Chapter III

METHODOLOGY

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, training interventions, administration of tests and statistical techniques have been elucidated.

Selection of Subjects

To accomplish the purpose of the study, forty eight (48) male intercollegiate kabaddi players were selected from affiliated colleges of Acharya Nargarjuna University. These players were classified into two groups namely combined strength and plyometric training group (24) and control group (24). These players age 24.26 ± 4.58 years, weight 73 ± 6.50 kg and height 173.25 ± 6.85 cm. These players represented their college in intercollegiate kabaddi and have more than six years of playing experience. The selected subjects gave willingness to participate in this study. After having got the consent, 48 male kabaddi players were medically examined and found that they were free from diseases and injuries to undergo training program.
Rationale for the Selection of Subjects

In perspective to the purpose of the study, the subjects were selected at convenience for both the groups and each group consists of twenty four subjects. The subjects were considered large enough and true representatives of the population as the selected subjects were the kabaddi-team members from four colleges that took part in intercollegiate kabaddi tournament. Above all-these subjects were adequate to draw meaningful conclusions and generalizations.

Selection of Variables

The investigator referred to various literatures and consulted with kabaddi coaches to identify ideal variables. In addition to this by using the investigator’s personal knowledge and professional experience the following most appropriate dependent variables were selected in the present investigation were presented in Table 1.
Table - 1
Variables

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Body composition</strong></td>
</tr>
<tr>
<td>1</td>
<td>Percent body fat</td>
</tr>
<tr>
<td>2</td>
<td>Lean body mass</td>
</tr>
<tr>
<td>3</td>
<td>Fat mass</td>
</tr>
<tr>
<td></td>
<td><strong>Physical fitness</strong></td>
</tr>
<tr>
<td>1</td>
<td>Speed</td>
</tr>
<tr>
<td>2</td>
<td>Agility</td>
</tr>
<tr>
<td>3</td>
<td>Explosive power</td>
</tr>
<tr>
<td>4</td>
<td>Maximum muscular strength of upper body</td>
</tr>
<tr>
<td>5</td>
<td>Maximum muscular strength of lower body</td>
</tr>
<tr>
<td>6</td>
<td>Endurance</td>
</tr>
<tr>
<td>7</td>
<td>Flexibility</td>
</tr>
<tr>
<td>8</td>
<td>Muscular endurance of abdominal muscle</td>
</tr>
</tbody>
</table>

*Independent variable*

The independent variable selected in the present study was combined strength and plyometric training which was administered three (3) days per week for ten (10) weeks. The experimental group underwent combined strength and plyometric training and control group remained passive.

**Justification of the Variables Selected**

The game of kabaddi is a fast body contact sport, which places great physical demands on the body. The success of a kabaddi player depends on physique and fitness. Modern kabaddi players require tremendous speed, agility, explosive power, maximum muscular strength of upper and lower body, endurance, flexibility and muscular endurance of abdominal muscles.
The importance of developing good conditioning programs based on the specific physiological demands of each sport is considered a key factor to success (Gillam 1985; Taylor 2003; 2004). The kabaddi player needs to train multiple components of fitness. Thus, the athlete will concurrently perform strength and plyometric training. In the present study combined strength and plyometric training was employed. This training benefit will be transferred to athletes during competitive environment.

**Selection of Test**

In the current exploration standardized tests and procedures were used to assess the physical fitness and physiological variables are presented in Table 2.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Variable</th>
<th>Methods/Tests/Equipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Percent body fat</td>
<td>Skin fold calliper</td>
</tr>
<tr>
<td>2</td>
<td>Lean body mass</td>
<td>Weighing machine</td>
</tr>
<tr>
<td>3</td>
<td>Fat mass</td>
<td>Weighing machine</td>
</tr>
<tr>
<td></td>
<td><strong>Body composition</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Speed</td>
<td>50 yard dash</td>
</tr>
<tr>
<td></td>
<td>2 Agility</td>
<td>T-test</td>
</tr>
<tr>
<td></td>
<td>3 Explosive power</td>
<td>Vertical jump test</td>
</tr>
<tr>
<td></td>
<td>4 Maximum muscular strength of upper body</td>
<td>1RM Bench press</td>
</tr>
<tr>
<td></td>
<td>5 Maximum muscular strength of lower body</td>
<td>1RM Squat</td>
</tr>
<tr>
<td></td>
<td>6 Endurance</td>
<td>Cooper’s 12 minutes run and walk test</td>
</tr>
<tr>
<td></td>
<td>7 Flexibility</td>
<td>Sit and reach test</td>
</tr>
<tr>
<td></td>
<td>8 Muscular endurance of abdominal muscle</td>
<td>Sit ups</td>
</tr>
<tr>
<td></td>
<td><strong>Physical fitness</strong></td>
<td></td>
</tr>
</tbody>
</table>
Calibration of Instruments

In this investigation standard equipments bought from reputed companies were used. These instruments were calibrated for its accuracy.

Physical fitness variables

The physical fitness data were obtained from kabaddi court, standard track and multi gym which is available in the University College of Physical Education and Sports Sciences, Acharya Nagarjuna University, Guntur; VRS & YRN College, Chirala; Bapatla Engineering College, Bapatla and TJPS College, Guntur. To measure speed, agility, explosive power, maximum muscular strength of upper body, maximum muscular strength of lower body, endurance, flexibility, muscular endurance of abdominal muscles. To measure various equipments were required which are reliable and the equipments like measuring tape, stop watch, barbells and cones were used for this study.

Body composition

In this investigation standard equipments were used to assess the selected body composition. The stadiometer, weighing machine and skinfold calliper which are available at University College of Physical Education and Sports Sciences, Acharya Nagarjuna University, Guntur. These equipments were
purchased from reputed firms, which ensure reliability. Hence their calibrations were accepted as accurate enough to use for present research.

**Reliability of Tests**

The testers 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, 8 male kabaddi players were selected from the University College of Physical Education and Sports Sciences, Acharya Nagarjuna University, Guntur. All the criterion variables selected in the present investigation were tested twice for same subjects under similar condition. The Pearson product moment correlation was computed separately for each variable and the coefficient of correlation thus computed is given in Table 3.
### Table - 3

**Reliability coefficients for test and retest on criterion variables**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variables</th>
<th>Coefficient of correlation</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td><strong>Body composition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Percent body fat</td>
<td>0.91</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td>Lean body mass</td>
<td>0.87</td>
<td>0.05</td>
</tr>
<tr>
<td>3</td>
<td>Fat mass</td>
<td>0.87</td>
<td>0.05</td>
</tr>
<tr>
<td>II</td>
<td><strong>Physical fitness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Speed</td>
<td>0.82</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td>Agility</td>
<td>0.89</td>
<td>0.05</td>
</tr>
<tr>
<td>3</td>
<td>Explosive power</td>
<td>0.91</td>
<td>0.05</td>
</tr>
<tr>
<td>4</td>
<td>Maximum muscular strength of upper body</td>
<td>0.78</td>
<td>0.05</td>
</tr>
<tr>
<td>5</td>
<td>Maximum muscular strength of lower body</td>
<td>0.88</td>
<td>0.05</td>
</tr>
<tr>
<td>6</td>
<td>Endurance</td>
<td>0.86</td>
<td>0.05</td>
</tr>
<tr>
<td>7</td>
<td>Flexibility</td>
<td>0.82</td>
<td>0.05</td>
</tr>
<tr>
<td>8</td>
<td>Muscular endurance of abdominal muscle</td>
<td>0.79</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table value required for 6 df at 0.05 level of significance is 0.707

From Table 3 the test, retest exhibits that all the criterion variables have a high inter class correlation coefficient. It implies that the interval consistency of all the criterion variables ranged between acceptable and reveals that the reliability of data is established.

**Orientation of Testers**

Since, the investigator alone could not organize the administration of tests, Ph.D. scholars from University College of Physical Education and Sports Sciences, Acharya Nagarjuna
University and Physical director of VRS & YRN College, Chirala; Bapatla Engineering College, Bapatla were recruited to serve as testing and training personals. 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 brief introduction about combined strength and plyometric training and highlighted its impact on body composition and physical fitness variables. 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 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 a control group and an experimental group that was used to find out effect of combined strength and plyometric training on body composition and physical fitness variables. Equal numbers (24)
of subjects were assigned randomly to both the groups. The combined strength and plyometric training group was exposed to ten (10) weeks training three days per week (i.e. Monday, Wednesday, and Friday).

**Collection of Data**

All the subjects were tested on body composition and physical fitness variables prior to training and after ten 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 on the day of testing measurements like height, weight, body composition, speed, explosive power, agility, flexibility and muscular endurance of abdominal muscle were assessed. However, in the evening maximum muscular strength of upper and lower body and endurance was evaluated.
Training Protocol

The combined training of strength and plyometric training was administered for ten weeks three days per week (Monday, Wednesday and Friday). The combined training program consists of a combination of both strength and plyometric training programs in which one week was allotted for plyometric training and the other week was for strength training out of the two sessions. While one session of plyometric training in even weeks; and two strength training sessions in odd weeks had been accomplished. The strength training load was fixed based on 1RM (repetition maximum) and plyometric training based on foot contact. The strength training loads are increased by 5% for every two weeks and the load commenced from 60% and ends at 80% of the one repetition maximum 1-3 sets, 12 repetitions per set with 3 minutes rest between sets. The strength exercises are performed in multi gyms and the exercises are presented in Table 4. The selected strength exercises are intended to develop strength of hip, thigh, leg, calves, back, chest and shoulder.

The plyometric training volume ranged from 90 to 140 foot contacts per session. Duration of recovery between repetitions of exercise was 5 to 10 seconds and 2 to 3 minutes between sets.
The progression of load is done by increasing 10 foot contact for every two weeks.

**Table – 4**

**Strength and plyometric exercises**

<table>
<thead>
<tr>
<th>Weeks</th>
<th>% of 1RM</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>60</td>
<td>1. Back Squat</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Knee Extension</td>
</tr>
<tr>
<td>3-4</td>
<td>65</td>
<td>3. Knee Curl</td>
</tr>
<tr>
<td>5-6</td>
<td>70</td>
<td>4. Standing heel raise</td>
</tr>
<tr>
<td>7-8</td>
<td>75</td>
<td>5. Lat pull down</td>
</tr>
<tr>
<td>9-10</td>
<td>80</td>
<td>6. Flat bench press</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Vertical chest press</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Heel raise</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Foot Contacts</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>90</td>
<td>1. Double leg tuck jump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Jump over hurdle</td>
</tr>
<tr>
<td>3-4</td>
<td>100</td>
<td>3. Single leg hop</td>
</tr>
<tr>
<td>5-6</td>
<td>110</td>
<td>4. Double arm alternate leg bound</td>
</tr>
<tr>
<td>7-8</td>
<td>120</td>
<td>5. Jump to box</td>
</tr>
<tr>
<td>9-10</td>
<td>140</td>
<td>6. Squat box jump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Depth jump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Power drop (medicine ball)</td>
</tr>
</tbody>
</table>
Administration of Tests

I – Body composition

Height

Purpose

To measure the stature of the subjects.

Equipment

A stadiometer.

Procedure

To measure the subjects standing height, the subjects were 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 subjects.

Equipment

Weighing machine
Procedure

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

Scoring

The zero point of the weighing machine was 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 calipers. This test only requires four measurements.

Equipment required

Skinfold Caliper and measuring tape
Procedure

Measurement be used 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, the median value taken later.

The sites

There are many common sites at which the skinfold pinch can be taken. The four sites proposed by Jackson and Pollock (1985) are applied in this research. The sites recommended by Jackson and Pollock (1985) are abdominal, triceps, thigh and suprailliac.

Abdominal:

A mark is made 5 cm adjacent to the umbilicus (belly – button), to the right side. Then make a vertical pinch at the marked site, and the calliper placed just below the pinch. Be careful not to place the calliper or fingers inside the navel.
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.

Thigh:

The mid-point of the anterior (front) surface of the thigh, midway between patella (knee cap) and inguinal fold (crease at top of thigh). After making anterior thigh landmarks take a vertical pinch. This measurement is normally taken with the subject sitting and the knee bent at right angles. If there is difficulty in lifting a fold of skin, it may be easier with the leg extended, or with the thigh supported from below by the subject.

Suprailliac:

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
Percentage body fat is calculated using the equations of Jackson and Pollock (1985), for each side of the body, using the following equations:

\[
\text{Percent body fat} = \left\{ (0.29288 \times \text{sum of skinfolds}) - (0.0005 \times \text{square of the sum of skinfolds}) + (0.15845 \times \text{age}) - 5.76377 \right\}
\]

\[
\text{Fat Weight} = \text{Body mass (kg)} \times \left( \frac{\text{Percent body fat}}{100} \right)
\]

\[
\text{Lean body mass} = \text{Body mass} - \text{Fat weight}
\]

II - Physical Fitness

50 yards dash

\textit{Purpose}

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

\textit{Equipment}

Electronic stop watch, marking cones and tape measure.

\textit{Procedure}

The test involves running a single maximum sprint over 50 yards dash, with the time recorded. A thorough warm up should be given, including some practice already started 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 encourage to continue running hard through the finish line.

Scoring

Two trials are allowed, and the best time is recorded to the nearest 1/100th of a second.

T – Test

Purpose

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

Measuring tape, marking cones and stopwatch.

**Procedure**

Set out four cones (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 touch 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 1/10th of seconds.

**Vertical jump test**

**Purpose**

Test to measure 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. An attempt 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 as score in centimetres.

1 RM Bench press test

Purpose

Test to measure maximum strength of the arm, shoulder and chest muscle groups.

Equipments

A barbell, weight plates (variety of plate sizes), two safety locks and a sturdy bench press bench with integral bar rack.
Procedure

The spotter stands at the head end of the bench throughout the test to help in raising the bar on a failed attempt and to help the athlete place the bar back on the rack. The bar is set to the appropriate weight, depending on the group to be tested. The athlete begins by lying in a supine position on the bench, with their feet flat on the floor and the upper and lower back in contact with the bench at all times. The bar is grasped at approximately 6 inches wider than shoulder width apart, so that the elbows are at right angles at the lowest point. A complete successful lift is counted from the starting position of the arms fully extended with the weight directly above the chest, to the weight just touching the chest and then returned to the starting position. The movement of the bar should be at a controlled speed and with a smooth motion, and the weight should remain in line with the nipples.

Scoring

The maximum weight of one full repetition successfully completed is recorded.
1 RM Back squat test

Purpose

Test to measure maximum strength endurance of the leg muscle groups.

Equipments

A barbell, weight plates (variety of plate sizes), two safety locks and a sturdy bench press bench with integral bar rack.

Procedure

The spotter stands at the head end of the bench throughout the test to help in raising the bar on a failed attempt and to help the athlete place the bar back on the rack. The bar is set to the appropriate weight, depending on the group to be tested. The athlete stands comfortably with legs feet apart to shoulder width. Grasp the bar with a closed, pronated grip and step under the bar and position the feet parallel to each other.
Place the bar in a balanced position on the upper back and shoulders in low bar position or high bar position. Lift the elbow, hold the chest up and tilt the head slightly up, once this position is resumed extend the hip and knees to lift the bar. After lifting the bar take one or two steps backward and perform squat by positioning both feet shoulder-width apart and toes pointed slightly outward.

**Scoring**

The maximum weight of one full repetition successfully completed is recorded.

**Cooper’s 12 minute run and walk test**

**Objective**

To monitor the development of the athlete’s VO$_{2}$max.

**Equipments required**

To undertake this test 400 metre track, stopwatch whistle or sound horn and an assistant

**Procedure**

Initially the the athletes were provided with warm up for 10 minutes. When the athlete is ready the assistant gives the command “GO” and starts the stop watch and the athlete commences the test. The athlete has to run and walk for around the track to aid in measuring the completed distance.
Participants run for 12 minutes, and the total distance covered is recorded. Walking is allowed, though the participants must be encouraged to push themselves as hard as they can to maximize the distance covered.

Assessment

The equation that can be used to estimate $\text{VO}_2\text{max}$ (in ml/kg/min) from the distance score is:

$$\text{VO}_2\text{max} = (22.35 \times \text{kilometres}) - 11.29$$

**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 furthermost point reached by both index fingers along a ruler fixed along the top of a box, is taken as the score.

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. The best of three attempts is recorded as the score in centimetres (cm).

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 an assistant too.
**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 had the maximum number of sit-ups completed in one minute. One point was scored for each correct sit-up.
**Statistical technique**

The collected data was evaluated using Analysis of Covariance (ANCOVA) and the changes elicited from pre to post in each group is calculated using Dependent *t* test. The α value of 0.05 was set for statistical significance. SPSS statistic software package (SPSS Company, America, version 17.0) was used.