Introduction

Rugby union is a full-contact, field-based team sport played by men and women in many countries worldwide. Matches are played over two 40 min halves with a short break between halves. The physiological demands of rugby union are broadly characterized by the high frequency of physical contacts and repeated bouts of short-duration, high-intensity efforts (Duthie et al. 2005). Although there is individual variation in the competition demands relative to each playing position, all rugby union players require a high degree of strength, power, speed, anaerobic and aerobic endurance (Duthie et al. 2003).

Testing in rugby union is valuable for a variety of reasons, including monitoring long- and short-term training adaptations, prescribing individualized programs, selecting players, and predicting performance outcomes. The testing protocols outlined in this chapter are approved by the Australian Rugby Union (ARU) and used at junior and senior levels of the game. The field-based testing protocols can largely be administered in basic indoor testing venues and generally don’t require specialist sport science laboratory facilities.

Athlete Preparation

Standardized pretest preparation is essential to enable reliable and valid physiological data to be obtained. The following areas require particular attention when testing rugby union players. These pretest conditions should be observed in addition to those outlined in the AIS Pretest Environment and Athlete Preparation document. Many of the considerations relevant to laboratory testing are equally important for field testing and data analysis and interpretation when athletes are tested in several different locations.

Diet -
Athletes should present for testing in a hydrated state. Hydration status may be assessed by checking the urine specific gravity of the midstream, first bladder void upon waking.
**Training**

To maximize the validity of test results in representing the current physiological status of athletes, testing should be scheduled a minimum of 1 day after intense activity (training or match). This practice will allow players sufficient recovery to ensure test results are not confounded by residual fatigue or soreness.

**Testing**

To help prevent injury and give athletes the opportunity to produce a maximal effort during tests, ensure athletes complete a thorough and standardized warm-up consisting of running and stretching before all tests (excluding anthropometry). Gym-based assessments of strength and power require an additional movement-specific warm-up. Tests should be scheduled at a similar time of day on each testing occasion or across testing locations to maintain consistency in athletes' physiological state. Diurnal variations in an athlete's circadian rhythm can influence test performance. The order of tests should be consistent between testing sessions (see Recommended Test Order). Athletes should be allowed sufficient recovery time between all tests and between individual trials within each test.

**Test Environment**

Whenever possible, athletes should be tested under similar environmental conditions (temperature and humidity). Consistent environmental conditions are important when comparing results between testing occasions: testing can be conducted in a wide variety of conditions from midwinter to midsummer. Running surface and athletes' footwear can have a significant effect on test performance and should be consistent between testing sessions. Testing should preferably be conducted indoors on a polished wooden floor in a sports hall or basketball stadium rather than outdoors on a grass surface with variable surface conditions, winds, and temperatures. Environmental conditions and running surface should be recorded for each testing session.

**Recommended Test Order**

It is important that tests are completed in the same order to control the interference between tests. This order also allows valid comparison of testing results from different testing sessions. The recommended order is as follows:

<table>
<thead>
<tr>
<th>DAY</th>
<th>TESTS</th>
</tr>
</thead>
</table>
| 1   | Anthropometry  
    | Vertical jump  
    | 40 m sprint  
    | Yo-Yo intermittent recovery (level 1) |
| 2   | Physical competency screening  
    | Strength testing |
| 3   | 6 x 30 m repeat sprint ability |
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

Vertical Jump Test:
[ ] Jump measuring device (e.g. Swift Performance Equipment Yardstick©)
[ ] Recording sheet
[ ] Pen

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

Yo-Yo Intermittent Recovery Test:
[ ] Measuring tape
[ ] Marker cones
[ ] Sound box or CD/MP3 player
[ ] Yo-Yo Intermittent Recovery Test CD/MP3
[ ] Recording sheet
[ ] Pen

6 x 30 m Repeat Sprint Ability Test:
[ ] Electronic light gate equipment
[ ] Measuring tape
[ ] Field marking tape
[ ] Marker cones
[ ] Sound box or CD/MP3 player
[ ] 6 x 30-m Repeat Sprint Ability Test CD/MP3
[ ] Stopwatch
[ ] Recording sheet
[ ] Pen
**Physical Competency Screening:**
- Bench press bench
- Squat rack or power cage
- Box or step (15-50 cm in height)
- Barbell (Olympic 20 kg)
- Recording sheet
- Pen

**Strength Tests:**
- Bench press bench
- Squat rack or power cage
- Chin up bar
- Barbell (Olympic 20 kg)
- Weight plates (2.5-25 kg increments)
- Recording sheet
- Pen

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**Test Protocol - Anthropometry**

**Rationale**
Rugby union players are often characterized by the heterogeneity of their physical attributes. Unlike athletes in many other team sports, rugby players in different positions frequently have distinct physiques. For example, a player’s height is an important characteristic for several positions in which a greater height may offer a competitive advantage (Duthie et al. 2003). However, the development of lean mass is desirable for rugby union players of all positions to enhance speed, strength, and power (Duthie et al. 2006a). Similarly, high levels of body fat are detrimental to performance by increasing energy expenditure and decreasing a player’s acceleration and power to weight ratio. The lean mass index (LMI) was developed as a practical method to track proportional body mass changes adjusted for skinfold thickness (Slater et al. 2006).

**Test Procedure**
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. More advanced anthropometric assessment including muscle girths, bone breadths and limb lengths can be conducted, if required. Although the description of skinfold measurement procedures appears simple, a high degree of technical skill is essential for consistent results. The measurements should be taken by an experienced tester who has been trained in these techniques. It is also important, where possible, that the same tester conduct each retest to ensure reliability.
Data Analysis -
Based on body mass and skinfolds, a different LMI coefficient is indicated for forwards and backs. The LMI is calculated as \( \frac{M}{S^x} \), where \( M \) is body mass (kg), \( S \) is sum of seven skinfolds (mm), and \( x \) is an exponent (0.132 for forwards and 0.139 for backs).

Anthropometric results should be interpreted primarily on an individual player basis using change scores and an athlete’s previous test results. For junior athletes, changes in height, body mass, body fat, and lean mass typically reflect the underlying growth and maturation in the adolescent years and the initial impact of dietary and strength and conditioning programs. There might be some interest in a between-player comparison of results, but this exercise needs to be position-specific (see tables below) and account for differences in rates of physical maturation. For older, more physically mature senior athletes, changes in anthropometric measures typically reflect the balance of diet, training demands, and strength and conditioning programs.

Normative Data -
The tables below present anthropometry normative data for male Australian junior talent squad players aged 14-18 years, provincial academy players aged 15-26 years and Super rugby players aged 17-35 years.

### Anthropometric data for male Australian junior talent squad players (mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>Height (cm)</th>
<th>Body Mass (kg)</th>
<th>( \sum ) 7 Skinfolds (mm)</th>
<th>LMI (mm.kg(^{0.14}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop (n = 45)</td>
<td>181.3 ± 5.1 (167.7-194.1)</td>
<td>102.02 ± 13.2 (60.2-142.2)</td>
<td>118.6 ± 28.8 (57.3-193.1)</td>
<td>55.3 ± 5.0 (49.0-71.0)</td>
</tr>
<tr>
<td>Hooker (n = 16)</td>
<td>176.3 ± 3.4 (169.0-182.0)</td>
<td>91.1 ± 9.9 (76.8-111.3)</td>
<td>108.2 ± 16.5 (78.1-130.6)</td>
<td>51.2 ± 4.2 (45.8-57.3)</td>
</tr>
<tr>
<td>Second Row (n = 37)</td>
<td>188.2 ± 6.0 (170.2-199.5)</td>
<td>91.0 ± 9.6 (71.0-111.5)</td>
<td>82.7 ± 25.1 (44.5-163.2)</td>
<td>53.1 ± 3.5 (47.9-59.2)</td>
</tr>
<tr>
<td>Back Row (n = 92)</td>
<td>182.2 ± 5.0 (169.7-194.1)</td>
<td>87.8 ± 10.8 (66.0-117.8)</td>
<td>78.0 ± 22.7 (43.8-150.2)</td>
<td>50.3 ± 4.9 (39.1-61.1)</td>
</tr>
<tr>
<td>Scrum Half (n = 29)</td>
<td>173.8 ± 6.6 (159.7-186.2)</td>
<td>73.5 ± 9.3 (55.0-92.3)</td>
<td>62.4 ± 18.0 (40.7-111.3)</td>
<td>42.6 ± 4.2 (32.9-50.7)</td>
</tr>
<tr>
<td>Fly Half (n = 29)</td>
<td>176.1 ± 5.5 (164.6-185.4)</td>
<td>76.7 ± 6.8 (62.2-93.9)</td>
<td>59.2 ± 11.8 (42.6-92.3)</td>
<td>44.0 ± 2.6 (40.2-48.4)</td>
</tr>
<tr>
<td>Centre (n = 56)</td>
<td>180.0 ± 6.0 (162.3-193.5)</td>
<td>82.5 ± 7.8 (67.9-100.3)</td>
<td>64.8 ± 15.3 (38.8-108.6)</td>
<td>47.0 ± 3.3 (40.7-52.3)</td>
</tr>
<tr>
<td>Wing/Fulback (n = 52)</td>
<td>179.0 ± 5.1 (165.8-187.5)</td>
<td>80.3 ± 8.8 (63.7-102.1)</td>
<td>59.6 ± 15.0 (34.0-92.6)</td>
<td>46.7 ± 4.4 (36.5-59.1)</td>
</tr>
</tbody>
</table>

Typical Error: Height = 1 cm; Body Mass = 1 kg; \( \sum \) 7 Skinfolds = ~1.5 mm; LMI = 0.3 mm.kg\(^{0.14}\)

Source: Australian Institute of Sport Rugby Union Testing Database 2001-2010; age 14-18 yrs.

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## Anthropometric data for male Australian provincial academy players
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>Height (cm)</th>
<th>Body Mass (kg)</th>
<th>∑7 Skinfolds (mm)</th>
<th>LMI (mm.kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop (n = 50)</td>
<td>182.3 ± 5.1 (173.6-193.1)</td>
<td>112.8 ± 11.0 (90.7-139.3)</td>
<td>116.7 ± 26.9 (55.1-179.1)</td>
<td>59.9 ± 4.3 (50.3-70.6)</td>
</tr>
<tr>
<td>Hooker (n = 24)</td>
<td>177.6 ± 3.5 (171.2-183.5)</td>
<td>100.4 ± 8.4 (79.3-119.2)</td>
<td>99.3 ± 27.1 (58.7-163.0)</td>
<td>54.7 ± 4.2 (43.7-61.7)</td>
</tr>
<tr>
<td>Second Row (n = 33)</td>
<td>193.6 ± 5.7 (176.0-204.4)</td>
<td>104.7 ± 7.5 (85.6-118.2)</td>
<td>85.9 ± 21.7 (46.9-129.4)</td>
<td>58.4 ± 3.5 (49.4-63.8)</td>
</tr>
<tr>
<td>Back Row (n = 66)</td>
<td>185.9 ± 4.9 (173.0-196.0)</td>
<td>96.2 ± 9.2 (75.7-122.6)</td>
<td>79.9 ± 26.2 (42.3-179.6)</td>
<td>54.6 ± 4.4 (43.0-64.8)</td>
</tr>
<tr>
<td>Scrum Half (n = 22)</td>
<td>174.5 ± 6.2 (161.9-187.4)</td>
<td>77.8 ± 4.7 (68.8-87.1)</td>
<td>54.3 ± 15.1 (33.8-93.6)</td>
<td>44.7 ± 2.5 (38.5-50.6)</td>
</tr>
<tr>
<td>Fly Half (n = 22)</td>
<td>179.1 ± 5.5 (171.2-188.5)</td>
<td>85.3 ± 7.7 (69.7-104.6)</td>
<td>62.4 ± 13.6 (41.2-88.0)</td>
<td>47.7 ± 3.8 (39.8-52.9)</td>
</tr>
<tr>
<td>Centre (n = 50)</td>
<td>180.2 ± 5.2 (170.0-194.6)</td>
<td>87.9 ± 8.5 (71.2-108.1)</td>
<td>72.6 ± 18.5 (46.5-116.0)</td>
<td>48.9 ± 4.2 (41.2-59.1)</td>
</tr>
<tr>
<td>Wing/Fullback (n = 52)</td>
<td>181.8 ± 5.5 (172.4-194.6)</td>
<td>86.6 ± 7.0 (75.0-104.4)</td>
<td>63.3 ± 15.6 (38.3-116.7)</td>
<td>48.9 ± 3.4 (42.3-57.0)</td>
</tr>
</tbody>
</table>

Typical Error: Height = 1 cm; Body Mass = 1 kg; ∑7 Skinfolds = ~ 1.5 mm; LMI = 0.3 mm.kg⁻¹

Source: Australian Institute of Sport Rugby Union Testing Database 2001-2010; age 15-26 yrs.

## Anthropometric data for male Australian Super rugby players
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>Height (cm)</th>
<th>Body Mass (kg)</th>
<th>∑7 Skinfolds (mm)</th>
<th>LMI (mm.kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop (n = 21)</td>
<td>184.7 ± 2.8 (182.0-188.9)</td>
<td>112.5 ± 9.1 (106.4-128.0)</td>
<td>100.1 ± 22.0 (79.4-148.8)</td>
<td>61.4 ± 4.7 (55.0-69.9)</td>
</tr>
<tr>
<td>Hooker (n = 8)</td>
<td>181.5 ± 3.6 (179.2-186.2)</td>
<td>103.8 ± 4.2 (98.0-115.7)</td>
<td>83.7 ± 18.4 (66.9-97.2)</td>
<td>58.0 ± 2.4 (53.8-63.2)</td>
</tr>
<tr>
<td>Second Row (n = 14)</td>
<td>194.2 ± 10.5 (193.3-202.0)</td>
<td>111.1 ± 3.7 (104.2-116.4)</td>
<td>78.9 ± 20.6 (52.7-116.1)</td>
<td>62.7 ± 2.3 (57.9-65.8)</td>
</tr>
<tr>
<td>Back Row (n = 25)</td>
<td>187.9 ± 3.8 (175.5-196.0)</td>
<td>105.7 ± 7.3 (96.4-117.9)</td>
<td>75.2 ± 21.9 (52.6-104.0)</td>
<td>60.0 ± 2.7 (54.4-66.4)</td>
</tr>
<tr>
<td>Scrum Half (n = 12)</td>
<td>180.0 ± 5.0 (174.6-183.7)</td>
<td>85.4 ± 9.5 (76.2-89.1)</td>
<td>60.5 ± 11.2 (37.0-64.8)</td>
<td>48.3 ± 4.6 (46.1-51.1)</td>
</tr>
<tr>
<td>Fly Half (n = 10)</td>
<td>181.5 ± 5.1 (174.0-188.7)</td>
<td>90.0 ± 5.8 (82.5-103.0)</td>
<td>57.1 ± 9.0 (42.7-99.7)</td>
<td>51.4 ± 3.8 (47.7-58.6)</td>
</tr>
<tr>
<td>Centre (n = 17)</td>
<td>182.2 ± 5.1 (176.6-188.9)</td>
<td>94.4 ± 5.5 (83.2-107.8)</td>
<td>62.5 ± 13.4 (47.6-99.5)</td>
<td>53.7 ± 4.7 (47.3-61.1)</td>
</tr>
<tr>
<td>Wing/Fullback (n = 29)</td>
<td>183.7 ± 5.5 (175.6-191.0)</td>
<td>93.6 ± 7.5 (77.1-105.9)</td>
<td>65.4 ± 15.0 (27.6-89.7)</td>
<td>52.5 ± 3.9 (43.1-60.4)</td>
</tr>
</tbody>
</table>

Typical Error: Height = 1 cm; Body Mass = 1 kg; ∑7 Skinfolds = ~ 1.5 mm; LMI = 0.3 mm.kg⁻¹

Source: Australian Institute of Sport Rugby Union Testing Database 2001-2010; age 17-35 yrs.
Test Protocol - Vertical Jump

Rationale -
Muscular power is fundamental for success in rugby union, particularly during tackles, scrums, line-outs, rucks, and mauls. The vertical jump test provides a useful field-based measure of leg power. Force produced during the maximal vertical jump has been shown to be related to scrummaging force (Robinson and Mills 2000).

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.

Data Analysis -
Vertical jump results can be interpreted against position standards (see table below) or against a player’s previous test results. Improvements in jump height should reflect increases in lower body power but also in jumping technique, timing, and coordination. Familiarization and prior practice can influence test results, particularly for junior athletes.
Normative Data -
The table below presents normative vertical jump data for male Australian junior talent squad players aged 14 to 18 years, provincial academy players aged 15 to 26 years, and Super Rugby players aged 18 to 35 years.

**Vertical jump data for male Australian rugby players**
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>JUNIOR TALENT SQUAD PLAYERS</th>
<th>PROVINCIAL ACADEMY PLAYERS</th>
<th>SUPER RUGBY PLAYERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jump Height (cm)</td>
<td>Jump Height (cm)</td>
<td>Jump Height (cm)</td>
</tr>
<tr>
<td>Prop (n = 46; 45; 21)</td>
<td>49 ± 7 (32-66)</td>
<td>53 ± 9 (36-75)</td>
<td>54 ± 6 (38-64)</td>
</tr>
<tr>
<td>Hooker (n = 15; 22; 11)</td>
<td>49 ± 8 (35-64)</td>
<td>56 ± 6 (47-68)</td>
<td>61 ± 6 (51-71)</td>
</tr>
<tr>
<td>Second Row (n = 37; 33; 20)</td>
<td>52 ± 7 (34-69)</td>
<td>56 ± 8 (39-70)</td>
<td>60 ± 7 (46-75)</td>
</tr>
<tr>
<td>Back Row (n = 94; 60; 25)</td>
<td>55 ± 7 (36-73)</td>
<td>58 ± 6 (40-72)</td>
<td>62 ± 6 (53-77)</td>
</tr>
<tr>
<td>Scrum Half (n = 29; 19; 15)</td>
<td>56 ± 5 (47-68)</td>
<td>61 ± 5 (49-70)</td>
<td>65 ± 6 (57-74)</td>
</tr>
<tr>
<td>Fly Half (n = 29; 20; 11)</td>
<td>56 ± 6 (41-70)</td>
<td>60 ± 6 (51-72)</td>
<td>66 ± 6 (57-78)</td>
</tr>
<tr>
<td>Centre (n = 61; 44; 20)</td>
<td>57 ± 7 (45-74)</td>
<td>58 ± 7 (41-71)</td>
<td>64 ± 6 (54-76)</td>
</tr>
<tr>
<td>Wing/Fullback (n = 55; 46; 40)</td>
<td>59 ± 6 (46-74)</td>
<td>61 ± 7 (46-78)</td>
<td>64 ± 5 (51-73)</td>
</tr>
</tbody>
</table>

Typical Error: Jump Height = 1 cm

Source: Australian Institute of Sport Rugby Union Testing Database 2001-2010; Junior talent squad, age 14-18 yrs; Provincial academy players, age 15-26 yrs; Super rugby players, age 18-35 yrs.
Test Protocol - 40 m Sprint

Rationale -
Speed is an essential quality for high-level rugby union players. Speed during sprinting is often classified into two related phases: initial acceleration and maximal velocity. Although the mean duration of sprints observed during competition is approximately 3 s (Deutsch et al. 2007), players also regularly achieve speeds in excess of 90% maximal velocity (Duthie et al. 2006b). These data suggest that both characteristics of speed are important in rugby union. The 40 m sprint with intermediate split distances allows the assessment of both acceleration and maximal velocity in the same test.

Test Procedure -
For rugby union, the sprint test is conducted over 40 m, with intermediate split distances of 10, 20, and 30 m. The athlete starts from a stationary standing position with the front foot at the horizontal start line marked 30 cm behind the start (0 m) timing gate. Typically two or three 40 m trials are undertaken at the discretion of the coach or athlete.

If testing is conducted outdoors on a synthetic running track or a grass surface, wind velocity and direction must be recorded and the times adjusted accordingly. Wind velocity is collected at the 20 m mark using a handheld environmental monitor. Wind velocity data collection commences when the athlete leaves the start and finishes when the athlete passes the 40 m gate. The mean wind velocity over this time is recorded.

Split times for the sprints are adjusted using the Linthorne (1994) formula:

\[ t_{ad} = t + [a (w - w^2(1/[2d/t]))] \]

where \( t_{ad} \) is the adjusted split time (s), \( t \) is the original split time (s), \( a = 0.056 \) for males and \( 0.067 \) for females, \( w \) is the wind velocity (m.s\(^{-1}\)), and \( d \) is the split distance (m).

An estimation of maximal velocity (m.s\(^{-1}\)) is obtained by dividing 10 by the value obtained by subtracting the 30 m split time from the 40m split time. The momentum of the athlete (kg.m.s\(^{-1}\)) over the last 10 m of the 40 m sprint is then calculated as the maximal velocity (m.s\(^{-1}\)) multiplied by the mass of the player (kg).

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., 10, 20, 30, and 40 m) with masking tape including a start line (0 m) and a finishing line (40 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, 10, 20, 30, and 40 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. 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.

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

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

ix. 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.

x. Record split times (at 5, 10 and 20m) and final time (40 m) for three trials to the nearest 0.01 s.

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

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

**Data Analysis** -
In rugby union, the fastest 40 m time is typically reported as the test score, although some coaches might prefer to use the mean 40 m time over the two or three trials. Improvements in 10 m sprint time will come from enhancements in lower-body power and the technique of sprint starts from a stationary position. Advice from a specialist sprint coach is useful in this process. Improvements in total 40 m time and maximal velocity should come from speed drills focusing on acceleration and maximal velocity. Speed-resisted and speed-assisted drills may also be useful. Momentum is often associated with the ability to break tackles and get over the advantage line. Improvements in momentum will arise from increases in both body mass and running speed.

**Normative Data** -
The following tables present 40 m sprint normative data for male Australian junior talent squad players aged 14-18 years, provincial academy players aged 15-26 years and Super rugby players aged 18-35 years.
Sprint data for male Australian junior talent squad players
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>10 m Time (s)</th>
<th>40 m Time (s)</th>
<th>Max. Velocity (m.s⁻¹)</th>
<th>Momentum (kg.m.s⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop (n = 44)</td>
<td>1.98 ± 0.14</td>
<td>5.82 ± 0.28</td>
<td>8.0 ± 0.4</td>
<td>808 ± 100</td>
</tr>
<tr>
<td></td>
<td>(1.71-2.27)</td>
<td>(5.20-6.41)</td>
<td>(7.2-9.1)</td>
<td>(533-1085)</td>
</tr>
<tr>
<td>Hooker (n = 15)</td>
<td>1.99 ± 0.13</td>
<td>5.87 ± 0.27</td>
<td>7.9 ± 0.4</td>
<td>727 ± 85</td>
</tr>
<tr>
<td></td>
<td>(1.80-2.20)</td>
<td>(5.38-6.42)</td>
<td>(6.9-8.7)</td>
<td>(634-896)</td>
</tr>
<tr>
<td>Second Row (n = 38)</td>
<td>1.94 ± 0.15</td>
<td>5.70 ± 0.28</td>
<td>8.2 ± 0.5</td>
<td>753 ± 86</td>
</tr>
<tr>
<td></td>
<td>(1.71-2.24)</td>
<td>(5.25-6.28)</td>
<td>(7.4-9.3)</td>
<td>(559-947)</td>
</tr>
<tr>
<td>Back Row (n = 95)</td>
<td>1.92 ± 0.14</td>
<td>5.58 ± 0.24</td>
<td>8.5 ± 0.4</td>
<td>742 ± 104</td>
</tr>
<tr>
<td></td>
<td>(1.69-2.29)</td>
<td>(5.10-6.16)</td>
<td>(7.5-9.3)</td>
<td>(502-990)</td>
</tr>
<tr>
<td>Scrum Half (n = 29)</td>
<td>1.89 ± 0.14</td>
<td>5.49 ± 0.26</td>
<td>8.6 ± 0.4</td>
<td>635 ± 92</td>
</tr>
<tr>
<td></td>
<td>(1.65-2.26)</td>
<td>(5.02-6.21)</td>
<td>(7.6-9.3)</td>
<td>(448-781)</td>
</tr>
<tr>
<td>Fly Half (n = 28)</td>
<td>1.88 ± 0.12</td>
<td>5.49 ± 0.22</td>
<td>8.6 ± 0.4</td>
<td>653 ± 69</td>
</tr>
<tr>
<td></td>
<td>(1.70-2.10)</td>
<td>(5.15-6.09)</td>
<td>(7.1-9.1)</td>
<td>(530-809)</td>
</tr>
<tr>
<td>Centre (n = 61)</td>
<td>1.88 ± 0.14</td>
<td>5.40 ± 0.21</td>
<td>8.8 ± 0.3</td>
<td>731 ± 72</td>
</tr>
<tr>
<td></td>
<td>(1.65-2.22)</td>
<td>(5.03-5.79)</td>
<td>(8.1-9.5)</td>
<td>(579-851)</td>
</tr>
<tr>
<td>Wing/Fullback (n = 58)</td>
<td>1.89 ± 0.14</td>
<td>5.38 ± 0.22</td>
<td>8.9 ± 0.4</td>
<td>718 ± 81</td>
</tr>
<tr>
<td></td>
<td>(1.63-2.14)</td>
<td>(4.89-5.91)</td>
<td>(7.8-9.7)</td>
<td>(541-879)</td>
</tr>
</tbody>
</table>

**Typical Error:** 10 m time = 0.4 s; 40 m time = 0.4 s; Maximum velocity = 0.1 m.s⁻¹; Momentum = 10 kg.m.s⁻³

**Source:** Australian Institute of Sport Rugby Union Testing Database 2001-2010; age 14-18 yrs.
Sprint data for male Australian provincial academy players
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>10 m Time (s)</th>
<th>40 m Time (s)</th>
<th>Max. Velocity (m.s(^{-1}))</th>
<th>Momentum (kg.m.s(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop (n = 45)</td>
<td>2.02 ± 0.13 (1.80-2.27)</td>
<td>5.83 ± 0.28 (5.37-6.47)</td>
<td>8.1 ± 0.5 (7.0-8.8)</td>
<td>940 ± 88 (755-1123)</td>
</tr>
<tr>
<td>Hooker (n = 24)</td>
<td>1.96 ± 0.14 (1.73-2.19)</td>
<td>5.64 ± 0.27 (5.26-6.22)</td>
<td>8.4 ± 0.4 (7.4-8.9)</td>
<td>853 ± 71 (695-985)</td>
</tr>
<tr>
<td>Second Row (n = 31)</td>
<td>1.99 ± 0.13 (1.74-2.21)</td>
<td>5.74 ± 0.26 (5.26-6.32)</td>
<td>8.3 ± 0.4 (7.3-8.9)</td>
<td>867 ± 64 (648-975)</td>
</tr>
<tr>
<td>Back Row (n = 60)</td>
<td>1.92 ± 0.12 (1.68-2.23)</td>
<td>5.47 ± 0.20 (5.10-5.89)</td>
<td>8.7 ± 0.3 (8.0-9.4)</td>
<td>846 ± 78 (644-1022)</td>
</tr>
<tr>
<td>Scrum Half (n = 21)</td>
<td>1.91 ± 0.15 (1.64-2.08)</td>
<td>5.39 ± 0.28 (4.93-5.86)</td>
<td>8.9 ± 0.4 (8.1-9.4)</td>
<td>694 ± 52 (573-770)</td>
</tr>
<tr>
<td>Fly Half (n = 21)</td>
<td>1.85 ± 0.12 (1.64-2.06)</td>
<td>5.33 ± 0.21 (4.91-5.89)</td>
<td>9.0 ± 0.5 (8.1-10.3)</td>
<td>771 ± 63 (676-931)</td>
</tr>
<tr>
<td>Centre (n = 48)</td>
<td>1.93 ± 0.14 (1.67-2.16)</td>
<td>5.42 ± 0.25 (4.97-6.00)</td>
<td>8.9 ± 0.4 (8.0-9.6)</td>
<td>786 ± 76 (647-918)</td>
</tr>
<tr>
<td>Wing/Fullback (n = 42)</td>
<td>1.86 ± 0.13 (1.63-2.06)</td>
<td>5.28 ± 0.22 (4.81-5.71)</td>
<td>9.2 ± 0.4 (8.4-10.1)</td>
<td>784 ± 72 (644-932)</td>
</tr>
</tbody>
</table>

Typical Error: 10 m time = 0.4 s; 40 m time = 0.4 s; Maximum velocity = 0.1 m.s\(^{-1}\); Momentum = 10 kg.m.s\(^{-1}\)

Source: Australian Institute of Sport Rugby Union Testing Database 2001-2010; age 15-26 yrs.
### Sprint data for male Australian Super rugby players

(mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>10 m Time (s)</th>
<th>40 m Time (s)</th>
<th>Max. Velocity (m.s(^{-1}))</th>
<th>Momentum (kg.m.s(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop (n = 24)</td>
<td>2.00 ± 0.13 (1.80-2.26)</td>
<td>5.86 ± 0.23 (5.53-6.39)</td>
<td>8.1 ± 0.4 (7.4-8.8)</td>
<td>925 ± 57 (823-1032)</td>
</tr>
<tr>
<td>Hooker (n = 12)</td>
<td>1.92 ± 0.12 (1.77-2.08)</td>
<td>5.60 ± 0.18 (5.32-5.81)</td>
<td>8.5 ± 0.2 (8.2-8.8)</td>
<td>870 ± 59 (823-956)</td>
</tr>
<tr>
<td>Second Row (n = 22)</td>
<td>1.90 ± 0.10 (1.75-2.10)</td>
<td>5.57 ± 0.21 (5.16-5.93)</td>
<td>8.5 ± 0.4 (7.8-9.3)</td>
<td>939 ± 61 (874-1029)</td>
</tr>
<tr>
<td>Back Row (n = 29)</td>
<td>1.90 ± 0.14 (1.73-2.28)</td>
<td>5.46 ± 0.23 (5.09-6.01)</td>
<td>8.7 ± 0.4 (7.8-9.6)</td>
<td>923 ± 53 (848-1057)</td>
</tr>
<tr>
<td>Scrum Half (n = 18)</td>
<td>1.86 ± 0.14 (1.66-2.13)</td>
<td>5.32 ± 0.21 (4.96-5.68)</td>
<td>9.1 ± 0.4 (8.5-9.6)</td>
<td>751 ± 45 (676-818)</td>
</tr>
<tr>
<td>Fly Half (n = 11)</td>
<td>1.84 ± 0.10 (1.68-1.98)</td>
<td>5.33 ± 0.15 (5.03-5.55)</td>
<td>9.0 ± 0.2 (8.7-9.4)</td>
<td>779 ± 43 (743-851)</td>
</tr>
<tr>
<td>Centre (n = 18)</td>
<td>1.88 ± 0.12 (1.70-2.05)</td>
<td>5.35 ± 0.19 (4.96-5.72)</td>
<td>9.0 ± 0.4 (8.0-9.7)</td>
<td>863 ± 59 (768-937)</td>
</tr>
<tr>
<td>Wing/Fullback (n = 41)</td>
<td>1.85 ± 0.11 (1.63-2.06)</td>
<td>5.22 ± 0.15 (4.84-5.54)</td>
<td>9.3 ± 0.3 (8.5-10.0)</td>
<td>848 ± 88 (659-1028)</td>
</tr>
</tbody>
</table>

**Typical Error:** 10 m time = 0.4 s; 40 m time = 0.4 s; Maximum velocity = 0.1 m.s\(^{-1}\), Momentum = 10 kg.m.s\(^{-1}\)

**Source:** Australian Institute of Sport Rugby Union Testing Database 2001-2010; age 18-35 yrs.

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**Test Protocol - Yo-Yo Intermittent Recovery Test**

**Rationale -**
Players may cover in excess of 7 km in an 80 min match of rugby union (Cunniffe et al. 2009). Aerobic endurance is related to fatigue resistance and promotes recovery from high-intensity activity, including sprints, tackles, rucks, and mauls (Tomlin and Wenger 2002). The Yo-Yo intermittent recovery test (IRT) level 1 involves acceleration, deceleration, and change of direction, making it more specific to the work demands of rugby union than continuous running endurance tests.

**Test Procedure -**
It is recommended that the level 1 test is completed at the conclusion of the rugby union testing battery, as fatigue associated with this test may impact on performance in the speed and power-type tests.
**Set-up:**

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.

**Procedure:**

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.

![Yo-Yo Intermittent Recovery Test Diagram](image)

**Data Analysis**
Test results presumably reflect the endurance fitness of players. Players seeking improved aerobic fitness should undertake additional endurance-type training including lower-intensity interval running, cross-training, and circuit training. Skill-based conditioning games have also been shown to improve markers of endurance (Gamble 2004). Strength and conditioning coaches need to be mindful of not comprising strength, speed, and power attributes in the quest for improved overall fitness. Endurance will be improved by a reduction in fat mass in certain players exhibiting elevated sum of skinfolds. In some players, Yo-Yo IRT results can be improved by attention to the efficiency of starting and turning technique.

**Normative Data**
The table below presents Yo-Yo IRT1 normative data for male Australian junior talent squad players aged 14-18 years and provincial academy players aged 15-26 years.
Yo-Yo intermittent recovery test data for male Australian rugby players
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Positional Group</th>
<th>JUNIOR TALENT SQUAD PLAYERS</th>
<th>PROVINCIAL ACADEMY PLAYERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distance Covered (m)</td>
<td>Distance Covered (level.shuttle)</td>
</tr>
<tr>
<td>Backs (n = 20; 18)</td>
<td>1654 ± 361 (1080-2240)</td>
<td>17.6 ± 1.1 (15.8-19.5)</td>
</tr>
<tr>
<td>Forwards (n = 25; 25)</td>
<td>1291 ± 380 (560-2120)</td>
<td>16.5 ± 1.2 (14.3-19.2)</td>
</tr>
</tbody>
</table>

Typical Error: Distance = 90 m

Source: Australian Institute of Sport Rugby Union Testing Database
2001-2010; Junior talent squad, n = 45, age 14-18 yrs; Provincial academy players, n = 43, age 15-26 yrs.

Test Protocol - 6 x 30 m Repeat Sprint Ability Test

Rationale -
Rugby union players frequently perform repeated high-intensity efforts with only short recovery between bouts (Duthie et al. 2005). These periods do not allow players to achieve complete recovery. The 6 x 30 m repeated-sprint ability (RSA) test is designed to evaluate a player’s speed-endurance qualities and ability to resist fatigue under time and distance demands similar to those experienced during a match (Pyne et al. 2008).

Test Procedure -
- The protocol is a 6 x 30 m maximal effort running sprint test on a 20 s cycle. All players are given appropriate instruction on the test procedures and a short warm-up of light running and stretching prior to the test. If this test is conducted after other tests, then adequate recovery should be provided.
- The protocol is a 6 x 30 m maximal effort running sprint test on a 20 s cycle. All players are given appropriate instruction on the test procedures and a short warm-up of light running and stretching prior to the test. If this test is conducted after other tests, adequate recovery should be provided.
- Testing is conducted indoors on a synthetic running track surface or a polished wooden (sprung) floor with sufficient space (~60-70 m in length) to allow for decelerations and turnarounds. Record the type of running surface. Each repeat sprint test takes 2 min; allow another 30 to 60 s changeover to the next player or group of players.
• Electronic timing gates are set up according to the manufacturer’s specifications at 0 m and 30 m. An amplifier with the test protocol loaded onto a MP3 or CD player is positioned halfway along the testing lane. A marker cone is positioned 10 m beyond the timing gates at each end of the testing lane to signify the specified 10 m recovery distance (turnaround point). The start line at both ends of the sprint lane is marked exactly 1 m back from the 0 m (start) timing gate.

• Each player will complete one maximal effort trial involving 6 x 30 m running sprints from a stationary standing (crouched) start. The player is asked to complete each 30 m sprint as a maximal effort.

• The player is required to run (decelerate) in a straight line at least 10 m past the 30 m timing gate (deceleration zone) and then return by walking or slowly jogging to the start line ready for the next effort. This procedure applies at both ends of the testing area. That is, the 30 m timing gate becomes the 0 m timing gate for the next sprint.

• The player is given a 5 s warning and then a verbal command of “ready” at approximately 0.5 s before a starting signal. The player commences the maximal sprint effort at the starting signal. The starting action is standardized in the same manner as for the 40 m sprint test (i.e., crouch start, front foot at the starting line, self-start). The players should be instructed not to assume the crouched starting position too early; they only need to adopt this position immediately prior to the starting signal. A common mistake is for the player to adopt the crouched starting position too early and lose balance.

• One submaximal repetition of the test should be undertaken to familiarize players with the test procedures (especially the jog intensity for the active recovery component). A recovery period of approximately 5 min should be given before commencing the test.

• The time for each of the six sprints is recorded accurate to 0.01 s and the total time (in seconds) used as the criterion score.

• The RSA test can be conducted in the same testing session as other speed and power fitness tests (40 m sprint, vertical jump), although given its fatiguing nature, should be the last test of the session.

• If sufficient timing equipment and staff resources are available, two or more athlete tests should be run in parallel to reduce the time needed to test all players.

**Data Analysis**

It is important players perform each sprint with a maximal effort. A common limitation is that a player pulls up short of the full 30 m sprint, particularly toward the end of the test when fatigue is apparent. Results should be interpreted in regard to previous results and by playing position. In general, backs are expected to have a total time approximately 1 to 2 s quicker than forwards. Training of both speed and endurance qualities is necessary to improve players’ RSA. Attention should be given to drills that emphasize both attributes in isolation and combination.

**Normative Data**

At the time of publication, insufficient data were available to compile reference values for the 6 x 30 m RSA test.
Test Protocol - Physical Competency Screening

Rationale -
Physical competency can change throughout the career of a rugby union player because of several factors, including balance and coordination, strength and muscle hypertrophy, injury, tightness, and muscular imbalances. Dysfunctional or limited movement patterns and asymmetries have been associated with an increased risk of injury (Kiesel et al. 2007). Changes in a player’s movement competency will influence the requirements of the training program and must be identified by the strength and conditioning coach. A qualitative understanding of the movement patterns of a player provides the foundation for individualized exercise programming and prescription (Kiesel et al. 2011).

The physical competency screen consists of eight basic movement tests. Physical competency is specific to each movement pattern and region of the body. The selected range of tests is designed to assess the functional movement dynamics over the player’s entire body. The screening allows coaches to track the long-term progression of players as well as monitoring for short-term injury-related weaknesses in specific areas. Photos of each physical competency test are included in Appendix A.

Test Procedure -
The physical competency movement screen is a qualitative assessment and should be conducted by an experienced practitioner. The screen takes approximately 8-10 min per player. The athlete is required to complete the set number of repetitions or duration for each test and based on the movement cues is deemed to be competent or not (pass/fail). The aim of the physical competency screen is to assess movement proficiency, not muscular strength. Junior athletes or those without previous strength training experience should substitute the 20 kg barbell for a broomstick or lightweight barbell when attempting the overhead squat and Romanian deadlift. The movement cues for each test are:

Barbell Overhead Squat (5 repetitions) (Figure 1):
- Head is centred
- Movement is initiated through hips
- Elbows are locked; bar is aligned with mid-foot
- Lumbar spine maintains a neutral position
- Thighs attain parallel position to the ground
- Heels remain on the ground
A-lunge with Twist (3 repetitions each side) (Figure 2):
- Arms are held across shoulders with elbows up
- Lunge begins at static ‘A’ position
- Stride length equates 90° knee bend at front and back leg
- Front knee is behind line of toes
- Back foot is positioned on forefoot
- Head is centred and trunk is stable
- Athlete rotates toward front leg through thoracic spine
- Lumbar position is neutral, resisting rotation
- Balance is maintained throughout movement

Barbell Romanian Deadlift (5 repetitions) (Figure 3):
- Head is centred
- Trunk is straight, scapulae set, chest up
- Bend occurs at hips, not the lumbar spine
- Knees maintain a slightly bent position

Single Leg Squat to Bench (5 repetitions each side) (Figure 4):
- Movement is initiated through hips
- Lumbar spine maintains a neutral position
- Knees are aligned over toes
- Pelvis remains parallel to the ground
- Athlete lowers in a controlled manner until buttocks touch bench
- Heels remain on the ground
- Trunk integrity is maintained throughout

Push Up (5 repetitions) (Figure 5):
- Head is centred and held stable
- Shoulders are held down and away from the ears
- Elbows are at 90° at bottom position
- Lumbar spine is in neutral position
- Athlete has obvious scapulae control
- Gluteals are activated
- Legs are straight and stable
45° Pull Up (5 repetitions) (Figure 6):
- Head is centred and held stable
- Shoulders are held down and away from the ears
- Head, shoulders, hips and feet maintain alignment
- Lumbar spine is in neutral position
- Elbows are approximately 90° at top, bar to nipple line
- Athlete has obvious scapulae control
- Athlete pulls up and lowers in a controlled manner

Single Leg Calf Raise (20 repetitions each side) (Figure 7):
- Athlete stands upright on edge of box/step
- Heel is down, leg straight
- Athlete performs 1 s concentric contraction (up), 1 s eccentric contraction (down)
- Athlete uses full, controlled range
- Pelvis remains parallel to the ground

Trunk Bridge (prone and lateral – 60 s each) (Figure 8):
Prone:
- Athlete begins on forearms and toes
- Head is centred, looking down
- Shoulders are held down and away from the ears
- Lumbar spine is in neutral position and gluteals are activated
- Body maintains alignment

Lateral:
- Athlete begins on forearm and foot
- Free arm is in line with body
- Shoulders are held down and away from ears
- Support arm is held at 90° to the body
- Lumbar spine is in neutral position and gluteals are activated
- Body maintains alignment

Data Analysis
The physical competency screening requires minimal equipment and is therefore relatively simple to implement with limited resources. It is important that all tests within the competency screening are attempted. The screening should be conducted on two or three occasions over various stages of the training year. Previous results should be kept as a reference to monitor the progress of each player. If a player fails to complete a test or their physical competency regresses, a review of the player’s current physical state is indicated. The S&C coach should determine whether there is any obvious reason for the result (e.g. injury) and modify the training or rehabilitation program as required.
Test Protocol - Strength Testing

Rationale -
Strength is a crucial quality for success in rugby union during both attack and defense. Absolute strength and power (regardless of body mass) are required to apply high forces quickly in contact situations and during the scrum (Quarrie and Wilson 2000). Players’ running velocity and ability to change direction are also related to their strength and power relative to body mass (Nimphius et al. 2010; Young et al. 1995). The back squat, bench press, and prone grip chin-up provide a useful index of whole body strength.

Test Procedure -
The strength tests used in rugby union include the 1RM back squat, bench press, and prone grip chin-up. Warm-up and submaximal attempts of the bench press and squat should be performed in an appropriate rack with spotters present.

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. The athlete must perform an appropriate warm-up. As a minimum, the athlete is required to perform a trial at approximately 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 approximately 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, typical error of measurement).

viii. It is recommended that a spotter, other than the supervising coach, be used where necessary.
1RM Back 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.

**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.
1RM 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° 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 2nd 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).

1RM Chin Up
- Chin-ups should be performed with a medium width pronated grip. The grip should be no wider than 1 hand width outside the shoulders while in the hang position. Athletes may choose the width of grip within limits, but this must remain consistent over consecutive attempts and test.
- A straight bar should be used for testing chin-ups.
- Results should be recorded as body mass plus any external mass lifted.
- Recommended assessor position is at the athlete’s side at eye level with bar.

Technique:
- Starting from a fully extended elbow position (hang position), the athlete is required to pull body up in one smooth action so that at the top of the lift, the top of the hands are level with the rear angle of the mandible (jaw). Legs can be held in semiflexed position or extended; however, they must not be moved in a way that increases momentum in the pulling phase of the lift. Athletes should be encouraged to complete the lift with minimal head movement.

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Technical Violations:
If any of the following technical violations occur, the trial will be considered invalid and the athlete will perform a second trial at the same weight:
- Not achieving correct height (top of hands level with rear angle of mandible)
- Movement at the hips or knees from start position during the lift.
- Swinging body during lift
- Failing to extend elbow fully between repetitions
- Resting more than 3 s rest between repetitions.

Data Analysis -
The use of the three standard strength tests will allow the coach to gain insight into the relative strength deficiencies of each player as they apply to his or her particular stage of physical development and prior training experience. The coach can identify imbalances between the upper and lower segments of the body as well as between the upper pushing (bench press) and upper pulling (prone grip chin-up) muscle groups. This analysis will assist individual program design and potentially reduce the likelihood of injuries associated with muscular imbalances.

At all levels of rugby union, there are recommended standards of physical strength (see table below). The strength program for each individual athlete should address the relative strength standards appropriate to the level of competition in which they are participating. If a player is unable to complete a single chin-up, loads of less than body mass can be achieved by testing the athlete using a standard lat pull-down machine.

Australian Rugby Union strength standards

<table>
<thead>
<tr>
<th>Lift</th>
<th>Junior 1RM or Estimated</th>
<th>Advanced Junior 1RM or Estimated</th>
<th>Intermediate 1RM or Estimated</th>
<th>Senior 1RM or Estimated</th>
<th>International 1RM or Estimated</th>
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<tbody>
<tr>
<td>Back Squat</td>
<td>1-1.2 x BM</td>
<td>1.2-1.4 x BM</td>
<td>1.4-1.6 x BM</td>
<td>1.6-1.8 x BM</td>
<td>1.8-2.0 x BM</td>
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<tr>
<td>Bench Press</td>
<td>0.5-0.7 x BM</td>
<td>0.7-0.9 x BM</td>
<td>0.9-1.1 x BM</td>
<td>1.1-1.3 x BM</td>
<td>1.3-1.5 x BM</td>
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<tr>
<td>Prone Grip Chin Up</td>
<td>0.5-0.7 x BM</td>
<td>0.7-0.9 x BM</td>
<td>0.9-1.1 x BM</td>
<td>1.1-1.3 x BM</td>
<td>1.3-1.5 x BM</td>
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BM = body mass
Traceability Information

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<th>Protocol / Code</th>
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<td>NP_Rugby Union_v1.1_2014</td>
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References


Figure 1. Barbell Overhead Squat
Figure 2. A-lunge with Twist
Figure 3. Barbell Romanian Deadlift

Figure 4. Single Leg Squat to Bench

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Figure 5. Push Up

Figure 6. 45° Pull Up

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Figure 7. Single Leg Calf Raise

Figure 8. Trunk Bridge (upper panel - prone; and lower panel - lateral)