CHAPTER – III

METHODOLOGY

In this chapter, procedures and methods applied in the selection of subjects, selection of variables, selection of tests, competence of the tester, reliability of the instruments, reliability of the data, orientation to the subjects, pilot study, training programme, collection of the data, administration of the tests, experimental design and statistical technique are presented.

SELECTION OF SUBJECTS

The purpose of the study was to find out the Effects of Isolated and Combined Weight and Plyometric Training and Detraining on Selected Strength and Speed Parameters. For this purpose, forty five students from the one thousand two hundred and fifty four studying bachelor’s degree in Engineering in Sudharsan Engineering College, Sathiyamangalam Pudukkottai District, Tamilnadu, India were selected as subjects at random. The age, height and weight of the subjects ranged from 18 to 21
years, 161 to 170 cms and 52 to 63 kg respectively, and the means were 19.6 years, 167 centimeters and 56 kilograms respectively. The subjects successfully completed the minimum strength requirement test recommended by Voight and Draovitch\textsuperscript{63}, which consists of static stability and dynamic movement testing for thirty seconds. The selected subjects were randomly assigned to three groups of fifteen each. Group-I underwent Weight Training, Group-II underwent Plyometric Training, and Group-III underwent Combined Weight and Plyometric Training. They underwent the respective training programme for the duration of twelve weeks with three days per week. After the training period, the detraining effects were assessed by every 10 days from the last session of the training. Like that four cessation were followed. During the detraining period, the subjects were advised not to do any specific exercises. A written consent was obtained from the subjects. However, they were free to withdraw their consent in case they felt any discomfort during the period of their participation. There were no such dropouts in this study.

\textsuperscript{63} Micheal L. Voight and Peter Draovitch, “Plyometrics”, as cited in Mark Albert., \textit{Eccentric Muscle Training in Sports and Orthopaedics}, (New York: Churchill Livingstone, 1991), Ch.V.
SELECTION OF VARIABLES

Dependent Variables

When a sports or game training is introduced it is likely to improve physical and bio-motor abilities. The sports performance depends largely on physical fitness.

In all sports, speed and strength are important qualities. Generally it requires developing performance in sports and games. Speed is a magic work in sports. The person who can run faster, throw harder and move quickly is likely to be a better athlete and win more contests. Power is an essential quality in many sports, for it represents the effective combination of strength and speed. Increase in strength or speed will increase power, and when power increases, more work can be done in less time.

Speed may be developed, but is in large part dependent upon a person’s genetic ability. Requirements for running speed are stride length; stride frequency, reaction time, acceleration, strength, power, endurance, flexibility and running form. Of all these components, stride length, stride frequency and speed endurance are most important and may contribute most to speed.
Different variables may affect athletes at different levels. All the factors that determine speed may be trained for improvement. However, an elite athlete attempting to improve his or her speed may be able to improve only one or two areas, such as strength and stride frequency.

Since Strength and Speed play an important role in almost all games and sports, the following dependent variables were selected for this study.

1. Arm Strength
2. Leg Strength
3. Explosive Strength
4. Strength Endurance
5. Speed
6. Stride Length
7. Stride Frequency
8. Speed Endurance

**Independent Variables**

All athletic programmes should incorporate the fundamental factors of training, namely physical, technical, tactical, psychological and theoretical training. They are an essential part of any training programme regardless of the athlete’s age,
individual potential, training level, or training phase. The relative emphasis placed on each factor varies, however, according to these features and the characteristics of the sport or event.

Resistance training is an anaerobic form of exercise. Many training programmes can be used to enhance the ability of the body to perform at very high force and/or power and to improve the body’s ability to perform repeated bouts of maximal activity.

Plyometric training is the key to develop maximal explosive power and speed of movement which in turn are the elements involved in all sports. By doing various exercises one can greatly increase the performance level.

Strength and speed are integral components of fitness found in varying degrees in virtually all athletic movements. Simply put the combination of speed and strength is power. For many years coaches and athletes have sought to improve power in order to enhance performance. Throughout this century and no doubt long before, jumping, bounding and hopping exercises have been used in various ways to enhance athletic performance. In recent years this distinct method of training for power or explosiveness has been termed plyometrics. Whatever the origins of the word the term is used to describe the method of training which seeks to
enhance the explosive reaction of the individual through powerful muscular contractions as a result of rapid eccentric contractions.

Based on the above mentioned concepts of Maximal Resistance Training and Plyometric Training the following independent variables have been designed.

1. Weight Training,
2. Plyometric Training
3. Combined Weight and Plyometric Training

**SELECTION OF TESTS**

The present study was undertaken to find the effects of Isolated and Combined Weight and Plyometric Training and Detraining on Arm Strength, Leg Strength, Explosive Strength, Strength Endurance, Speed, Stride length, Strength Frequency and Speed Endurance. As per the available literature, the following standardized tests were used to collect relevant data on the selected dependent variables and they are presented in Table I.
### TABLE – I

#### TESTS SELECTION

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Criterion Variables</th>
<th>Test Items</th>
<th>Unit of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Arm Strength</td>
<td>Dip Strength</td>
<td>1/10&lt;sup&gt;th&lt;/sup&gt; of a second</td>
</tr>
<tr>
<td>2.</td>
<td>Leg Strength</td>
<td>Vertical Jump Test</td>
<td>In Centimeters</td>
</tr>
<tr>
<td>3.</td>
<td>Explosive Strength</td>
<td>Vertical Jump Test</td>
<td>In Centimeters</td>
</tr>
<tr>
<td>4.</td>
<td>Strength Endurance</td>
<td>Sit-Ups Test</td>
<td>In Numbers</td>
</tr>
<tr>
<td>5.</td>
<td>Speed</td>
<td>50 Meters Run</td>
<td>1/10&lt;sup&gt;th&lt;/sup&gt; of a second</td>
</tr>
<tr>
<td>6.</td>
<td>Stride Length</td>
<td>50 Meters Run</td>
<td>In Meters</td>
</tr>
<tr>
<td>7.</td>
<td>Stride Frequency</td>
<td>50 Meters Run</td>
<td>In Numbers</td>
</tr>
<tr>
<td>8.</td>
<td>Speed Endurance</td>
<td>150 Meters Run</td>
<td>In Meters per seconds</td>
</tr>
</tbody>
</table>

#### COMPETENCY OF THE TESTER

All the measurements in this study were taken by the investigator with the assistance of scholar of Department of Physical Education, H. H. The Rajah’s College, Pudukkottai District India. To ensure that the assistants of the investigator were well versed with the technique of conducting tests, they had a number of practice sessions in the correct testing procedure. The tester’s reliability was established by test and re-test methods.
RELIABILITY OF THE INSTRUMENTS

The Stopwatches and measuring tape, used in this study were borrowed from Department of Physical Education, Health Education and Sports, H. H. The Rajah’s College, Pudukkottai, Tamilnadu in India. The video camera used in the study was secured from a well-established studio in Pudukkottai. These instruments had been purchased from reliable and standard companies and were considered accurate enough for the purpose of the study.

RELIABILITY OF THE DATA

Test and retest method was followed in order to establish the reliability of data by using ten subjects at random. All the dependent variables selected in the present study were tested twice for the subjects by the same personnel under similar conditions. The intra class co-efficient of correlation was used to find out the reliability of the data as suggested by Johnson and Nelson\(^6\) and the results are presented in Table II.

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TABLE – II

INTRA CLASS CO-EFFICIENT OF CORRELATION ON SELECTED DEPENDENT VARIABLES

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Criterion Variables</th>
<th>‘R’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Arm Strength</td>
<td>0.94*</td>
</tr>
<tr>
<td>2.</td>
<td>Leg Strength</td>
<td>0.96*</td>
</tr>
<tr>
<td>3.</td>
<td>Explosive Strength</td>
<td>0.94*</td>
</tr>
<tr>
<td>4.</td>
<td>Strength Endurance</td>
<td>0.94*</td>
</tr>
<tr>
<td>5.</td>
<td>Speed</td>
<td>0.96*</td>
</tr>
<tr>
<td>6.</td>
<td>Stride Length</td>
<td>0.97*</td>
</tr>
<tr>
<td>7.</td>
<td>Stride Frequency</td>
<td>0.92*</td>
</tr>
<tr>
<td>8.</td>
<td>Speed Endurance</td>
<td>0.93*</td>
</tr>
</tbody>
</table>

* Significant at 0.01 level of confidence.

(Table value required for significance at 0.01 level of confidence is 0.77)

Since the obtained ‘R’ values were much higher than the required value, the data were accepted as reliable in terms of instrument, tester and the subjects.

ORIENTATION TO THE SUBJECTS

The investigator explained the purpose of the training programme and their part in the study to the subjects. For the collection of data, the investigator explained the procedure of testing on selected dependent variables and gave instruction
about the procedure to be adopted by them for measuring. Five sessions were spent to familiarize the subjects with the techniques involved in undergoing Weight Training, Plyometric Training, and Combined Weight and Plyometric Training. It helped them to perform the Weight Training, Plyometric Training, and Combined Weight and Plyometric Training exercises perfectly without injuries. The subjects of all the groups were sufficiently motivated to perform their assigned tasks during the testing periods.

**PILOT STUDY**

A pilot study was conducted to assess the initial capacity of the subjects to fix the load and also to design the training programme. For that purpose, ten men subjects were selected at random and they were given different kinds of Weight Training, Plyometric Training, and Combined Weight and Plyometric Training under the watchful eyes of the investigator. During the pilot study, the subjects underwent Weight Training, Plyometric Training, and Combined Weight and Plyometric Exercises. Finally, limited exercises were conducted which were closely related to develop the dependent variables and design the training programme. The initial loads of the subjects were fixed based on
the results of the pilot study and the directions given by Dan Wathen\textsuperscript{65}. The training in respective intensities and programmes were fixed for Weight Training, Plyometric Training, and Combined Weight and Plyometric separately. While constructing the training programmes, the basic principles of sports training (progression of overload and specificity) were followed. During construction of the training programme, the individual differences were also being considered.

**TRAINING PROGRAMME**

During the training period, the experimental groups underwent their respective training programmes. Group-I underwent Weight Training, Group-II underwent Plyometric Training, and Group-III underwent Combined Weight and Plyometric Training for all three days per week for twelve weeks.

The duration of training session in all the days were between one hour to one and half hours approximately which included warming up and limbering down. All the subjects involved in this study were carefully monitored throughout the training programme to be away from injuries. They were questioned about their health status throughout the training

programme. None of them reported any injuries. However, muscle soreness appeared in the earlier period of the training programme and was reduced in due course.

The percentage of intensities for Weight Training, Plyometric Training and Combined Weight and Plyometric Training are presented in Table III.

**TABLE – III**

**PERCENTAGE OF INTENSITY FOR WEIGHT TRAINING, PLYOMETRIC TRAINING AND COMBINED WEIGHT TRAINING AND PLYOMETRIC TRAINING GROUPS**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Groups</th>
<th>Components</th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
<th>Phase IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Weight Training Group</td>
<td>Sets</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repetition</td>
<td>10 to 12</td>
<td>14 to 18</td>
<td>10 to 12</td>
<td>10 to 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intensity</td>
<td>60-70%</td>
<td>60-70%</td>
<td>70-80%</td>
<td>80-90%</td>
</tr>
<tr>
<td>2</td>
<td>Plyometric Training Group</td>
<td>Sets</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repetition</td>
<td>10 to 12</td>
<td>14 to 18</td>
<td>10 to 12</td>
<td>10 to 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intensity</td>
<td>60-70%</td>
<td>60-70%</td>
<td>70-80%</td>
<td>80-90%</td>
</tr>
<tr>
<td>3</td>
<td>Combined Weight and Plyometric Training Group</td>
<td>Sets</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repetition</td>
<td>10 to 12</td>
<td>14 to 18</td>
<td>10 to 12</td>
<td>10 to 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intensity</td>
<td>60-70%</td>
<td>60-70%</td>
<td>70-80%</td>
<td>80-90%</td>
</tr>
</tbody>
</table>

* A Phase consists of Three weeks duration.
COLLECTION OF THE DATA

Pre test data were collected two days before the training programme and post test data were collected two days after the twelfth week of training. Detraining effects were assessed every 10 days from the last session of the training programme for 4 cessations. In all the cases, the data were collected two consecutive days. On the first day Arm Strength Test, Length Strength Test, Explosive Strength Test and Strength Endurance Test were conducted, whereas 50 meters run (Speed, Stride Length, and Stride Frequency) and 150 meters Run (Speed Endurance) were conducted on the second day.
ADMINISTRATION OF THE TESTS

1. Dip Strength Test

Purpose

To measure the arm strength of the subject.

Equipment Used

Adjustable parallel bar, weight plates, straps and a chair.

Procedure

The parallel bar was adjusted according to the height of the subject, so that the subject could perform freely above the ground. After securing the desired amount of weight to the waist, the subject stepped upon the chair and took a secure grip on the bars. As the subject assumed a straight arm support, the chair was removed and the subject proceeded to lower himself downward until the elbows formed a right angle. As the subject pushed up to a straight arm support, the chair was replaced under his feet. If a second trail was to be taken, the subject might step down and read the weight before he repeated the exercise and he had to repeat the same, as many times as possible.

Scoring

The score was recorded in seconds; the best of the three trials was recorded as the test score.
2. 25 Meters Hopping Test (Leg Strength)

Objective

To monitor the development of the athlete's elastic leg strength.

Required Resources

To undertake this test you will require:

- A 400 metre track - 25 metre marked section on the straight, cones, stop watch.

Procedure

Mark out a 25 metre section on the straight section of the track with two cones. The athlete starts 10 to 15 metres behind the starting line. Using a jog run up, the athlete starts hopping on the dominant leg from the first cone. The time taken to hop between the two cones is recorded. The test is then repeated with the other leg.

Scoring

Best of three trials was taken; least score would indicate an improvement⁶⁶.

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⁶⁶ www. brianmac.co.uk/legtest.htm.
3) **Vertical Jump Test**

**Purpose**

To measure explosive power in vertical direction.

**Equipment used**

A plywood board as suggested by Sargent was used to obtain the data.

**Procedure**

To obtain data for vertical jump, Sargent jump was administered to the subjects. Before the execution of the test, all the subjects were instructed by the tester regarding the test performance. They were taught how to perform the test perfectly by the investigator. Before the execution of the vertical jump test, subjects were directed to practice for a few minutes.

A plywood board (blackened 1 cm. Thick 1.50 mts. Long and 50 cm. Wide) with lines marked horizontally 1 cm apart was used. This board was placed vertically, the zero point of the scale being at the reaching height of the shortest subject tested. The subject stood with his side toward the wall and reached as high as possible with heels on the floor and made a mark on the wall with chalked fingers. The subject then swung his arms downward
and backward assuming a crouched position with the knees bent at about right angle. The subject then jumped as high as possible, swinging the arms upward, as the highest point of the jump was reached, and another mark was made above the initial one. Three trails were allowed with one-minute rest in between.

**Scoring**

The score was recorded to the nearest centimeters, between the reach and jump mark. The best of the three trials was recorded as the test score\(^67\).

4) **Sit-Ups Test**

**Purpose**

To measure the strength endurance of the abdominal muscles.

**Equipments Used**

Mats and stopwatch

**Procedure**

The subject lay flat on the back with knees bent and the feet on the floor with the heels not more than 30 cms from the

\(^67\) Dudley A. Sargent., “Physical Test of a Man”, *American Physical Education Review*, 26, (April 1921), 188.
buttocks. The knee angle should not be less than 90 degrees. The fingers were interlocked and placed behind the neck with elbows touching the mat. The feet were held securely by a partner. The subject then curled up to a sitting position and touched his knees with the elbows. The exercise was repeated as many times as possible in one minute.

Scoring

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

5) 50 meters run

Purpose

To assess Speed, Stride length and Stride Frequency.

Equipments Used

Measuring tape, starting clapper, stopwatch, and video camera.

Procedure

The standing start method was adopted for this purpose. The time from the ‘clap’ to the runner crossing the finish line was

\[ 68 \text{ A.K Uppal, “Physical Fitness” (New Delhi: Friends Publications, 1992), pp 119-120} \]
taken as the test score. The fractions were rounded to the next largest one tenth of a second. For this purpose digital electronic watch was used. Two trials were conducted with sufficient rest in between and the better of the two trials were recorded. Further, each subject’s run was video-recorded to assess the number of contacts (strides) he made between the starting and finishing lines. The recorded cassette was played in slow motion and the number of contacts was counted for the best trials.

**Scoring**

1) Speed was recorded in 1/10 second.

2) Stride length was computed by using the following formula.

   \[
   \text{Stride length} = \frac{50\text{mts}}{N}.
   \]

   \((N= \text{Number of contacts (Strides during the run)}).\)

3) Stride Frequency was calculated by using the following formula.

   \[
   \text{Stride Frequency} = \frac{N}{t}
   \]

   \((N= \text{Number of contacts (stride during the run)} \ t= \text{Time taken to run the 50 metres distance})\)
6) 150 meters Run

Purpose

To assess speed endurance.

Equipments Used

Measuring tape, Starting clapper and Stopwatch.

Procedure

The standing or crouch start method of maximum effort sprint over 150mts was adopted for this purpose. The time from the ‘clap’ to the runner crossing the finish line was taken as the test score. The fractions were rounded to the next largest one tenth of a second. For this purpose digital electronic watch was used.

Scoring

The average velocity is calculated by using the following formula

\[
\text{Speed Endurance} = \frac{\text{Distance}}{\text{Time taken}} \quad \text{Mts / Seconds} \tag{69}
\]
EXPERIMENTAL DESIGN AND
STATISTICAL TECHNIQUE

The experimental design used in this study was pre and post random group design. The selected subjects were divided at random into three groups of fifteen each (n=15). Group I underwent weight training, Group II underwent plyometric training and Group III underwent combined weight and plyometric training. All the subjects were tested prior to and after the training and during detraining period and the data were collected at the end of first, second, third and fourth phases for all the selected variables. A Phase consists of ten days. The total period of detraining was limited to 40 days.

The data collected from the three groups prior to and post experimentation and detraining on Arm Strength was assessed by Dip Strength Test, Leg Strength was assessed by 25 Meters Hopping Test, Explosive Strength was assessed by Vertical Jump Test, Strength Endurance was assessed by Sit-Ups, Speed, Stride Length, and Stride Frequency were assessed by 50mts Run, Speed Endurance was assessed by 150mts Run were statistically analyzed by using two way (3x6) factorial ANOVA with last factor repeated measures.
Whenever the obtained F-ratio for interaction effect was found to be significant, the simple effect test was used as a follow up test. Since, three groups and six different stages of test were compared, whenever the obtained F-ratio value in the simple effect was significant the Scheffe’s test was applied as post hoc test to determine the paired mean differences, if any. In all the cases .05 level of significance was fixed.