Once the components of fitness have been identified we must know how to measure them. It is obvious that any evaluation of training will depend on the measure of progress shown from one level of fitness to another. For that reason it is sensible to measure the level of fitness prior to the training programme.

The most effective method of evaluating the effects of training is by performance in play. Ultimately, this is what really matters. Playing performance, however, is sometimes difficult to measure for it is influenced by many other factors such as personal skills level and the ability of the opponent. In view of this it is helpful to have an indication of levels of fitness which are independent of the game. It is also necessary to isolate each component and to establish the player's relative strengths and weaknesses and check if training has changed these.

Fitness can be evaluated by many tests and so we have selected the following for ease of administration and simplicity of equipment. These can be carried out in a hall or gymnasium lacking in equipment and are designed to measure each component of fitness. When evaluating these components it is important to have an adequate rest between each test. The order of the tests must be carefully arranged to prevent fatigue in any one component especially if all the tests are to be completed in one session. It is essential that players do not undertake physical work if there is any suspicion of illness or disease. Refer to the section on medical advice on page 99.

FITNESS TESTING PROCEDURE

Before commencing the tests, make out a fitness test card to record the results, as shown overleaf. Write in the date and then record the result obtained for each test. Regular testing with a record of results will provide an accurate indication of fitness progress and confirm or question the value of the training programme.
Agility run

This test involves a timed run over a clearly defined course on one half of the badminton court.
The player carries a racket and is required to touch each corner of the half court. He starts from A and sprints to B, C and D and returns to A to repeat the course a second time. His time for the two circuits is recorded to the nearest one-tenth second.

Figure 4.1 Agility test

Local muscular endurance
This varies according to the muscle groups to be tested. Three tests are described, one for each of the local muscle groups, i.e. arms, legs and abdominals. Usually, to give a clear indication of endurance, unlimited time should be allowed to complete the activity. As this would prolong the testing session, a time limit has been imposed. Although a time will tend to introduce an element of speed into the test it will not be sufficient to reduce the effectiveness of the test for local muscular endurance.

1 LEG ENDURANCE
This exercise is known as a 'squat--thrust'.
Method: The player starts in the press-up position with the legs fully extended. The hands remain fixed throughout the exercise. On the command 'Go' the player springs forward to land with his knees level with his arms and then jumps back to return his legs to the fully extended position. This is one squat-thrust. He repeats this continuously for as many times as possible within the 60 seconds. It is advisable to have a second person counting and checking that the movement is completed properly.

Figure 4.2 Squat-thrust
2 ABDOMINAL ENDURANCE
This exercise is known as a `sit-up'.

*Method:* The player lies on his back with the hands clasped behind his head. He sits up to touch his right elbow to his left knee and returns to the lying position. He repeats the movement to touch his left elbow to his right knee. This alternating sit-up is repeated continuously as many times as possible in 60 seconds.

![Figure 4.3 Sit-up](image)

3 ARM ENDURANCE
This exercise is the 'net-smash'.

*Method:* The player adopts a net attack position. The arm is flexed at right-angles, racket-head pointing upwards ready to hit down above the net. The player performs a hitting action which involves a rapid extension of the arm and a return to the 90-degree flexed position on each hit. He repeats this as many times as possible in 30 seconds.

![Figure 4.4 Net-smash](image)

**Cardiovascular endurance**

1 TWELVE-MINUTE RUN

*Method:* One of the simplest tests to administer if suitable facilities are available is to measure the distance run in 12 minutes. An athletics track or clearly marked running field is ideal. Distances can also be measured on any flat surface of measurable length or overall size. The advantage of the 12-minute run is that fitness standards have been published as opposite.
Twelve-Minute Test for Menu
(Distances in miles covered in 12 minutes)

<table>
<thead>
<tr>
<th>Fitness category</th>
<th>Under 30</th>
<th>30–9</th>
<th>40–9</th>
<th>50+</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Very poor</td>
<td>&lt;1.0</td>
<td>&lt;0.95</td>
<td>&lt;0.85</td>
<td>&lt;0.80</td>
</tr>
<tr>
<td>II Poor</td>
<td>1.0–1.24</td>
<td>0.95–1.14</td>
<td>0.85–1.04</td>
<td>0.80–0.99</td>
</tr>
<tr>
<td>III Fair</td>
<td>1.25–1.49</td>
<td>1.15–1.39</td>
<td>1.05–1.29</td>
<td>1.0–1.24</td>
</tr>
<tr>
<td>IV Good</td>
<td>1.50–1.74</td>
<td>1.40–1.64</td>
<td>1.30–1.54</td>
<td>1.25–1.49</td>
</tr>
<tr>
<td>V Excellent</td>
<td>1.75+</td>
<td>1.65+</td>
<td>1.55+</td>
<td>1.50+</td>
</tr>
</tbody>
</table>

< Means less than

Twelve-Minute Test for Women
(Distances in miles covered in 12 minutes)

<table>
<thead>
<tr>
<th>Fitness category</th>
<th>Under 30</th>
<th>30–9</th>
<th>40–9</th>
<th>50+</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Very poor</td>
<td>&lt;0.95</td>
<td>&lt;0.85</td>
<td>&lt;0.75</td>
<td>&lt;0.65</td>
</tr>
<tr>
<td>II Poor</td>
<td>0.95–1.14</td>
<td>0.85–1.04</td>
<td>0.75–0.94</td>
<td>0.65–0.84</td>
</tr>
<tr>
<td>III Fair</td>
<td>1.15–1.34</td>
<td>1.05–1.24</td>
<td>0.95–1.14</td>
<td>0.85–1.04</td>
</tr>
<tr>
<td>IV Good</td>
<td>1.35–1.64</td>
<td>1.25–1.54</td>
<td>1.15–1.44</td>
<td>1.05–1.34</td>
</tr>
<tr>
<td>V Excellent</td>
<td>1.65+</td>
<td>1.55+</td>
<td>1.45+</td>
<td>1.35+</td>
</tr>
</tbody>
</table>

2 THE 1.5-MILE TEST

Method: Run a distance of 1.5 miles and record the time taken. Check for your fitness level on the table below. The test can be completed on a running track or measured quite easily on the road using the car mileometer.

1.5-Mile test*
(Running time in minutes for 1.5-mile distance)

<table>
<thead>
<tr>
<th>Fitness category</th>
<th>Under 30</th>
<th>30–9</th>
<th>40–9</th>
<th>50+</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Very poor</td>
<td>16:30+</td>
<td>17:30+</td>
<td>18:30+</td>
<td>19:30+</td>
</tr>
<tr>
<td>II Poor</td>
<td>16:30–</td>
<td>17:30–</td>
<td>18:30–</td>
<td>19:30–</td>
</tr>
<tr>
<td>III Fair</td>
<td>14:31</td>
<td>15:31</td>
<td>16:31</td>
<td>17:01</td>
</tr>
<tr>
<td>IV Good</td>
<td>14:30–</td>
<td>15:30–</td>
<td>16:30–</td>
<td>17:00–</td>
</tr>
<tr>
<td>V Excellent</td>
<td>&lt;10:15</td>
<td>&lt;11:00</td>
<td>&lt;11:30</td>
<td>&lt;12:00</td>
</tr>
</tbody>
</table>

3 HARVARD STEP-TEST INDEX

Method: This is an alternative method, devised at Harvard University, which requires minimal equipment and is based on the fact that a person with good cardiovascular endurance will return more quickly to a slower heart rate after exercise than will a person with poor cardiovascular endurance. The subject steps up and down, on and off a chair or bench for 5 minutes at a rate of 30 steps per minute. Ideally a bench 20 inches high for men and 16 inches high for women is used. This height is not important providing the height is the same on each testing occasion. At the end of the period of exercise the player sits down and waits for exactly one minute. Immediately he counts his heart beats for a period of exactly 30 seconds by placing his fingers on the carotid pulse in the neck as shown in Figure 1.4 on page 20. The number of heart beats is put into the following formula and the test score is calculated.

\[
\text{number of seconds of exercise} \times 100
\]

\[
\frac{5.5 \times \text{number of heart beats in 30 seconds}}{}
\]

If the player fails to maintain the stepping rate of 30 steps per minute he sits down and records the 1 minute recovery from then. In this case it is important to have noted the number of seconds of the exercise that was completed before stopping.

To ensure that any later test would involve an identical work load, the stepping rate must be kept constant at 30 steps per minute (up and down in rhythm 30 times per minute). One of the simplest ways of doing this is to use a partner to call out the stepping rate. A further standardization procedure is to make certain that the legs are fully extended at the knee-joint when standing on the chair or bench. The following table provides a rough guide for standards of performance after a period of training.

<table>
<thead>
<tr>
<th>Performance</th>
<th>Step test score</th>
</tr>
</thead>
<tbody>
<tr>
<td>good</td>
<td>81 and above</td>
</tr>
<tr>
<td>average</td>
<td>50-80</td>
</tr>
<tr>
<td>poor</td>
<td>49 and below</td>
</tr>
</tbody>
</table>

Examples
1 A player who stepped up and down for 5 minutes (300 seconds) and
had a heart-beat count of 50 in the timed period of 30 seconds would score:

\[
\frac{300 \times 100}{5.5 \times 50} = 109 \text{ (a good score)}
\]

2 A player who only managed to step up and down for 3 minutes and 15 seconds (195 seconds) and had a heart-beat count of 73 after the timed period would score:

\[
\frac{195 \times 100}{5.5 \times 73} = 48 \text{ (a poor score)}
\]

**Strength**
Strength is usually measured with a special machine called a dynanometer. However, as these machines are not readily available, the following methods can be used.

1 GRIP STRENGTH
*Method:* One simple way to test grip strength is to grasp a pair of bath-room scales to give a reading on the dial.

2 ARM STRENGTH
This can be measured in several ways.

*Method 1:* Pull-ups. Count the number of pull-ups (chins) completed by lifting the body weight up to a high bar. Start with extended arms, pull up to chin the bar and extend the arms again. This is one pull-up.

*Note:* The bar should be over-grasped with the palms facing forwards.

![Figure 4.5 Pull-up](image)
Method 2: Dips. Rest supported between a pair of parallel bars. Flex the arms to 90 degrees and straighten them. This is one dip. Count the maximum number you can perform.

![Figure 4.6 Dip](image)

Method 3: Press-ups. These are also a good indication of arm strength. Note: For women a modified version of the pull-ups and press-ups can be attempted. In both exercises shown some of the load on the arms can be reduced. Pull-up. Lower the bar so that the heels rest on the ground in the starting position.

![Figure 4.7 Modified pull-up for women](image)

Press-up. Perform the press-up in a kneeling position. Make certain that the shoulders are directly above the hands and the chin touches the ground ahead of the hands when lowering the body. To equate players of different body weights the arm-strength index can be calculated. See Appendix I on page 120.

![Figure 4.8 Modified press-up for women](image)
Power
As stated in the previous chapter, power is more relevant to badminton than pure strength. Leg-power, in particular, is very important. This can be measured by recording the height a player can jump above his normal reach height. The test is the Sargent jump (see Figure 4.9).
Method: Face a wall and stretch both hands upwards against the wall. Mark the stretch height. Chalk the finger-tips of the dominant hand. Stand sideways to the wall and prepare to jump upwards. Jump and touch the wall to leave a chalk mark at the highest point. The difference between the first mark and the chalk mark is measured. This is the jump height. A good indication of leg power is obtained if the result is related to the body weight.

Speed
The test is a short sprint.
Method: Record the time taken to run a straight 50 yards. A maximum of 50 yards is recommended particularly as the shorter distances are more applicable to badminton. The run is usually performed out of doors. If this is not possible the badminton hall can be used as an alternative. This may involve some turns and introduce the element of agility, so it is more suitable to run the length of the hall than the width.

Flexibility
A general indication of flexibility is to test spinal flexibility. There are several possible methods.
I STAND AND REACH TOES
Method: Take a chair and fix a ruler vertically at the front with the mid-point of the ruler at the level of the chair seat. Stand on the chair with the toes touching the front of the chair. Keep the legs straight and then gently bend down to reach the toes or beyond. The ruler will record the score of the reach beyond the toes (positive score) or above the toes (negative score).

2 SIT AND REACH
Method: Place a box on the floor with the mid-point of the ruler fixed horizontally at the edge of the box. Sit on the floor with the legs straight and feet resting against the box. Gently reach forwards to the toes and measure the reach score, i.e positive or negative.

3 BACK EXTENSION
Method: Place a ruler to stand in a vertical position. Lie face downwards with the head near to the ruler and the hands placed palm downwards on the floor by the chest. Gently arch backwards using the hands to assist to raise the head and shoulders off the ground as far as possible. Measure the height that the nose reaches from the ground.
Correct body weight

An indication of body weight can be gained from the weight table (see page 30). Although this is some guide to fitness a more effective test is to examine the fat deposits on your body. Badminton is a non-contact sport and as such excess fat is quite unnecessary. There is too much fat if you can take hold of a handful of fat anywhere around the waistline. There is too much fat if you look in the mirror and cannot see good muscle definition in the stomach and the legs. There are more accurate ways of assessing body fat but they require special instruments such as skin-fold calipers. Occasionally inexpensive plastic skin-fold calipers are sold in association with slimming campaigns and these are a useful substitute.