Chapter III

METHODOLOGY
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In this chapter the methodology adopted for the selection of subjects, rationale for selection of subjects, selection of variables, justification of the variables selected, selection of tests, calibration of instruments, reliability of tests, orientation of testers, orientation of subjects, design of the study, collection of data, pilot study, training interventions, administration of tests and statistical techniques have been elucidated.

Selection of Subjects

A total of thirty (30) male handball players were selected from Sports Authority of India, Sports Training Center (STC), Sarurnagar, Hyderabad, Andhra Pradesh. Their mean age, height and weight of the selected subjects are 21.33±2.00 years, 168.50 ± 6.85 cm, and 63.83 ± 6.83 kg respectively. These subjects were randomly distributed into three groups namely PLYO training group (N=10), SAQ training group (N=10) and CON group (N=10). All subjects were subjected to medical examination by a general medical practitioner before participation in the study to ensure that they met the required standard to be able to take part in fitness testing and training.
Rationale for the selection of subjects

For any research the subjects should be selected carefully. By considering the purpose of the study the subjects were selected at random by lot and each group consists of ten subjects each. The subjects were considered large enough and true representatives of the population. Above all these subjects were adequate to draw meaningful conclusions and generalizations.

Selection of Variables

The investigator referred to various relevant literatures, consulted with experienced experts in sports to identify ideal variables. In addition to this, by using the investigator’s personal knowledge and professional experience, the following most appropriate variables were selected in the present investigation.

Dependent Variables

The dependent variables selected in this study were physiological variables – percent body fat, lean body mass, anaerobic capacity, fatigue index, aerobic capacity and physical fitness variables – speed, vertical explosive power, horizontal explosive power, agility, flexibility, muscular endurance.

Independent variables

The independent variables selected in the present study were PLYO training and SAQ training for 6 weeks.
Justification of the Criterion Variables Selected

In modern handball success of players depends on several physical components which must be performed repeatedly with maximum intensity (Gabbett, 2005; Ronglan et al., 2006). The ability to run faster, to jump higher, to demonstrate greater agility and throwing velocity with great accuracy are the skills needed for successful play at all levels and all ages (Greene et al., 1998; Lidor et al., 2005). All these actions of physical activity, which play a fundamental role in handball, are anaerobic in nature (Wallace & Cardinale, 1997; Hoffmann et al., 2000; Rannou et al., 2001). However, the physique of players and body composition may be essential factors that guarantee success in sports and games (van der Tillaar & Effema 2004; Ostojic et al., 2006). So keeping these ideas in mind above mentioned variables are selected.

There are several training interventions employed by coaches to train and condition handball players. SAQ training impact on handball player’s physiological and physical fitness attributes are not discussed. The difference between PLYO and SAQ training are studied.

Selection of Tests

In the current exploration, the ultimate and consistent tests were used to assess the selected physiological and physical fitness attributes as presented in table 2.
Table 2

Tests used for criterion variables

<table>
<thead>
<tr>
<th>S.No</th>
<th>Variables</th>
<th>Methods / Tests /Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Physiological attributes</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Percent body fat (%)</td>
<td>Skinfold caliper</td>
</tr>
<tr>
<td>2</td>
<td>Lean body mass</td>
<td>Skinfold caliper</td>
</tr>
<tr>
<td>3</td>
<td>Anaerobic capacity</td>
<td>Running based anaerobic sprint test</td>
</tr>
<tr>
<td>4</td>
<td>Fatigue index</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Aerobic capacity</td>
<td>Multi stage fitness test</td>
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<tr>
<td></td>
<td><strong>Physical fitness attributes</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Speed</td>
<td>30 m sprint</td>
</tr>
<tr>
<td>2</td>
<td>Power in Vertical</td>
<td>Vertical jump test</td>
</tr>
<tr>
<td>3</td>
<td>Power in Horizontal</td>
<td>Standing broad jump</td>
</tr>
<tr>
<td>4</td>
<td>Agility</td>
<td>T – test</td>
</tr>
<tr>
<td>5</td>
<td>Flexibility</td>
<td>Sit and reach test</td>
</tr>
<tr>
<td>6</td>
<td>Muscular endurance</td>
<td>Sit ups</td>
</tr>
</tbody>
</table>

**Calibration of Instruments**

In this investigation standard equipments were used to assess the selected physiological and motor performance variables. The stadiometer, weighing machine, skinfold caliper, stopwatch, multi stage fitness test audio CD, sit and reach box and measuring tape which are available at University
College of Physical Education and Sports Sciences, Acharya Nagarjuna University were used. These equipments were purchased from reputed firms, which ensure reliability. Hence their calibrations were accepted as accurate enough to use for present research.

**Table 3**

**Reliability of tests**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Variables</th>
<th>Coefficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Physiological attributes</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Percent body fat (%)</td>
<td>.856</td>
</tr>
<tr>
<td>2</td>
<td>Lean body mass</td>
<td>.863</td>
</tr>
<tr>
<td>3</td>
<td>Anaerobic capacity</td>
<td>.791</td>
</tr>
<tr>
<td>4</td>
<td>Fatigue index</td>
<td>.743</td>
</tr>
<tr>
<td>5</td>
<td>Aerobic capacity</td>
<td>.758</td>
</tr>
<tr>
<td></td>
<td><strong>Physical fitness attributes</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Speed</td>
<td>.782</td>
</tr>
<tr>
<td>2</td>
<td>Power in Vertical</td>
<td>.780</td>
</tr>
<tr>
<td>3</td>
<td>Power in Horizontal</td>
<td>.951</td>
</tr>
<tr>
<td>4</td>
<td>Agility</td>
<td>.843</td>
</tr>
<tr>
<td>5</td>
<td>Flexibility</td>
<td>.791</td>
</tr>
<tr>
<td>6</td>
<td>Muscular endurance</td>
<td>.763</td>
</tr>
</tbody>
</table>
Reliability of Tests

The tester’s competency for test administration was evolved with the reliability of tests. To establish the reliability of tests, test and retest method was followed. For this purpose, 10 handball players as subjects were selected at random. All the criterion variables selected in the present investigation were tested twice for same subjects under similar condition. As suggested by Johnson & Nelson (1982) Univariate correlation (intra class correlation) was computed separately for each criterion variable. The obtained reliability coefficient is given in table 3.

The entire criterion variables were acceptable at 0.05 level and this reveals that all the test items are reliable. Hence, these tests were used in this study.
Orientation of Testers

Since, the investigator alone could not organize the administration of tests, M.Phil. and Ph.D. scholars from University College of Physical Education and Sports Sciences, Acharya Nagarjuna University were recruited to serve as testing personnel. The purpose of the study, testing procedures and method of scoring were briefly explained and demonstrated to the testers. The investigator had overall supervision on the subjects and the testers. All the testers performed their duty to the utmost gratification.

Orientation of Subjects

Prior to exploration, the investigator informed the rationale of the study and concise preface of different training methodology adopted and its impact on physiological and physical fitness attributes. The way of doing each test was demonstrated and explained to subjects by the researcher. Subjects were motivated to exhibit their maximum performance in selected test. All the subjects cooperated to their best during the course of experimentation.

Design of the Study

For the present study pre test – post test randomized group design (Thomas, Nelson & Silverman, 2005) which consists of control group and two
Experimental groups was used to find out effect of PLYO and SAQ training on the physiological and physical fitness attributes of handball players. Equal numbers (ten) of subjects were assigned randomly to all the groups. Experimental groups were exposed to training with a set of drills selected for specific purpose. The experimental groups were trained with PLYO and SAQ drills for a period of six weeks (42 days). The training sessions were conducted three days a week (i.e. Monday, Wednesday, and Friday). Measurement of physiological and physical fitness attributes was taken for all the groups.

**Collection of Data**

All the subjects reported to the University College of Physical Education and Sports Sciences, Acharya Nagarjuna University, and they were tested on physiological and physical fitness attributes prior to training and after six weeks of training. The testing session consists of warm-up and test interspersed with rest. All tests were explained and demonstrated. Before testing, subjects were given practice trials to become familiar with the testing procedures. All tests were counterbalanced pre and post testing to ensure that testing effects were minimized. Subjects performed each test as per test procedure and the scores of best trials were taken for this study.

In the morning of the first day of testing, measurements like height, weight, body composition, speed, flexibility, abdominal strength, and agility were measured. In the evening power and anaerobic capacity were evaluated. Next day evening these subjects were tested for their aerobic capacity.
Pilot Study

Prior to the formal study sessions, a pilot study was conducted to validate research procedure and the initial capacity of the participants to design the training programme. For the purpose, twelve participants (n=12) were selected at random. These subjects were classified into two groups as PLYO training group (n=6) and SAQ training group (n=6). Both the groups underwent 5 session of training under the watchful eyes of the investigator. The initial loads of the participants were fixed and the training programme for both groups were designed separately based on the performance in the pilot study.

Training Interventions

PLYO

A 6-week plyometric training program was developed using three training sessions per week. The PLYO training schedule followed was different for each week (see Table 4). The training program was based on recommendations of intensity and volume from Piper and Erdmann (1998), using similar drills, sets, and repetitions. From a physiological and psychological standpoint, four to six weeks of high intensity power training is an optimal length of time for the CNS to be stressed without excessive strain or fatigue (Adams, et al., 1992). It is the belief of some sports physiologists that neuromuscular adaptations contributing to explosive power occur early in the
power cycle of the periodization phase of training (Adams, et al., 1992). Plyometrics were only performed three days per week to allow for sufficient recovery between workouts as recommended by researchers (Adams, et al., 1992; Wathen, 1993).
Table 4

PLYO Training Schedule

<table>
<thead>
<tr>
<th>Training Week</th>
<th>Training Volume (foot contacts)</th>
<th>Plyometric Drill</th>
<th>Sets × Reps</th>
<th>Training Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>90</td>
<td>Side to side ankle hops</td>
<td>2×15</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standing jump and reach</td>
<td>2×15</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Front cone hops</td>
<td>5×6</td>
<td>Low</td>
</tr>
<tr>
<td>Week 2</td>
<td>120</td>
<td>Side to side ankle hops</td>
<td>2×15</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standing long jump</td>
<td>5×6</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral jump over barrier</td>
<td>2×15</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Double leg hops</td>
<td>5×6</td>
<td>Medium</td>
</tr>
<tr>
<td>Week 3</td>
<td>120</td>
<td>Side to side ankle hops</td>
<td>2×12</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standing long jump</td>
<td>4×6</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral jump over barrier</td>
<td>2×12</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Double leg hops</td>
<td>3×8</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral cone hops</td>
<td>2×12</td>
<td>Medium</td>
</tr>
<tr>
<td>Week 4</td>
<td>140</td>
<td>Diagonal cone hops</td>
<td>4×8</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standing long jump with lateral sprint</td>
<td>4×8</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral cone hops</td>
<td>2×12</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Single leg bounding</td>
<td>4×7</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral jump single leg</td>
<td>4×6</td>
<td>High</td>
</tr>
<tr>
<td>Week 5</td>
<td>140</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-----</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagonal cone hops</td>
<td>2×7</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standing long jump with lateral sprint</td>
<td>4×7</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral cone hops</td>
<td>4×7</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cone hops with 180 degree turn</td>
<td>4×7</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single leg bounding</td>
<td>4×7</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral jump single leg</td>
<td>2×7</td>
<td>High</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 6</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagonal cone hops</td>
<td>2×12</td>
</tr>
<tr>
<td>Hexagon drill</td>
<td>2×12</td>
</tr>
<tr>
<td>Cone hops with change of direction sprint</td>
<td>4×6</td>
</tr>
<tr>
<td>Double leg hops</td>
<td>3×8</td>
</tr>
<tr>
<td>Lateral jump single leg</td>
<td>4×6</td>
</tr>
</tbody>
</table>

Training volume ranged from 90 foot contacts to 140 foot contacts per session while the intensity of the exercises increased for five weeks before tapering off during week six as recommended by Piper and Erdmann (1998) and used previously in another study (Miller, et al., 2002). The intensity of training was tapered so that fatigue would not be a factor during post-testing. The plyometric training group trained at the same time of day, three days a week, throughout the study. During the training, all subjects were under direct supervision and were instructed on how to perform each exercise.
SAQ training was performed thrice a week for the period of six weeks in outdoor handball court. This training was performed under the direction of handball coach. SAQ training sessions lasted for one hour which includes 15 min of general warm-up and 30 to 45 min of prescribed exercise. The training commenced with one week of general physical conditioning for the SAQ training group, so that the subjects were ready physically and mentally to take on specific load administrated to them for the purpose of the study. After one week of conditioning the SAQ training was administrated, which include speed, agility, and quickness drills respectively for three days in a week (i.e. Monday, Wednesday, and Friday). The SAQ training schedule followed was different for each week (see Table 5). These SAQ training drills and specific warm-up exercises were selected from book “Training for speed, agility and quickness” (Brown, et al., 2000). Speed, agility and quickness drills cover the complete spectrum of biomotor skills, from basic and low intensity to complex and high intensity.
Table 5: SAQ Training Schedule

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>“A” March Walk “B” March</td>
<td>Ladder speed run</td>
<td>Run through (Hurdle drill)</td>
</tr>
<tr>
<td></td>
<td>“A” Skips “B” Skips</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Partner assisted lets go</td>
<td>Partner-resisted starts</td>
<td>Run through (Hurdle drill)</td>
</tr>
<tr>
<td>Agility</td>
<td>Z-Pattern cuts Zig Zag</td>
<td>T-Drill</td>
<td>Change of direction</td>
</tr>
<tr>
<td></td>
<td>Dot drill Hexagon drill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quickness</td>
<td>Back pedal Side Shuffle</td>
<td></td>
<td>Foot tapping frequency</td>
</tr>
<tr>
<td>Speed, agility &amp; quickness</td>
<td>Squirm X-Pattern multi-skill</td>
<td>Z- Pattern run X- Pattern Multi-Skill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hexagon drills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed &amp; Quickness</td>
<td>Stadium stair Sand running Vertical jump to sprint</td>
<td>Light sled/Tire pull Sprint to vertical jump</td>
<td></td>
</tr>
<tr>
<td>Agility &amp; Quickness</td>
<td>Side to side cone reach Carioca</td>
<td>Direction mirror drill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sprint and back pedal on command</td>
<td>Back pedal and cut on command</td>
<td></td>
</tr>
</tbody>
</table>
Administration of Tests

Height

Purpose

To measure the stature of the subject.

Equipment

A stadiometer.

Procedure

To measure the subject’s standing height, he was asked to stand erect on the platform of the stadiometer without shoes, by keeping the heels together, back and head touching the scale and the face looking straight.

Scoring

Height was recorded correct to the nearest centimetre.

Weight

Purpose

To measure the body weight of the individual subject.

Equipment

Standard weighing machine
Procedure

The subjects were wearing the minimum of clothing. The standard weighing used to measure body weight should be placed in an area, which is a smooth and even surface and with sufficient light, so that, the investigator is capable of properly recording the observation.

Scoring

The zero point of the weighing machine must be checked often during the measurements. The weight of the subjects was recorded to the nearest kilogram.

Percent body fat

Purpose

Measuring body fat percentage is an easy method of discovering correct body weight and composition. Beneath the skin is a layer of subcutaneous fat, and the percentage of total body fat can be measured by taking the 'skinfold' at selected points on the body with a pair of callipers. This test only requires four measurements.

Equipment required

Skinfold Calliper and measuring tape
**Procedure**

Estimation of bodyfat by skinfold thickness measurement. Measurement can be made use from 3 to 9 different standard anatomical sites around the body. The right side is usually only measured (for consistency). The tester pinches the skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calipers are then applied 1 cm below and at right angles to the pinch, and a reading in millimeters (mm) taken two seconds later. The mean of two measurements should be taken. If the two measurements differ greatly, a third should then be done, then the median value taken.

**The sites**

There are many common sites at which the skinfold pinch can be taken. The four sites proposed by Durnin and Womersley (1974) is applied in this research. The sites recommended by Durnin and Womersley (1974) are Triceps, Biceps, Subscapular and Suprailliac (waist).

**Triceps:**

A mark is made at the mid-upper arm, midline of the posterior aspect of the arm over the triceps muscle, measured with the elbow bent at 90°, used for identifying the biceps and triceps SFT. During the measurement, the arm should be hanging freely by the side, palms inwards towards the thighs.
Biceps:

Measured midline of the anterior aspect of the arm, over the biceps muscle, mid-point on the arm as above.

Subscapular:

Found just below and lateral to the bottom tip of the scapula, measured in a 45° angle. Subjects stand with their arm relaxed by their side. The scapula was palpated with the fingertips to find the bottom of the bone and the SFT is then measured in the natural crease. Subject’s shoulders are relaxed.

Suprailliac (waist):

Found 1 cm above the anterior superior iliac spine (top of the hip bone) in the mid-axillary line (waistline). Measured horizontally with the subject breathing gently.

Formula to Calculate

Body density and percentage body fat is calculated using the equations of Durnin and Womersley (1974), for each side of the body, using the following equations:

\[ \text{Density (g/cm}^3\text{)} = c - m (\log \Sigma S) \]
Where:

\[ D = \text{Density} \]

\( c \) and \( m \) = standard age and sex-specific coefficients

\[ SS = \text{Sum of all four skinfold measurements (mm)} \]

Once density is calculated, the Siri (1961) equation is used to estimate Percentage body fat:

\[
\text{Fat (\%)} = \left[ \frac{4.95}{D} - 4.5 \right] \times 100
\]

Where:

\[ D = \text{Density} \]

4.95 and 4.5 are the constants calculated by Siri (1961) using the assumptions on the density of FM and FFM.

Lean body mass (Wilmore & Costill, 1994) was measured using the following equation:

\[
\text{LeanBodyMass} = \left( \frac{100 - \text{bodyfatpercentage}}{100} \right) \times \text{weight}
\]
RAST

Purpose

The Running-based Anaerobic Sprint Test (RAST) provides measurements of anaerobic capacity and fatigue index.

Facilities and equipment used

The test was administered in 400 metres track - with a 35 metre marked section on the straight. Two cones to mark the 35 metre section and stopwatches were used to administer the test.

Procedure

The subjects were weighed prior to the test. Undertakes a 10-minute warm session and has a 5-minute recovery. Then completes six 35 metre runs at maximum pace with 10 seconds between each sprint for turnaround. The testers record the time taken for each 35 metre sprint to the nearest hundredth of a second.

Scoring

By using following equation anaerobic capacity and fatigue index was found.

Power output for each sprint is found using the following equations:

\[
\text{Anaerobic capacity} = \text{Weight} \times \text{Distance}^2 \div \text{Time}^3
\]
From the six times calculate the power for each run and then determine:

\[
\text{Average power} = \frac{\text{Total time for the 6 sprints}}{6}
\]

\[
\text{Fatigue Index} = \frac{(\text{Maximum power} - \text{Minimum power})}{\text{Total time for the 6 sprints}}
\]

**20m Multistage shuttle run test**

*Purpose*

To assess the aerobic capacity of the player.

*Equipment*

- Audiocassette, portable cassette/CD player
- 20m marked distance on a flat surface (tape measure)
- Cones

*Procedure*

This progressive multistage shuttle run is based on the protocol of Lèger *et al.* (1988). A 20 m distance is measured out and marked on the floor. The player runs between these two lines. The player should attempt to complete each 20 m distance (lap) and turn according to the pace determined by the recorded sound signal. One foot must touch the marked line by the time the signal sounds. Players may not run wide circles; each player must place one
foot just over the line and then turn immediately to face the opposite direction. The timing between signals starts off slowly but becomes progressively faster with each passing minute. The player is allowed to voluntary withdraw when he is unable to maintain the pace dictated by the sound. The player can also be withdrawn from the test if he fails to complete the 20m distances in time for 2 consecutive laps. The score is taken at the last completed lap.

*Scoring*

Measured as number of successfully completed shuttles of 20 m. This can be converted to give an approximation of the player’s VO\(_2\) max.

**30m sprint**

*Purpose*

The purpose of the test is to determine the player’s maximum sprint speed and the ability to accelerate from a stationary position.

*Equipment*

Electronic stop watch, marking cones and tape measure.

*Procedure*

The test involves running a single maximum sprint over 30 meters, with the time recorded. A thorough warm up should be given, including some practice starts and accelerations. Start from a stationary position, with one foot
in front of the other. The front foot must be on or behind the starting line. This starting position should be held for 2 seconds prior to starting, and no rocking movements are allowed. The tester should provide hints for maximizing speed (such as keeping low, driving hard with the arms and legs) and encouraged to continue running hard through the finish line.

Scoring

Two trials are allowed, and the best time is recorded to the nearest 2 decimal places. The timing starts from the first movement (if using a stopwatch).

Vertical jump test

Purpose

Test to measures vertical leg power of the athletes.

Equipments

Vertical jump board or chalk, a metre ruler, weights scales.

Procedure

The athlete stands side on to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. The athlete then stands away from the wall, and jumps vertically as high as possible using both arms and legs to assist in projecting the
body upwards. He attempts to touch the wall at the highest point of the jump.

*Scoring*

The difference in distance between the reach height and the jump height is the score. The best of three attempts is recorded.

**Standing broad jump**

*Purpose*

The objective of this test is to measure the horizontal explosive power of the legs.

*Equipments*

Tape measure to measure distance jumped, non-slip floor for takeoff, and soft landing area preferred. Commercial Long Jump Landing Mats are also available. The take off line should be clearly marked.

*Procedure*

The athlete stands behind a line marked on the ground with feet slightly apart. A two foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. The subject attempts to jump as
far as possible, landing on both feet without falling backwards. Three attempts are allowed.

**Scoring**

The measurement is taken from take-off line to the nearest point of contact on the landing (back of the heels). Record the longest distance jumped, the best of three attempts.

**T-test**

**Purpose**

The T-Test is a test of agility for athletes, and includes forward, lateral and backward running.

**Equipments**

- Tape measure
- Marking cones
- Stopwatch

**Procedure**

Set out four cones as illustrated in the diagram (5 yards = 4.57 m, 10 yards = 9.14 m). The subject starts at cone A. On the command of the timer, the subject sprints to cone B and touches the base of the cone with their right hand. They then turn left and shuffle sideways to cone C, and also touches its base,
this time with their left hand. Then shuffling sideways to the right to cone D and touching the base with the right hand. Then they shuffle back to cone B touching with the left hand, and run backwards to cone A. The stopwatch is stopped as they pass cone A.

Scoring

The trial will not be counted if the subject crosses one foot in front of the other while shuffling, fails to touch the base of the cones, or fails to face forward throughout the test. Take the best time of three successful trials to the nearest 0.1 seconds.

Sit and reach test

Purpose

The sit and reach test is used to determine the joint range of motion and flexibility of the muscles around the hip joint (the test simultaneously examines the flexibility of the lower back and hamstrings). The reliability of the test has been documented previously (Johnson and Nelson, 1979).

Equipment

A sit and reach box is required. The “zero” point of the box should be at 26 cm.
Procedure

For this test, the player sits on the floor with knees extended (straight), ankles flexed and bare feet against the vertical edge of the sit and reach box. The player then flexes (bends) at the hip and reaches forward, with both hands together, towards his toes. The player is encouraged to flex maximally at the hip joint without flexing the extended knees. The furthestmost point reached by both index fingers along a ruler fixed along the top of a box, is taken as the score. The best of three attempts is recorded as the score in centimetres (cm).

Scoring

The point directly above the vertical edge that the foot is resting against is recorded as zero cm. The sit and reach box must have the zero point set at 26 cm on the ruler that runs along the top of the box.

Sit-ups test

Purpose

Abdominal muscle strength and endurance is important for core stability and back support. This sit up test measures the strength and endurance of the abdominals and hip-flexor muscles.

Equipments

Non-slippery flat surface, exercise mat, stopwatch, partner to hold the feet and assistant to
Procedure

The starting position was a supine position with knees flexed to less than 90 degrees, feet on the mat, 12 inches from the buttocks. Arms remained clasped behind the neck throughout the test. A partner held the feet in contact with the ground throughout the test. To begin the test he curled up touching the thigh with chest and goes back. This sequence is continued for a minute.

Scoring

The score was the maximum number of sit-ups completed in one minute. One point was scored for each correct sit-up.

Statistical techniques

The pre test and post test data collected from the experimental and control groups on physiological and physical fitness attributes confined to the study have been analyzed using Analysis of Covariance (ANCOVA). Whenever, the obtained ‘$F$’ ratio value for interaction was found to be significant, the Scheffé S test was applied as post hoc test to determine the paired mean differences. SPSS statistical software package (SPSS Company, America, version 17.0) was used for analyzing. The α value of 0.05 was set for statistical significance.