FITNESS TESTING FOR SWIMMING

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Fitness Testing for Swimming

Testing and measurement are the means of collecting information upon which subsequent training and performance evaluations and decisions are made.
Fitness Testing for Swimming

- Fitness is a vital part of success in swimming

- Many physical, physiological and psychological components combine to make 'good' swimmer

- The relevance of these components depends on race distance, age, sex, stroke swum, etc.

- Ideally, fitness tests used to access a swimmer should reliably and repeatedly duplicate these fitness components

- The interpretation of results should also be relative to the importance of the various fitness components as related to the swimmers specific situation (male/female, pre/post puberty, junior or senior swimmer, sprinter or distance swimmer, etc)
Fitness Testing for Swimming

- A swimmer is more than their 200 IM PB and 7x200 Step Test
- Swimming results alone offer very little information about your programme
- The more information you have about your swimmers, the better decisions you can make
- Complete assessment of a swimmer must include all relevant components necessary for success
Components of Swimming

Question: What is important in swimming success?

- Body Size and Composition
- Reaction Time
- Muscle Strength
- Muscular Endurance
- Power
- Speed
- Agility
- Flexibility
- Balance and Coordination
- Anaerobic Capacity
- Aerobic Capacity
- Technique
- Mental ‘toughness’
Components of Swimming

- **Body Size and Composition:**
  - Swimmers are usually tall and relatively lean
  - Some body fat is not a hindrance as it can add to buoyancy in the water

- **Reaction Time:**
  - Starts are very important, particularly over short distance events
  - The body's physical reaction time is not something that can usually be trained, though starting practice, technique and improvements in power can improve a swimmer's start

- **Strength and Power:**
  - Strength and power are important for explosive starts, and for fast and powerful turns

- **Anaerobic Capacity:**
  - The sprint swimming events rely heavily on the anaerobic system

- **Aerobic Capacity:**
  - Cardiovascular endurance is arguably the most important physiological factor in swimming success
Components of Swimming

- **Agility:**
  - Brings together a range of attributes, such as strength, speed, balance, coordination. Vital in any good athlete.

- **Flexibility:**
  - Greater range of motion and general flexibility will improve technique, training effectiveness and recovery in your swimmers.

- **Balance and Coordination:**
  - Can the swimmer maintain a state of equilibrium (balance) in a static position?
  - Vital for maintaining correct body shape or 'Swimming Signature' in all events.
  - Good eye/hand coordination is a basic requirement of all sports, even swimming!

- **Psychological:**
  - Is the swimmer up to the task, or too anxious to perform? Not discussed here.

- **Technique:**
  - The number one important component for swimming success - also not discussed here.
Testing the Complete Swimmer

<table>
<thead>
<tr>
<th>Fitness Component</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic Endurance</td>
<td>CSS, 7 x 200 Step Test, Pulse Plot Test</td>
</tr>
<tr>
<td>Anaerobic Endurance</td>
<td>Sprint Index Test (SIT)</td>
</tr>
<tr>
<td>Body Composition</td>
<td>Body Fat Percentage</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Sit and Reach Test</td>
</tr>
<tr>
<td>Core Strength</td>
<td>Core Muscle Strength Stability Test</td>
</tr>
<tr>
<td>Elastic Strength</td>
<td>Standing Long Jump Test</td>
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<td>Eye Hand Coordination Test</td>
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<td>Reaction Time</td>
<td>Ruler Drop Test</td>
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<td>Agility</td>
<td>Lateral Change of Direction Test</td>
</tr>
</tbody>
</table>
Swimming Specific Tests

• Aerobic Capacity Tests
  – Critical Swim Speed (CSS) Test
  – 7 x 200 Step Test

• Anaerobic Capacity Test
  – Sprint Index Test (SIT)

• Training Adaptation Test
  – Pulse Plot Test
Purpose:
– The objective of the Critical Swim Speed (CSS) test is to monitor the athlete’s Aerobic Capacity (Ginn 1993)

Gives You:
– CSS value can be used to determine goal training times for the swimmer
– Repeat Distance / CSS = goal time (sec)
– E.g. 400m training swim for a swimmer with CSS of 1.28m/s yields a goal time of 312.5sec = 5:12.5
– Training at or just below this pace yields significant aerobic training adaptations
– If swimmers CSS, or speed at threshold increases, race performance will improve
Critical Swim Speed (CSS)

- **Equipment:**
  - Pool
  - Stopwatch

- **Method:**
  - 2 Methods commonly used
  - 400m + 50m and 400m + 200m
  - Swim 400m (D1) all out, record time (T1). Rest 10min, then swim 50/200m (D2) all out and record time (T2)
  - CSS = (D2-D1) / (T2-T1)
  - Compare result with swimmer’s previous results for this test.
  - With effective training between each test, results would show improvement in the athlete’s lactate threshold and critical swim speed
Critical Swim Speed (CSS)

• Who Is It For?
  – Experienced swimmers (male and female), who are brave enough to push

• Is It a Reliable Test?
  – CSS has been shown to be a valid measure of a swimmer's aerobic capacity
  – CSS speed is also about 80-85% of 100m PB, and 90-95% of 400m PB
7 X 200 Step Test

- **Purpose:**
  - To test *Aerobic Capacity* during normal swimming

- **Gives you:**
  - Heart rate/Velocity curve or a Lactate/Velocity curve
  - Changes in these are used to monitor changes in swimming specific Aerobic fitness
  - A good estimate of Anaerobic Threshold from the graphs
7 X 200 Step Test

- **Advantages:**
  - The detailed measurements provide great feedback to the coach and swimmer

- **Disadvantages:**
  - The equipment and assistants required make this a costly and time consuming test
7 X 200 Step Test

**Equipment:**
- 25m or 50m Pool
- Pace Clock
- Stopwatch
- Lactate Tester
- Heart Rate Monitor

**Record:**
- All splits and total times
- Stroke rate (strokes/min)
- Strokes per length
- RPE (scale of 6-20) and heart rate after each swim, AND
- Lactate measure at 3min after each swim
7 X 200 Step Test

Method:
- Take the swimmers 200m PB (eg 1:55)
- Add 5sec to account for push-off start and that it's a training situation, to estimate the time for the final max effort swim (No. 7) (eg 1:55 + 5sec = 2:00)
- Working in reverse order from the 7th swim, add 5sec for each subsequent interval to establish the test goals, for example:

<table>
<thead>
<tr>
<th>Repeat</th>
<th>Goal Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>1:55 + :35 = 2:30</td>
</tr>
<tr>
<td>No. 2</td>
<td>1:55 + :30 = 2:25</td>
</tr>
<tr>
<td>No. 3</td>
<td>1:55 + :25 = 2:20</td>
</tr>
<tr>
<td>No. 4</td>
<td>1:55 + :20 = 2:15</td>
</tr>
<tr>
<td>No. 5</td>
<td>1:55 + :15 = 2:10</td>
</tr>
<tr>
<td>No. 6</td>
<td>1:55 + :10 = 2:05</td>
</tr>
<tr>
<td>No. 7</td>
<td>1:55 + :05 = 2:00</td>
</tr>
</tbody>
</table>
7 X 200 Step Test

- **Who Is It For?**
  - Experienced swimmers (male and female), who have good pacing ability

- **Is It a Reliable Test?**
  - As it relies on good pacing ability of the swimmers, practice will improve this, as well improve the reliability of your results
Pulse Plot Test

- **Purpose:**
  - To test the effectiveness of the training programme by measuring *Training Adaptation*

- **Gives You:**
  - Heart Rate vs. Speed graph
  - For a given speed, a more conditioned swimmer will have a lower heart rate, and a faster recovery than a less conditioned swimmer
  - By watching the shift of the resultant curve, the coach can determine training effectiveness, and even catch overtraining before it’s critical
Pulse Plot Test

- **Equipment:**
  - Pool
  - Stopwatch
  - Heart Rate Monitor (or use a manual measure)
  - Recording Sheet

- **Record:**
  - Time for each swim
  - Heart Rate at the end of each swim, as well as after 30sec and 1min after each swim
Pulse Plot Test

- **Method:**
  - Swim 8 x 100m on 4:30 in Main Stroke
  - Effort of each swim is 70 - 80 - 90 - 100 - 100 - 90 - 80 - 70
  - Swimmer measures heart rate on completion of swim (6 or 10sec count), at :30 and again at 1:00
  - Time for the swim is recorded in seconds
  - Plot Total Heart Rate against Speed (m/s)
  - Draw a 'best fit' line and compare this to previous tests
  - Shift to Left = Overtraining
  - Shift to Right = Desirable Training Adaptation
Pulse Plot Test

• Who Is It For?
  – Experienced swimmers (male and female), who have good pacing and heart rate reporting ability

• Is It a Reliable Test?
  – As it relies on good pacing ability and accurate heart rate reporting by the swimmers, practice will improve this, as well as improve the reliability of your results
Sprint Index Test

• Purpose:
  – To measure a swimmer's Anaerobic Capacity

• Gives You:
  – An easy and quick index of a swimmer's ability to maintain performance in the Anaerobic range
  – The lower the index score, the better the swimmer copes with anaerobic activity
Sprint Index Test

- **Equipment:**
  - 25m Pool
  - Stopwatch

- **Method:**
  - 6 x 12.5m or 15m all out sprints from a pushoff, swimming easy to 25m on :30
  - Time each effort as accurately as possible - use markers on lane ropes and pool side to make timing accurate
  - Record the swimmer's weight
Sprint Index Test

• Calculate:

Sprint Index (SI) = \( \text{Weight} \times \text{Distance}^2 \div \text{Time}^3 \)

Velocity = \( \frac{\text{Distance}}{\text{Time}} \)

Fatigue Index = \( \frac{(\text{Max SI} - \text{Min SI})}{\text{Total Time}} \) = 0.405

<table>
<thead>
<tr>
<th>Sprint #</th>
<th>Time</th>
<th>Velocity</th>
<th>Sprint Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.43</td>
<td>2.02</td>
<td>39.06</td>
</tr>
<tr>
<td>2</td>
<td>6.74</td>
<td>2.23</td>
<td>52.32</td>
</tr>
<tr>
<td>3</td>
<td>7.09</td>
<td>2.12</td>
<td>44.95</td>
</tr>
<tr>
<td>4</td>
<td>7.52</td>
<td>1.99</td>
<td>37.67</td>
</tr>
<tr>
<td>5</td>
<td>7.31</td>
<td>2.05</td>
<td>41.01</td>
</tr>
<tr>
<td>6</td>
<td>7.74</td>
<td>1.94</td>
<td>34.55</td>
</tr>
</tbody>
</table>
Sprint Index Test

- **Assessment:**
  - Compare the swimmer's results to previous tests
  - Appropriate and effective training will:
    - Increase in the swimmers Average Velocity
    - Increase the SI scores for MaxSI, MinSI and Average SI
    - Decrease the Fatigue Index
General Population Tests

These tests are **land based** and are not sports specific

- Advantage is that large populations have been tested and meaningful norms and percentiles exist against which you can compare your swimmers
- Generally, these tests are easy to administer, require little or no specialist equipment, and are not overly time consuming
Bodyfat Percentage Test

• **Purpose:**
  - To measure the swimmer's level of body fat and hence their *Body Composition*

• **Normative Data:**
  - The average healthy man has 15-17% body fat
  - The average healthy woman has 18-22% body fat
  - Elite level male swimmers have 9-13% body fat
  - Elite level female swimmers have 14-24% body fat
Bodyfat Percentage Test

- **Method:**
  - A set of calipers is used to measure the thickness of the skinfold on the right side of the body at:
    - Triceps, vertical skinfold midway between the shoulder and the elbow on the back of the arm
    - Biceps, vertical skinfold midway between the shoulder and the elbow on the front of the arm
    - Subscapula, diagonal skinfold just below the scapula
    - Suprailiac, diagonal skinfold just above the hip bone
  - Total all measurements, and refer to body fat composition tables to determine body fat percentage
Sit and Reach Test

• **Purpose:**
  – To measure lower back and hamstring **Flexibility** as an indicator of general flexibility

• **Method:**
  – Secure a ruler to the top of a box so the 15cm mark on the ruler is in line with the front of the box, with the zero end pointing toward the swimmer
  – Swimmer sits on the floor with straight legs and their bare feet up against the box
  – Placing one hand on top of the other, the swimmer slowly reaches as far forward as possible, and holds the position for at least 2sec - bouncing not allowed!
  – Record the distance on the ruler reached by the fingertips
  – Perform the test 3 times, and use the average for assessment
Sit and Reach Test

• Normative Data:
  – The test is widely used, and normative data exists for many specific populations
  – For example, American National Norms for 16 - 19 years olds:

<table>
<thead>
<tr>
<th>Sex</th>
<th>Excellent</th>
<th>Above Average</th>
<th>Average</th>
<th>Below Average</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>&gt; 14cm</td>
<td>11.0 - 14.0cm</td>
<td>7.0 - 10.9cm</td>
<td>4.0 - 6.9cm</td>
<td>&lt; 4cm</td>
</tr>
<tr>
<td>Female</td>
<td>&gt; 15cm</td>
<td>12.0 - 15.0cm</td>
<td>7.0 - 11.9cm</td>
<td>4.0 - 6.9cm</td>
<td>&lt; 4cm</td>
</tr>
</tbody>
</table>
Core and Stability Test

• Purpose:
  – To monitor the development of the swimmer's abdominal and lower back muscles, or their Core Strength

• Gives You:
  – A measure of core strength
  – Poor core strength will lead to instability and wasting energy
  – Good core strength means your swimmer can move with a high degree of efficiency
Core and Stability Test

- **Method:**
  - Stage 1 - hold start position for 30sec
  - Stage 2 - lift right arm off ground, extend to the front and hold parallel to the ground for 15sec
  - Stage 3 - return to start, lift left arm as before and hold for 15sec
  - Stage 4 - Return to start, lift and extend right leg parallel to the ground and hold for 15sec
  - Stage 5 - Return to start, lift and extend left leg parallel to the ground and hold for 15sec
  - Stage 6 - Return to start, lift left arm and right leg parallel to the ground and hold for 15sec
  - Stage 7 - Return to start, lift right arm and left leg parallel to the ground and hold for 15sec
  - Stage 8 - Return to start, hold this position for a further 30sec
  - Stage 9 - End of Test
Core and Stability Test

- **Result:**
  - The swimmers score corresponds to the last *completed* position
  - If the swimmer can't complete the test, core strength is lacking and should be brought into the training programme 2-3 times per week until the test can be completed
Standing Long Jump Test

**Purpose:**
- To measure progression in a swimmer’s *Elastic Leg Strength* useful for starts and turns

**Gives You:**
- Results that can be compared to normative data from several general or specific populations
- Information about the potential explosive leg power of your swimmer, and hence allows informed decisions about training intervention
Standing Long Jump Test

- **Equipment:**
  - A hard place to take off
  - A soft place to land
  - Tape measure

- **Method:**
  - Swimmer warms up for 10min
  - From a stationary position, the swimmer crouches down and, using both arms and legs, jumps as far as possible, landing on both feet.
  - Measure the distance from the toe position at launch to the heel position at landing
  - Repeat the test 3 times, using the longest jump to calculate results
Standing Long Jump Test

• **Who is it For?**
  – Anyone aged 14 and over

• **Is it a Reliable Test:**
  – The test is used by sports and education institutions all over the world and the normative data is highly reliable

<table>
<thead>
<tr>
<th>15-16 yrs</th>
<th>Excellent</th>
<th>Above Average</th>
<th>Average</th>
<th>Below Average</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>&gt; 2.01m</td>
<td>2.00 - 1.86m</td>
<td>1.85 - 1.76m</td>
<td>1.75 - 1.65m</td>
<td>&lt; 1.65m</td>
</tr>
<tr>
<td>Female</td>
<td>&gt; 1.66m</td>
<td>1.65 - 1.56m</td>
<td>1.55 - 1.46m</td>
<td>1.45 - 1.35m</td>
<td>&lt; 1.35m</td>
</tr>
</tbody>
</table>

The world record for the standing long jump was held by Norwegian Arne Tvervaag who, in 1968, jumped 3.71 meters! That was beaten in February this year by Dallas Cowboys corner-back Byron Jones who jumped 3.73m.
Standing Stork Test - Blind

• Purpose:
  – To test the swimmer's ability to \textit{Balance} in a static position, and balance endurance

• Gives You:
  – The test will highlight balance issues which should be addressed. If a swimmer has weak balance on one foot you must work to correct this as this can cause them to become injury prone, develop stroke defects or muscle imbalances
Standing Stork Test - Blind

Method:

- After a warm up, the swimmer comfortably stands on both feet
- Lift the right foot and place it against the inner left knee, and close the eyes
- On 'Go' the swimmer raises the heel of the left foot and stands on their toes and holds the position for as long as possible
- Stop timing when left heel touches the floor, or right foot moves away from the left knee
- Record the time achieved, while the swimmer rests for 3min
- Repeat the test for the other side
- After repeating the test 3 times, use the longest time recorded to assess the swimmer
Standing Stork Test - Blind

- Normative Data:
  - Data exists for many specific populations as this test is used globally
  - As an example, 16-19 year olds:

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Above Average</th>
<th>Average</th>
<th>Below Average</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>&gt; 50sec</td>
<td>41 - 49sec</td>
<td>31 - 40sec</td>
<td>20 - 30sec</td>
<td>&lt; 20sec</td>
</tr>
<tr>
<td>Female</td>
<td>&gt; 30sec</td>
<td>23 - 29sec</td>
<td>16 - 22sec</td>
<td>10 - 15sec</td>
<td>&lt; 10sec</td>
</tr>
</tbody>
</table>
Hand-Eye Test

• Purpose:
  – To monitor the ability of the athlete's vision system to coordinate the information received through the eyes to control, guide, and direct the hands in the accomplishment of catching a ball - **Hand-Eye Coordination**
  – Hand-Eye coordination is important in all sports
Hand-Eye Test

- **Method:**
  - You'll need a tennis ball, a stopwatch and a smooth wall
  - Swimmer stands 2m away from the wall
  - On 'Go' the stopwatch is started and the swimmer throws the ball against the wall with the right hand, catches with the left, throws with the left, catches with right, etc.
  - Cycle is repeated for 30sec
  - Count the number of catches
  - Compare the swimmer's score with normative data for their population, eg:

<table>
<thead>
<tr>
<th>Age</th>
<th>High Score</th>
<th>Above Average</th>
<th>Average</th>
<th>Below Average</th>
<th>Low Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-16 years</td>
<td>&gt; 35</td>
<td>30 - 35</td>
<td>25 - 29</td>
<td>20 - 24</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>
Ruler Drop Test

- **Purpose:**
  - To test a swimmer’s *Reaction Time*

- **Method:**
  - Using a centimeter ruler, hold the ruler between the extended index and forefinger of the swimmer’s dominant hand, so that the zero mark of the ruler aligns with the top of the subject’s thumb.
  - Instruct the swimmer to catch the ruler as soon as possible after it has been released.
  - Release the ruler, and the swimmer catches it as soon as they can.
  - Record the measure on the ruler, level with the top of the thumb, where the ruler has been caught.
  - Repeat the test 3 times, and average the result for assessment.
Ruler Drop Test

• **Normative Data:**
  - This is a widely used test, and normative data exists across many specialist populations, eg. elite athletes, kids, teens, the elderly, Tibetan monks etc.
  - American National Norms for 16 to 19 year olds are:-

<table>
<thead>
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<th>Below Average</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 7.5cm</td>
<td>7.5 - 15.9cm</td>
<td>15.9 - 20.4cm</td>
<td>20.4 - 28cm</td>
<td>&gt; 28cm</td>
</tr>
</tbody>
</table>
Lateral Change of Direction Test

• **Purpose:**
  - To measure the swimmers speed with directional change - *Agility*
  - The test brings together a host of fitness components - balance, core strength, hand-eye coordination, flexibility, reaction time and elastic strength
  - The better a swimmer can score on each component, the better their performance will be on this test

• **Equipment:**
  - A flat, non-slip surface
  - 3 cones
  - Stopwatch
Lateral Change of Direction Test

Method:
- Place 3 cones 5m apart in a straight line
- Start from the middle cone, facing the recorder
- On 'Go' the swimmer runs to a far cone and touches it, then runs past the middle cone to other cone, touches that and returns to and touches the middle cone
- The time taken to go from the middle, to the left, across to the right and back to the middle is recorded
- Run the test 4 times, twice in each starting direction (left and right)
**Lateral Change of Direction Test**

- **Normative Data:**
  - The following table is based on test results from world class athletes across a host of sports:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>91 - 100</td>
<td>2.90 - 3.05sec</td>
<td>3.22 - 3.37sec</td>
</tr>
<tr>
<td>81 - 90</td>
<td>3.06 - 3.21sec</td>
<td>3.38 - 3.53sec</td>
</tr>
<tr>
<td>71 - 80</td>
<td>3.22 - 3.37sec</td>
<td>3.54 - 3.69sec</td>
</tr>
<tr>
<td>61 - 70</td>
<td>3.38 - 3.53sec</td>
<td>3.70 - 3.85sec</td>
</tr>
<tr>
<td>51 - 60</td>
<td>3.54 - 3.69sec</td>
<td>3.86 - 4.01sec</td>
</tr>
<tr>
<td>41 - 50</td>
<td>3.70 - 3.85sec</td>
<td>4.02 - 4.17sec</td>
</tr>
<tr>
<td>31 - 40</td>
<td>3.86 - 4.01sec</td>
<td>4.18 - 4.33sec</td>
</tr>
<tr>
<td>21 - 30</td>
<td>4.02 - 4.17sec</td>
<td>4.34 - 4.49sec</td>
</tr>
<tr>
<td>11 - 20</td>
<td>4.18 - 4.33sec</td>
<td>4.50 - 4.65sec</td>
</tr>
<tr>
<td>1 - 10</td>
<td>4.34 - 4.49sec</td>
<td>4.66 - 4.81sec</td>
</tr>
</tbody>
</table>
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