uneven extension of arms during lift);
- Having greater than 3 s rest between repetitions.

**3RM Bench Pull:**
- Set bench height so that the athlete can comfortably take the desired grip whilst the weight is off the ground in the hang position.
- Start position – athletes must start all lifts from hang position.
- Athletes may choose the width of grip that they prefer initially but this should remain consistent over consecutive attempts and tests.
- Recommended assessor position is 45\textdegree to front of athlete level with hips to facilitate observation of feet, knees, shoulders and head and bar contacting underside of bench.

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Technique:
- A valid repetition is one in which the bar touches the underside of the bench (no bar pad) and the bar is lowered in a controlled manner to the hang position without touching the ground. Feet should remain off the ground throughout lift and in the same position throughout lifts.
- Use of abducted or adducted bench pull technique should be noted on testing results information. Abducted Bench Pull – bar is lifted towards chest; Adducted Bench Pull – bar is lifted towards navel.

Technical Violations:
The following technical violations will result in the trial being invalid and a 2nd trial at the same weight provided:
- Movement of the head and/or legs from chosen start position (ie. athlete can start with head down or to the side but it must remain in this position and in contact with the bench at all times);
- Movement of trunk away from bench, and/or any hip flexion/extension;
- Failing to make contact with bar on the bench;
- Excessive deviation of bar from ‘normal’ position observed in warm-up (ie. maintain abducted or adducted position);
- An uneven bar during the lift (shoulder depression, uneven flexion of elbows during lift);
- Having greater than 3 seconds rest between repetitions.

Data Analysis -
The selected 3RM strength tests enable basic diagnosis of strength levels and changes related to training for lower- and upper-body pushing and pulling movements. As well as providing information on force production capabilities under high loads, the assessment of absolute changes after specific training interventions can assist in determining the appropriateness of the training program. Because maximal strength is largely influenced by body size and muscle mass, between-athlete comparisons of maximal strength scores are often divided by body mass, as presented in the table below.

Normative Data -
Normative data for AIS Scholarship holders (under 19) and National squad netball players for 3RM strength tests are presented below.
### 3RM test data for AIS Scholarship holders (U19) and National squad netball players (mean ± SD; range)

<table>
<thead>
<tr>
<th>Squad/Level</th>
<th>3RM Squat</th>
<th></th>
<th>3RM Bench Press</th>
<th></th>
<th>3RM Bench Pull</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kg</td>
<td>Ratio to Body Mass</td>
<td>Kg</td>
<td>Ratio to Body Mass</td>
<td>Kg</td>
<td>Ratio to Body Mass</td>
</tr>
<tr>
<td>AIS Squad</td>
<td>71.4 ± 12.6</td>
<td>(37.5-90.0)</td>
<td>1.0 ± 0.2</td>
<td>(0.6-1.3)</td>
<td>43.5 ± 7.2</td>
<td>(30.0-60.0)</td>
</tr>
<tr>
<td>National Team</td>
<td>74.2 ± 11.0</td>
<td>(60.0-100.0)</td>
<td>1.0 ± 0.1</td>
<td>(0.8-1.2)</td>
<td>46.7 ± 5.0</td>
<td>(35.0-55.0)</td>
</tr>
</tbody>
</table>

**Source:** AIS Netball database 2010; AIS Squad (n=26); National Team (n=18)
Traceability Information

<table>
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<tr>
<th>Date</th>
<th>Protocol / Code</th>
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<tr>
<td>1999</td>
<td>Protocols for the Physiological Assessment of Netball Players</td>
<td>Physiological Tests for Elite Athletes, Chapter 20</td>
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<tr>
<td>Jan 2003</td>
<td></td>
<td>Veer agility test replaced with 5-0-5 agility test</td>
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<tr>
<td>2004</td>
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<td>Start distance for sprints moved to 0cm instead of 30cm; Reactive strength test removed</td>
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<tr>
<td>Feb 2011</td>
<td>NP_Netball_v2.0_2011</td>
<td>Netball chapter prepared for 2nd edition of Physiological Tests for Elite Athletes; Revised normative data included;</td>
</tr>
<tr>
<td>Feb 2014</td>
<td>NP_Netball_v2.0_2014</td>
<td>Protocol document formatted for National use; New AIS logo included</td>
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References


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