Protocols for the Physiological Assessment of Judo Athletes

Judo Federation of Australia (JFA) Sports Science Advisory Committee
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JUDO

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1. Introduction

The Judo Federation of Australia (JFA) Sports Science Advisory Committee (SSAC) has been appointed by the JFA under the direction of the Australian Sports Commission and Australian Institute of Sport to assist judo athletes. It is also responsible for the development of young and promising judo athletes. The SSAC’s role is as an Advisory Committee, providing feedback and reporting to the High Performance Manager, National Elite Coaching Director and National Head Coach. It is the National Elite Coaching Director’s role to disseminate that information to judo athletes and to provide specific programs, in conjunction with the State coaches, coordinated by the High Performance Manager.

The SSAC objectives are to:

- Improve the level of training of athletes
- Monitor athletes physically, physiologically and psychologically
- Determine achievable standards based on developed Australian and overseas data
- Monitor and assist athletes in injury prevention.

The protocols outlined in this document have been developed for two reasons. Firstly, they are part of the testing procedures that the SSAC use at each camp where testing is involved. There they are used as a means of gathering information on the physical characteristics of each player so that meaningful feedback can be given to each player to assist them improve their judo performance. Usually testing has been carried out at National training camps only, but now the SSAC see the opportunity to expand testing options to State Institutes of Sport that players can access for more regular feedback on performance characteristics. This provides a standardised test battery for sport scientists to evaluate judo players’ progress against the benchmarks and any previously obtained results (e.g. camp data). This document has been developed so that the Institutes, sport science staff, Judo players and their coaches can access the protocols and adhere to them so that testing is scientifically managed and monitored.

Judo is a multifaceted sport, and for optimal performance at the elite level its many aspects must be addressed. High levels of skill and technique are vital for success at the international level. The physiological demands incorporate a range of components, these include; body composition, muscular strength and power, aerobic and anaerobic energy production, and flexibility. Therefore, physical conditioning and training is vitally important,
not only for the purpose of enhancing performance but also in the prevention of injury and enhancing recovery. Physiological testing is a valuable tool for the assessment of the components of Judo and can assist both scientists and coaches in the following areas:

- Generate a fitness profile of strengths, weaknesses and potential problems
- Monitor, assess and evaluate the effectiveness of training programs
- Set realistic and attainable goals (motivation, feedback, education)
- Incorporate fitness measures into athlete assessment.

The following pages outline protocols developed for various tests recommended by the SSAC. These tests are used to monitor the physiological status across a range of parameters for the specific nature of Judo. They have been selected on the basis of specificity, time and cost effectiveness and to assist the SSAC in the development of objective benchmarks and standards.

It should be emphasized that fitness testing is merely a guide to general fitness without being judo specific, but does not guarantee a player’s performance in judo competition. A certain level of fitness is essential for effective training and successful performance.
2. Athlete Preparation

Standardized pre-test preparation is needed to obtain reliable and valid physiological data. To ensure test reliability, the following specific pre-test conditions should be observed.

2.1 Diet

Athletes should be encouraged to follow their normal dietary practices in the 24 to 48 h preceding testing. A light breakfast should be consumed before testing conducted in the morning, and similarly a light lunch consumed should be consumed 2 to 3 h before any afternoon testing. Athletes should arrive to testing sessions well hydrated. No beverages containing alcohol or caffeine should be consumed in the 2 h prior to testing.

2.2 Training

Athletes should be tested in a relatively fresh state so that they can give a full unhindered effort in all tests. No training inducing severe physiological or neural fatigue should be undertaken in the 24 h prior to testing. This includes any high-intensity skills or physical training. It is preferred that athletes have only a light session on the evening before testing, and that intensive training be conducted after testing.

2.3 Testing

All test sessions should be scheduled at the same time of day to avoid fluctuations in physiological response to the set protocols due to circadian rhythm (Winget et al. 1985). All tests must be completed in the recommended standardized order, with adequate and consistent recovery time between tests. This will promote optimal performance and allow for a valid comparison of results on different test occasions. Athletes should be familiar with test procedures and protocols before commencement. Athletes being tested for the first time should undertake familiarization trials or sessions, when possible.
2.4 Test Environment

Anthropometry testing should be conducted in a suitable indoor area (small room) where athletes can be measured in private. Vertical jump and multistage shuttle run tests should all be conducted indoors, preferably on a court with a properly sprung wooden floor. The surface should be clean, free of dust and in good condition. Environmental conditions, including ambient temperature and humidity should be recorded; if conditions are too adverse, testing should be postponed to another time.

3. 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 different test occasions. The recommended order is as follows:

<table>
<thead>
<tr>
<th>DAY</th>
<th>TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, morning session</td>
<td>Anthropometry and USG</td>
</tr>
<tr>
<td></td>
<td>Vertical jump</td>
</tr>
<tr>
<td></td>
<td>Judo specific fitness test</td>
</tr>
<tr>
<td></td>
<td>Multistage shuttle run</td>
</tr>
<tr>
<td>1, afternoon session</td>
<td>Rope climb</td>
</tr>
<tr>
<td></td>
<td>Muscular strength</td>
</tr>
</tbody>
</table>
4. Equipment Checklist

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

**Urine Specific Gravity:**
- [ ] Sterile collection container
- [ ] Reagent strips for urinalysis (e.g. Bayer Multistix 10SG)
- [ ] Stopwatch
- [ ] Recording sheet
- [ ] Pen

**Vertical Jump Test:**
- [ ] Yardstick © jumping device (e.g. Swift Performance Yardstick)
- [ ] Measuring tape
- [ ] Recording sheet
- [ ] Pen
**Judo Specific Fitness Test:**

- Judo mats
- Measuring tape
- Marking tape
- Heart rate monitor
- Stopwatch
- Recording sheet
- Pen

**Multistage Shuttle Run Test:**

- Measuring tape
- Marking tape
- Witches hats
- Sound box or CD player
- Multi-Stage Fitness Test CD (or MP3 file)
- Stopwatch
- Recording sheet
- Pen

**Rope Climb:**

- Suspended rope, 36mm in diameter, minimum 4.0 metres in length
- Tape measure
- Electrical tape (2x colours)
- Chalk or towel(s)
- Safety mat
- Stop watch
- Recording sheet
- Pen
Muscular Strength Tests:
[ ] Bench press bench and rack
[ ] Bench pull bench
[ ] Squat rack or power cage
[ ] Barbell (Olympic 20kg)
[ ] Weight plates (2.5-25 kg increments)
[ ] Recording sheet
[ ] Pen

5. Test Protocols

5.1 Anthropometry

5.1.1 Rationale
Anthropometric measurements of height, body mass, and sum of skinfolds provide a clear appraisal of the structural status of an individual at any given time (Ross et al. 1991). In addition, anthropometric measures can provide an insight into the athlete’s response to training, adaptation to training intervention, and seasonal variations across a training year. More practically, skinfolds are of use in making modifications to training and dietary strategies. Excess body fat can have a detrimental effect on performance by increasing fat mass. Non functional body weight can impede explosive power and acceleration, both important characteristics of elite Judo players.

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 a qualified anthropometrist (Level 1, 2 or 3 ISAK qualified anthropometrist). It is also important that the same tester conduct each retest to ensure reliability where possible.
5.1.2 Test Procedure

- Measurement of height, body mass and skinfolds should be carried out prior to other fitness testing protocols.
- Stretch stature using Frankfort plane should be used.
- Athlete should remove shoes and weigh in minimal clothing.
- Skinfolds are recorded over 7 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.
- All measures should be made in accordance with protocols detailed by International Society for the Advancement of Kinanthropometry (ISAK) (Stewart, et al. 2011).
- More advanced anthropometric assessment including muscle girths, bone breadths and limb lengths can be conducted if required.

5.1.3 Data Analysis

An anthropometric assessment gives a detailed overview of a player’s body composition. Changes in body composition targeted through specific training and/or dietary interventions can be tracked through repeated anthropometric measures. Depending on the end goal, the focus should be on changes in lean muscle mass or skinfolds rather than purely on weight gains or losses.

5.1.4 Normative Data

The table below presents anthropometric normative data for female and male Judo athletes.
### Anthropometric data for national female and male Judo athletes (mean ± SD; range)

<table>
<thead>
<tr>
<th>Athlete category</th>
<th>Height, cm</th>
<th>Body Mass, kg</th>
<th>Σ7 Skinfolds, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 52kg (n=18)</td>
<td>160.8 ± 3.0 (151.4-166.1)</td>
<td>54.4 ± 3.1 (46.5-57.1)</td>
<td>64.1 ± 16.8 (30.8-100.5)</td>
</tr>
<tr>
<td>≤ 63kg (n=21)</td>
<td>165.2 ± 2.8 (160.2-168.8)</td>
<td>62.6 ± 3.7 (56.9-68.8)</td>
<td>77.0 ± 26.7 (40.7-142.4)</td>
</tr>
<tr>
<td>≤ 70kg (n=11)</td>
<td>168.3 ± 4.4 (161.4-178.0)</td>
<td>70.7 ± 6.3 (55.0-79.2)</td>
<td>89.8 ± 20.4 (57.3-119.7)</td>
</tr>
<tr>
<td>≤ 78kg (n=5)</td>
<td>173.2 ± 2.6 (171.2-177.4)</td>
<td>86.3 ± 3.7 (81.7-91.9)</td>
<td>147.4 ± 49.5 (99.2-224.3)</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 60kg (n=14)</td>
<td>165.9 ± 3.5 (156.3-170.6)</td>
<td>64.1 ± 2.8 (57.5-67.3)</td>
<td>46.9 ± 6.9 (35.1-61.0)</td>
</tr>
<tr>
<td>≤ 73kg (n=20)</td>
<td>173.0 ± 3.9 (169.5-183.6)</td>
<td>73.0 ± 3.3 (68.7-78.1)</td>
<td>52.0 ± 11.5 (39.3-89.5)</td>
</tr>
<tr>
<td>≤ 81kg (n=12)</td>
<td>181.8 ± 2.6 (178.5-185.9)</td>
<td>83.0 ± 2.6 (77.4-86.3)</td>
<td>48.1 ± 5.2 (42.4-57.1)</td>
</tr>
<tr>
<td>≤ 100kg (n=19)</td>
<td>187.0 ± 6.3 (176.1-194.9)</td>
<td>95.7 ± 4.3 (90.9-103.1)</td>
<td>70.1 ± 18.6 (47.7-126.8)</td>
</tr>
<tr>
<td>&gt; 100kg (n=10)</td>
<td>192.3 ± 8.8 (169.0-197.0)</td>
<td>122.9 ± 9.8 (103.8-138-5)</td>
<td>127.8 ± 50.0 (86.3-186.5)</td>
</tr>
</tbody>
</table>

**Typical Error:** Height = 1 cm; Body Mass = 1 kg; Σ7 Skinfolds = ~ 1.5 mm

Data source: AIS Physiology Judo results database, 2000-2012.

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### 5.2 Urine Specific Gravity

#### 5.2.1 Rationale

Urine specific gravity (USG) is a test that measures the concentration of chemical particles in the urine. This test helps evaluate the body's water balance and urine concentration. Normal values are between 1.001 and 1.035. Increased urine specific gravity is an indication of dehydration.
5.2.2 Test Procedure

- The athlete is required to provide a fresh urine sample in provided collection container as close to the time of testing as possible. Mix the sample well before testing.
- Wearing gloves, remove one test strip from sealed bottle. Replace lid and securely tightly.
- Dip the reagent strip into the urine sample ensuring all reagent pads are covered. Immediately remove the strip and start stopwatch.
- Drag the edge of the strip against the container rim to remove excess urine.
- At 45s, compare the urine specific gravity test pad to the specific gravity colour blocks on the bottle label. Hold the strip close to the colour blocks and match carefully.
- Record matching specific gravity reading.
5.2.3 Normative Data
The table below presents USG normative data for female and male Judo athletes.

USG data for national female and male Judo athletes
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Athlete category</th>
<th>Jump Height, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 52kg (n=14)</td>
<td>1.018 ± 0.008 (1.004-1.031)</td>
</tr>
<tr>
<td>≤ 63kg (n=20)</td>
<td>1.017 ± 0.008 (1.003-1.033)</td>
</tr>
<tr>
<td>≤ 70kg (n=8)</td>
<td>1.016 ± 0.005 (1.011-1.023)</td>
</tr>
<tr>
<td>≤ 78kg (n=4)</td>
<td>1.019 ± 0.010 (1.015-1.029)</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 60kg (n=11)</td>
<td>1.021 ± 0.006 (1.011-1.029)</td>
</tr>
<tr>
<td>≤ 73kg (n=19)</td>
<td>1.019 ±0.006 (1.013-1.030)</td>
</tr>
<tr>
<td>≤ 81kg (n=11)</td>
<td>1.019 ± 0.008 (1.007-1.029)</td>
</tr>
<tr>
<td>≤ 100kg (n=15)</td>
<td>1.023 ± 0.006 (1.011-1.030)</td>
</tr>
<tr>
<td>&gt; 100kg (n=5)</td>
<td>1.017 ± 0.004 (1.010-1.020)</td>
</tr>
</tbody>
</table>

Data source: AIS Physiology Judo results database, 2000-2012.

5.3 Vertical Jump
5.3.1 Rationale
The vertical jump test is an established measure of explosive and anaerobic power of the lower limbs and hips that is easy to perform, requires limited equipment, and is common to many power-related sports, allowing easy comparison.
5.3.2 Test Procedure

5.3.2.1 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. Record this as the standing reach height in centimetres.

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 centimetres.

5.3.2.2 Vertical Jump Height

i. The tester moves several of the lower vanes away before instructing the athlete to stand close to the Yardstick® for their jump.

ii. An arm swing and countermovement are used to jump as high as possible with the athlete displacing the vanes at the height of the jump.

iii. The take-off 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 centimetres (cm).

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; either 160, 170, 180 cm etc.) plus the highest vane displaced (e.g. vane 80 = 80 cm). Record this measure in centimetres.

5.3.3 Limitations

The test is affected by player motivation and individual technique (particularly in relation to the athlete hitting the vane at the peak of the jump).
5.3.4 Normative Data

Vertical jump normative data for female and male Judo athletes are presented in the table below.

Vertical jump data for national female and male Judo athletes (mean ± SD; range)

<table>
<thead>
<tr>
<th>Athlete category</th>
<th>Jump Height, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALE</td>
<td></td>
</tr>
<tr>
<td>≤ 52kg (n=17)</td>
<td>38.4 ± 5.4 (31-49)</td>
</tr>
<tr>
<td>≤ 63kg (n=20)</td>
<td>43.4 ± 5.7 (32-55)</td>
</tr>
<tr>
<td>≤ 70kg (n=12)</td>
<td>43.8 ± 9.2 (34-60)</td>
</tr>
<tr>
<td>≤ 78kg (n=4)</td>
<td>34.0 ± 3.9 (29-38)</td>
</tr>
<tr>
<td>MALE</td>
<td></td>
</tr>
<tr>
<td>≤ 60kg (n=14)</td>
<td>52.1 ± 8.1 (43-71)</td>
</tr>
<tr>
<td>≤ 73kg (n=20)</td>
<td>50.0 ± 7.2 (43-75)</td>
</tr>
<tr>
<td>≤ 81kg (n=12)</td>
<td>60.9 ± 9.3 (50-75)</td>
</tr>
<tr>
<td>≤ 100kg (n=19)</td>
<td>55.1 ± 6.0 (47-64)</td>
</tr>
<tr>
<td>&gt; 100kg (n=10)</td>
<td>44.7 ± 6.4 (38-61)</td>
</tr>
</tbody>
</table>

Data source: AIS Physiology Judo results database, 2000-2012.
5.4 Judo Specific Fitness Test

5.4.1 Rationale
This test is of an intermittent nature and simulates the intensity of ‘the fight’. The test indirectly evaluates the aerobic and anaerobic capacity of athletes and helps to determine the level of special motor efficiency. Its accuracy is attested by a correlation between the JSFT and the level of anaerobic capacity (measured by Wingate-test) and aerobic power ($\dot{V}O_2\text{max}$ in ml.kg.min$^{-1}$) as well as by the ranking of athletes.

5.4.2 Test Procedure
The test is divided into three periods, 15s (period A), 30s (period B) and 30s (period C) with an interval of 10s between each period. Two judokas (uke) of similar stature and body mass of the athlete being tested (same category) are positioned 6 m apart from each other. The test athlete (tori) starts between the judokas at the 3 m mark. During each period (A, B, C) the athlete runs between the judokas and performs as many throws (ippon-seoi-nage technique) as possible (see figure below). The total number of throws for each period is recorded. Additionally, immediately on completion of period C as well as 1 min post, heart rate is recorded.

i. Measure 6 m distance and mark it clearly with marking tape. Measure and mark the middle 3 m point.
ii. Fit heart rate monitor to athlete.
iii. Have test athlete perform a warm up. This should include a 5 min run at moderate intensity followed by some throws at a slow velocity so that they can adjust to the running distance and the uke.
iv. Position one judoka (uke) at each end of the 6 m distance.
v. When ready to commence, athlete should assume start position at 3 m mark (halfway in between the two ukes).
vii. Athlete should run as fast as possible (3 m) to one judoka, perform throw, then run as fast as possible (6 m) to judoka at opposite end and perform throw. Repeat as many times as possible for total time of 15s.

viii. After 15 s athlete should stop and reposition at start position. Record total number of throws completed for period A.

ix. Allow 10 s rest interval before repeating for periods B and C (both 30 s). Give 3,2,1 countdown and ‘go’ command before starting each period. A 10 s rest interval should be allowed between periods B and C.

x. Record total number of throws completed for periods B and C.

xi. Immediately on completion of period C, record heart rate. With stopwatch still running, record heart rate 1 min post completion of the test. Athlete should remain standing until after the 1 min post heart rate is recorded.

Contour of the *ippon-seoi-nage* technique (according to IWAI et al. 1977)

5.4.3 Data Analysis

The total of throws accomplished in each period should be added and JSFT index calculated according to the following equation:

\[
\text{JSFT Index} = \frac{(HR_{\text{end}} + HR_{1\text{min}})}{(\text{total throws for all periods})}
\]

For example:

\[
= \frac{(180 + 160)}{(7 + 12 + 11)}
\]

\[
= \frac{340}{30}
\]

\[
= 11.3
\]
5.4.4 Normative Data

Normative data for female and male Judo athletes for the judo specific fitness test are presented in the table below.

### JSFT data for national female and male Judo athletes

(mean ± SD; range)

<table>
<thead>
<tr>
<th>Athlete category</th>
<th>JSFT Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 52kg (n=12)</td>
<td>12.6 ± 1.1 (10.4-14.8)</td>
</tr>
<tr>
<td>≤ 63kg (n=20)</td>
<td>12.0 ± 1.2 (9.6-13.8)</td>
</tr>
<tr>
<td>≤ 70kg (n=12)</td>
<td>12.2 ± 0.6 (11.1-12.9)</td>
</tr>
<tr>
<td>≤ 78kg (n=3)</td>
<td>13.6 ± 1.7 (12.6-15.6)</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 60kg (n=12)</td>
<td>11.3 ± 1.0 (10.3-13.6)</td>
</tr>
<tr>
<td>≤ 73kg (n=17)</td>
<td>11.3 ± 0.9 (10.0-13.1)</td>
</tr>
<tr>
<td>≤ 81kg (n=7)</td>
<td>11.9 ± 0.8 (11.0-13.1)</td>
</tr>
<tr>
<td>≤ 100kg (n=16)</td>
<td>13.0 ± 1.5 (10.3-15.3)</td>
</tr>
<tr>
<td>&gt; 100kg (n=5)</td>
<td>12.8 ± 0.8 (11.7-13.7)</td>
</tr>
</tbody>
</table>

Data source: AIS Physiology Judo results database, 2000-2012.

5.5 Multistage Shuttle Run Test

5.5.1 Rationale

The multistage shuttle run test (MSRT) has been shown to provide a valid estimate of maximal oxygen consumption (Brewer et al. 1988; Leger and Lambert 1982; Ramsbottom et al. 1988) and has been used extensively for the field assessment of maximal oxygen consumption for more than 20 years. The MSRT is a continuous time-efficient test capable of assessing a whole team or squad simultaneously. Given a maximal effort by an athlete, the MSRT also allows for the reliable measurement of peak heart rate.
5.5.2 Test Procedure

i. Measure the 20 m distance and mark it clearly with marking tape and cones set at approximately 1.5 m intervals.

ii. Have athletes line up along one of the lines, ready to start.

iii. Start the CD and ensure the athletes listen carefully to the instructions. The commentary will provide a brief explanation of the test leading to a 5 s countdown before the start of the test itself. Begin the test at level 1.

iv. The CD emits a single ‘beep’ at various intervals. The athlete must try to be at the opposite end of the 20 m track by the time the following beep sounds. After approximately each min, the time interval between beeps decreases with running speed increasing accordingly.

v. The first running speed is referred to as “Level 1” and so on until the final speed at Level 21.

vi. The athlete must place one foot on or over the 20 m mark at the sound of each ‘beep’.

vii. If the athlete arrives at the line before the beep sounds, they should turn (by pivoting) and wait for the beep before continuing to the next line.

viii. If an athlete fails to reach the line at the sound of the ‘beep’ the athlete must receive a warning that they will be eliminated if they are not at the opposite end of the 20 m track at the sound of the next ‘beep’.

ix. When near exhaustion, athletes falling short of the 20 m line twice in succession (one warning and a subsequent missed line) have their test terminated and their score recorded. Their score is the level and number of shuttles immediately previous to the ‘beep’ on which they were eliminated.

x. Collection of additional indicators of maximal effort such as rating of perceived exertion (RPE), HR and blood lactate concentration can be done at the completion of the test.

xi. After completing the test athletes should cool down by walking followed by stretching.
5.5.1 Limitations
The test can be affected by player motivation, running and turning technique, and environmental conditions. A limitation of this test is that athletes must know how to push themselves to their physiological limit. The test is affected by player motivation, technique and environmental conditions.

5.5.2 Normative Data
The table below presents multistage shuttle run test normative data for female and male Judo athletes.

<table>
<thead>
<tr>
<th>Athlete category</th>
<th>Level / shuttle</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALE</td>
<td></td>
</tr>
<tr>
<td>≤ 52kg (n=15)</td>
<td>10/4 ± 1/3</td>
</tr>
<tr>
<td></td>
<td>(7/1-11/9)</td>
</tr>
<tr>
<td>≤ 63kg (n=16)</td>
<td>9/4 ± 1/3</td>
</tr>
<tr>
<td></td>
<td>(7/1-11/10)</td>
</tr>
<tr>
<td>≤ 70kg (n=9)</td>
<td>9/7 ± 1/4</td>
</tr>
<tr>
<td></td>
<td>(7/1-10/11)</td>
</tr>
<tr>
<td>≤ 78kg (n=4)</td>
<td>7/5 ± 0/3</td>
</tr>
<tr>
<td></td>
<td>(7/2-7/8)</td>
</tr>
<tr>
<td>MALE</td>
<td></td>
</tr>
<tr>
<td>≤ 60kg (n=13)</td>
<td>12/5 ± 1/3</td>
</tr>
<tr>
<td></td>
<td>(10/1-14/11)</td>
</tr>
<tr>
<td>≤ 73kg (n=18)</td>
<td>12/6 ± 1/3</td>
</tr>
<tr>
<td></td>
<td>(9/1-13/10)</td>
</tr>
<tr>
<td>≤ 81kg (n=9)</td>
<td>11/4 ± 1/3</td>
</tr>
<tr>
<td></td>
<td>(8/1-13/10)</td>
</tr>
<tr>
<td>≤ 100kg (n=19)</td>
<td>10/5 ± 1/3</td>
</tr>
<tr>
<td></td>
<td>(9/1-12/10)</td>
</tr>
<tr>
<td>&gt; 100kg (n=7)</td>
<td>8/5 ± 1/3</td>
</tr>
<tr>
<td></td>
<td>(7/1-9/9)</td>
</tr>
</tbody>
</table>

Data source: AIS Physiology Judo results database, 2000-2012.
There is a strong correlation \( r = 0.92, p < .01 \) between MSRT score and maximal oxygen consumption, and it is possible to predict maximal oxygen consumption \( (\dot{V}O_2\text{max}) \) from MSRT final level scores using the following regression (Ramsbottom et al. 1988):

\[
\text{Predicted } \dot{V}O_2\text{max} \ (\text{ml.kg}^{-1}.\text{min}^{-1}) = 14.4 + 3.48 \times \text{MSFT (shuttle level)}; \text{ sd } 3.5 \text{ ml.kg}^{-1}.\text{min}^{-1}.
\]

Athletes who score poorly on this test need additional endurance or aerobic training. Endurance fitness often improves substantially during the preseason period and is then maintained rather than improved during a long competitive season. Positional variation is common: Athletes who generally cover the most ground during competition score the best in this test.

Because the MSRT is a maximal test of approximately 1 min increments to exhaustion, it is possible to measure maximal heart rate values, generally during the final stages of this test. Unpublished TE data for this measure are 2 beats.min\(^{-1}\) (data provided by SA Sports Institute, \( N = 40 \)). Maximal heart rate can then be used to calculate and prescribe aerobic training intervals.

### 5.6 Rope Climb

#### 5.6.1 Rationale

Upper body strength and power underlie successful judo performance. The maintenance of a strong grip over the period of competition directly influences an athlete’s ability to execute throws. Furthermore, when seeking to throw an opponent, an athlete must be able to pull their opponent powerfully towards themselves. The Rope Climb tests an athlete’s ability to maintain grip over a period of time whilst examining the power the athlete can generate in a pulling motion.

#### 5.6.2 Test Procedure

- Starting at 1.0 m above the base floor level, measure and mark the rope at 1.0 m increments using one colour of electrical tape.
• Starting at 0.5 m above the initial 1.0 m marking, measure and mark the rope at 1.0 m increments with the second colour of electrical tape (creating alternate coloured markings every 0.5 m).
• Should the suspended rope not reach the floor, a base should be created by placing a knot at the bottom end of the rope. The base floor level is the top of the knot.
• The first 1.0 m marking denotes the starting hand placement for the test.

5.6.2.1 Test Procedure
i. Athlete should place chalk on both hands.
ii. Have athlete assume the starting position, seated on base with both feet extended, preferably in an open scissor position.
iii. Athlete should grip the rope at the 1st mark (1.0 m).
iv. Lift should be generated with upper body musculature only (i.e. both feet must clear the ground by the initial lifting only). Body sway should be kept to a minimum, and on ascent and decent the legs must not assist and remain open, preferably in an open scissor position.
v. The highest mark reached with the hand(s) is recorded to the closest 0.5 m increment. The maximum measured height is 4.0 m.
vi. The test stops and the result is recorded if:
• athlete releases their grip
• the floor base is used to rest momentarily
• legs or feet close together to squeeze the rope
vii. If a subsequent ascent is planned there must be a continuous action allowing a momentary hover at the change of direction without contact of the base. Both hands must be gripping the rope at the first mark before the next ascent.
viii. The total distance upward only is recorded in 0.5 m increments.
5.6.3 Normative Data

The table below presents rope climb test normative data for female and male Judo athletes.

Rope climb test data for national female and male Judo athletes
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Athlete category</th>
<th>Rope Climb, m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 52kg (n=17)</td>
<td>3.2 ± 1.7</td>
</tr>
<tr>
<td></td>
<td>(0.7-6.5)</td>
</tr>
<tr>
<td>≤ 63kg (n=19)</td>
<td>2.6 ± 1.7</td>
</tr>
<tr>
<td></td>
<td>(0.5-5.5)</td>
</tr>
<tr>
<td>≤ 70kg (n=9)</td>
<td>1.0 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>(0.5-1.8)</td>
</tr>
<tr>
<td>≤ 78kg (n=4)</td>
<td>0.7 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>(0.3-1.5)</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 60kg (n=13)</td>
<td>7.5 ± 2.2</td>
</tr>
<tr>
<td></td>
<td>(4.0-11.0)</td>
</tr>
<tr>
<td>≤ 73kg (n=18)</td>
<td>7.3 ± 2.2</td>
</tr>
<tr>
<td></td>
<td>(3.5-11.0)</td>
</tr>
<tr>
<td>≤ 81kg (n=10)</td>
<td>7.2 ± 3.6</td>
</tr>
<tr>
<td></td>
<td>(1.8-11.5)</td>
</tr>
<tr>
<td>≤ 100kg (n=19)</td>
<td>5.7 ± 2.8</td>
</tr>
<tr>
<td></td>
<td>(1.0-11.0)</td>
</tr>
<tr>
<td>&gt; 100kg (n=6)</td>
<td>1.8 ± 2.0</td>
</tr>
<tr>
<td></td>
<td>(0.5-6.0)</td>
</tr>
</tbody>
</table>

Data source: AIS Physiology Judo results database, 2000-2012.

5.7 Muscular Strength Tests

5.7.1 Rationale

Strength is a crucial quality for success in Judo. Absolute strength and power (regardless of body mass) are required to apply high forces quickly in contact situations. The back squat, bench press, and bench pull tests provide a useful index of whole body strength. All tests should be completed as 3 repetition maximum efforts (3RM) and should be completed in standardised order – squat, bench press, bench pull. The athlete’s coach or an accredited strength and conditioning coach should supervise all testing.
5.7.2 Test Procedure

The National strength protocols in use across Australian institutes and academies of sport suggest a general aerobic warm-up, followed by a specific warm-up consisting of 40% to 60% of specified RM for a maximum of 10 repetitions, a minimum of 2 min recovery, 60% to 80% of specified RM for a maximum of 5 repetitions, another rest of at least 2 min, 90% of specified RM for a maximum of 3 repetitions and an extended rest period of at least 5 min prior to the test set.

In addition to specifications regarding pretest preparation and warm-up, the National protocols include the following guidelines:

- Lowering and lifting actions must be performed in a continuous manner with a single rest of no more than 3 s allowed between repetitions.
- Maximum of 5 min recovery is allowed between test sets.
- Minimum weight increments should be dictated by equipment availability; however, increments smaller than the typical error of the test may not allow determination of a biological change.
- The athlete should aim to achieve the highest RM score in a maximum of four test trials.
- A designated spotter should be used for safety.

5.7.2.1 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 or 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 is beside the athlete to facilitate observation of hip and 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 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:**
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:
• Moving forward or sideways excessively during test
• Losing controlled spinal position
• Lifting heels off the floor
• Not lowering to required depth
• Raising hips prior to shoulder elevation
• Resting more than 3 s rest between repetitions.

5.7.2.2 **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 (both feet either on the floor or on the bench).
• Recommended assessor position is side on to the athlete to allow observation of feet, shoulders, and buttocks and visibility of the bar touching the athlete’s 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:**

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:

• 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 or ground so that it breaks contact
• Excessive deviation of bar from “normal” position (observed in warm-up)
• Uneven movement of the bar during the lift (shoulder elevation or uneven extension of arms during lift)
• Resting more than 3 s rest between repetitions.

5.7.2.3 Bench Pull

• Bench height is set so that the athlete can comfortably take the desired grip while the weight is off the ground in the hang 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.
• The recommended assessor position is side on to the athlete to allow observation of feet, knees, shoulders, and head and visibility of the bar touching the underside of the bench.
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 toward chest; adducted bench pull: bar is lifted toward navel).

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:

- Moving the head or legs from chosen start position (i.e., athlete may start with head down or to the side, but it must remain in this position and in contact with the bench at all times).
- Moving the trunk away from bench or any hip flexion or extension.
- Failing to make contact with bar on the bench.
- Excessive deviation of bar from ‘normal’ position observed in warm-up (i.e., maintain abducted or adducted position).
- Uneven movement of the bar during the lift (shoulder depression, uneven flexion of elbows during lift).
- Resting more than 3 s rest between repetitions.
5.7.3 Normative Data

The table below presents muscular strength test normative data for female and male Judo athletes.

**Muscular strength test data for national female and male Judo athletes**
(mean ± SD; range)

<table>
<thead>
<tr>
<th>Athlete category</th>
<th>Back Squat (kg)</th>
<th>Bench Press (kg)</th>
<th>Bench Pull (kg)</th>
<th>Total Tonnage (kg)</th>
<th>Strength Ranking (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 52kg (n=17)</td>
<td>80.7 ± 9.2</td>
<td>44.7 ± 8.9</td>
<td>47.8 ± 8.0</td>
<td>160.9 ± 41.5</td>
<td>2.6 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>(60.0-100.0)</td>
<td>(30.0-62.5)</td>
<td>(30.0-57.5)</td>
<td>(35.0-220.0)</td>
<td>(0.6-4.1)</td>
</tr>
<tr>
<td>≤ 63kg (n=21)</td>
<td>83.2 ± 14.5</td>
<td>46.5 ± 11.1</td>
<td>51.0 ± 9.9</td>
<td>176.5 ± 39.0</td>
<td>2.8 ±0.7</td>
</tr>
<tr>
<td></td>
<td>(60.0-110.0)</td>
<td>(30.0-67.5)</td>
<td>(35.0-70.0)</td>
<td>(85.0-247.5)</td>
<td>(0.5-3.7)</td>
</tr>
<tr>
<td>≤ 70kg (n=9)</td>
<td>87.2 ± 9.1</td>
<td>48.1 ± 4.3</td>
<td>55.6 ± 6.0</td>
<td>190.8 ± 16.5</td>
<td>2.5 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>(70.0-100.0)</td>
<td>(40.0-55.0)</td>
<td>(45.0-65.0)</td>
<td>(155.0-210.0)</td>
<td>(1.2-1.9)</td>
</tr>
<tr>
<td>≤ 78kg (n=5)</td>
<td>95 ± 15.4</td>
<td>53.0 ± 8.2</td>
<td>57.0 ± 2.1</td>
<td>205.0 ± 9.7</td>
<td>2.2 ± 0.6</td>
</tr>
<tr>
<td></td>
<td>(70.0-110.0)</td>
<td>(45.0-65.0)</td>
<td>(55.0-60.0)</td>
<td>(195.0-217.5)</td>
<td>(1.1-2.7)</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 60kg (n=13)</td>
<td>102.5 ± 14.2</td>
<td>75.6 ± 11.2</td>
<td>69.0 ± 3.6</td>
<td>233.5 ± 39.0</td>
<td>3.5 ± 0.9</td>
</tr>
<tr>
<td></td>
<td>(80.0-130.0)</td>
<td>(60.0-90.0)</td>
<td>(60.0-72.5)</td>
<td>(135.0-270.0)</td>
<td>(1.5-4.6)</td>
</tr>
<tr>
<td>≤ 73kg (n=18)</td>
<td>113.1 ± 23.3</td>
<td>86.7 ± 7.3</td>
<td>77.5 ± 6.6</td>
<td>277.2 ± 27.1</td>
<td>3.7 ± 0.6</td>
</tr>
<tr>
<td></td>
<td>(60.0-140.0)</td>
<td>(80.0-100.0)</td>
<td>(70.0-90.0)</td>
<td>(215.0-320.0)</td>
<td>(1.5-4.3)</td>
</tr>
<tr>
<td>≤ 81kg (n=10)</td>
<td>132.2 ± 24.8</td>
<td>97.5 ± 13.0</td>
<td>90.0 ± 15.1</td>
<td>306.5 ± 53.6</td>
<td>3.4 ± 0.7</td>
</tr>
<tr>
<td></td>
<td>(105.0-170.0)</td>
<td>(80.0-110.0)</td>
<td>(70.0-110.0)</td>
<td>(220.0-380.0)</td>
<td>(2.1-4.6)</td>
</tr>
<tr>
<td>≤ 100kg (n=19)</td>
<td>147.5 ± 28.2</td>
<td>111.3 ± 20.8</td>
<td>95.4 ± 12.5</td>
<td>354.2 ± 55.5</td>
<td>3.4 ± 0.9</td>
</tr>
<tr>
<td></td>
<td>(100.0-205.0)</td>
<td>(60.0-140.0)</td>
<td>(80.0-120.0)</td>
<td>(240.0-455.0)</td>
<td>(1.7-5.0)</td>
</tr>
<tr>
<td>&gt; 100kg (n=7)</td>
<td>154.3 ± 25.1</td>
<td>91.8 ± 12.6</td>
<td>96.4 ± 12.1</td>
<td>342.5 ± 45.0</td>
<td>2.6 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>(110.0-190.0)</td>
<td>(70.0-107.5)</td>
<td>(70.0-105.0)</td>
<td>(250.0-382.5)</td>
<td>(1.7-3.1)</td>
</tr>
</tbody>
</table>

Typical Error:

Data source: AIS Physiology Judo results database, 2000-2012.
6. References


