CHAPTER – III

METHODOLOGY
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Research methodology involves the systematic process by which the research starts from the identification of the problem to its conclusions. The role of methodology is to carry out the research work in a scientific and valid manner.

The methodological aspects related to the present investigation have been described. In this chapter, the selection of the subjects, selection of variables, selection of test, orientation of the subjects, tester’s competency, instrument reliability, reliability of the data, pilot study, training programme, administration of the test, collection of the data, experimental design and statistical procedure are presented.

3.1. SELECTION OF SUBJECTS

The purpose of the study was to find out the effect of a plyometric and resistance training programme on selected physical, physiological and bio-motor variables among school athletes. To achieve the purpose of the study, forty-five school athletes studying
in Campion Anglo-Indian Higher Secondary School, Tiruchirappalli, Tamilnadu, India were selected as subjects. The age, height and weight of the subjects ranged from 15 to 17 years, 160 to 175 centimeters and 45 to 60 kilograms respectively. The selected subjects were medically examined by a qualified physician and certified that they were medically and physically fit enough to undergo the training programme. The selected subjects (N=45) were classified into three equal groups of fifteen each (n=15) at random. Group I underwent plyometric training, group II underwent resistance training and group III acted as control.

3.2. SELECTION OF VARIABLES

The present study was undertaken primarily to assess the effect of plyometric and resistance training programme on selected physical, physiological and bio-motor variables among school athletes. The researcher had gone through the available literature and had discussions with various experts and with his guide before selecting the variables. The availability of technique for the purpose of analysis, feasibility, reliability of the procedure and the outcome were extensively taken care before finalizing the variables. The selected independent and dependent variables of this study are as follows:

3.3. INDEPENDENT VARIABLES

In this experimental study two experimental groups were selected, while one group was kept as control to assess the difference.

1. Plyometric training
2. Resistance training
3.4. DEPENDENT VARIABLES

The following physical fitness, physiological and bio-motor variables were selected for this study.

3.4.1. PHYSICAL FITNESS VARIABLES

1. Speed
2. Leg strength
3. Cardio-respiratory Endurance

3.4.2. PHYSIOLOGICAL VARIABLES

1. VO$_2$ max
2. Vital capacity

3.4.3. BIO-MOTOR VARIABLES

1. Agility
2. Reaction Time

3.5. JUSTIFICATION FOR SELECTION OF EXPERIMENTAL VARIABLES

The experimental variables used in the present study were plyometric and resistance training. Though many methods prevail to alter physical fitness, physiological and bio-motor variables, the role of plyometric and resistance training is an undisputed one. A lot of research had been carried out on the effects of plyometric and resistance training, but the bone of contention is about the duration and also the different kinds of training methods to get the maximum benefit. In this context, the investigator makes an attempt to analyze the impact of two different modes of plyometric and resistance training on two groups. Each method of training is designed to achieve specific training
goals. Hence, the investigator is motivated to select plyometric training and resistance training as experimental training.

3.6. JUSTIFICATION FOR SELECTION OF DEPENDENT VARIABLES

Physical fitness is the key to success in sports and games. Each sports demands specific requirement of speed, strength, cardio-respiratory endurance and anaerobic power for successful performance. These are an important factor in all sports and games. The investigator is keenly interested to know whether the improvement in cardio-respiratory endurance and leg strength are due to the plyometric and resistance training. Therefore, in this study selected physical fitness variables namely speed, leg strength and cardio-respiratory endurance have been included as dependent variables.

Examining the changes on physiological variables as a result of plyometric and resistance training is a useful research objective. For the physiological system of the body to be fit, it must function well enough to support the specific activity that the individual is performing. Moreover, different activities make different demands upon the organism with respect to circulatory, respiratory, metabolic, neurological and thermo regulatory functions. It is evident that there is a growing realization of the importance of physiological variables enhancing health and performance. Therefore, physiological variables such as VO$_2$ max and Vital capacity receive special consideration, and it is an important pre-requisite for outstanding performance in sports activity.

We have to analyze the changes on bio-motor variables as a result of plyometric and resistance training programme. The athlete obviously has greater fitness than the non-athlete because of his training for a chosen event or events. The law of specificity states that there is a specific response to the specific nature of a training load. This
specific response will tend to emphasize one or more of the abilities that make up fitness. The investigator is also interested in knowing whether the positive changes occurred in the bio-motor variables such as agility and reaction time.

3.7. SELECTION OF TESTS

The investigator has analysed various literature, consulted the experts in physical education and selected the test items to collect data on the selected physical fitness, physiological and bio-motor variables which were standardized and most suitable to this study, presented in Table - I.

| Table – I |
| Dependent Variables and Tests |

<table>
<thead>
<tr>
<th>Variables</th>
<th>Test Items</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Fitness Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>50 Meters run test</td>
<td>Seconds</td>
</tr>
<tr>
<td>Leg Strength</td>
<td>Leg lift dynamometer</td>
<td>Kilograms</td>
</tr>
<tr>
<td>Cardio-respiratory Endurance</td>
<td>Cooper’s 12 min run/walk test</td>
<td>Meters</td>
</tr>
<tr>
<td><strong>Physiological Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO₂ max</td>
<td>Astrand – Astrand Nomogram</td>
<td>L/min</td>
</tr>
<tr>
<td>Vital Capacity</td>
<td>Wet- spirometer</td>
<td>Millilitre</td>
</tr>
<tr>
<td><strong>Bio-motor Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agility</td>
<td>Shuttle run</td>
<td>Seconds</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>Ruler Test</td>
<td>Seconds</td>
</tr>
</tbody>
</table>

3.8. ORIENTATION OF THE SUBJECTS

Before the commencement of the plyometric and resistance training, the investigator explained the purpose of programme to the subjects and their part in the study. For the collection of the data, the investigator explained the procedure of training
and testing on selected criterion variables and gave instructions about the procedure to be adopted by them for measuring. The subjects were sufficiently motivated to perform their maximal level during the training and testing period. The control group had no specific training and was advised not to involve in any sport of practice or specific training programme during the experimental period. All the participants who co-operated in the study were well informed of the seriousness and importance of the study.

3.9. COMPETENCE OF THE TESTER

The investigator collected the data with the assistance of research scholars from the Alagappa University College of Physical Education. The purpose of the study and testing procedures were explained and demonstrated to the testers. The investigator had a number of practice sessions in order to familiarize the correct testing procedure. The testers’ reliability was established by test and re-test method. As very high correlation was obtained, the tester competency in taking measurement and test reliability were accepted.

3.10. RELIABILITY OF THE INSTRUMENT

The required instruments were availed from the Alagappa University college of Physical Education. They were in good working condition. The instruments were purchased from the reliable and standardized companies. Their calibrations were tested and found to be accurate enough to serve the purpose of the study.

3.11. RELIABILITY OF THE DATA

Before the commencement of experiment, the reliability of the data was established by test and retest method. Ten athletes’ from Campion Anglo-Indian Higher Secondary School, Tiruchirappalli, Tamilnadu were tested twice on selected dependent
variables by the same personals under similar conditions. The intra class co-efficient of correlation was used to find out the reliability of the data with test and retest scores on each criterion variables separately, and the results are presented in Table - II.

### 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>Speed</td>
<td>0.87*</td>
</tr>
<tr>
<td>2</td>
<td>Leg Strength</td>
<td>0.88*</td>
</tr>
<tr>
<td>3</td>
<td>Cardio-respiratory Endurance</td>
<td>0.91*</td>
</tr>
<tr>
<td>4</td>
<td>VO₂ max</td>
<td>0.90</td>
</tr>
<tr>
<td>5</td>
<td>Vital Capacity</td>
<td>0.89*</td>
</tr>
<tr>
<td>6</td>
<td>Agility</td>
<td>0.91*</td>
</tr>
<tr>
<td>7</td>
<td>Reaction Time</td>
<td>0.93*</td>
</tr>
</tbody>
</table>

*Significant at 0.05 level of confidence.

(Table value require for significance at 0.05 level of confidence is 0.77)

Table-II states the intra class co-efficient correlation on selected variables. Since the obtained ‘r’ values were much higher than the required table value, the data were accepted as reliable in terms of instrument, tester and the subjects.

### 3.12. PILOT STUDY

A pilot study was conducted to assess the initial fitness of the subjects in order to fix the training load. Further, it helped to know the subjects, to be involved in the current study. For that purpose, fifteen subjects were selected at random and plyometric and resistance training were given to them for three weeks. Under the strict supervision of
the investigator the subjects performed their respective training. Based on the results of the pilot study the training programme was designed. While constructing the training programmes the basic principles of sports training were followed.

3.13. TRAINING PROGRAMME

In this study, training was done under close supervision with frequent adjustments in training intensity to maintain the desired training stimulus. The training programmes were scheduled for one session a day for plyometric training and resistance training groups each session lasted between sixty to ninety minutes approximately including warming up and warming down. During the training period, the experimental groups underwent their respective training programme three days per week (alternative days) for twelve weeks in addition to their curriculum.

The plyometric training groups performed the following exercises namely single leg hopping, medicine ball overhead throw, tuck jump, box jump, medicine ball side throw, depth jump, hurdle jump, medicine ball overhead back pass, barrier lateral jump,
chest pass medicine ball, squat jump and box lateral shuffle. The intensity was fixed at low, medium & high with the training volume ranged from 90 to 120 foot contacts per session for twelve weeks. Detailed plyometric training programme given in appendix –II.

The resistance training groups performed the following exercises namely Push-up, chest press, Fly, Triceps curl, Lateral raise, dumbbell squats, walking lunges, calf raise, biceps curl and bent over row with dumbbell, leg press, and leg curl. The initial intensity was fixed at 40% of their 1RM and it was progressively increased once in a week by 5% for 12 weeks. Detailed resistance training programme given in appendix –III.
3.14. ADMINISTRATION OF THE TESTS

3.14.1. 50 Meters Dash

**Purpose:** To measure the speed of the subjects.

**Facilities and Equipments:**

Smooth surface, test course, scorecards, electronic stop-watch and a starting clapper.

**Procedure**

The subjects were taken to the starting positions behind the starting line. The test administrator (*at the finish line*) raised both arms sideways to indicate the set position. The ‘Go’ signal is given rapidly lowering the arms to the side. The administrator had a stop-watch in his hand and started it when the arms reach the side of the body. The subjects ran as fast as possible across the finish line. The watch was stopped when the subjects body (*not head or arms*) crossed the finish line. One trial was taken.
Scoring:

The score was the time between the ‘Go’ signal and the moment the participants body crossed the finish line. The time was recorded to the nearest tenth of a second.

3.14.2. Leg Lift with Dynamometer

Purpose

To measure the leg strength

Equipment

Leg dynamometer and hip belt

Procedure

The subject stood on the dynamometer base, with the feet placed parallel and body weight equally balanced on both feet. A belt was used around the subject’s hip to stabilize the bar, as the lifting force of the legs was too great to be helped by the hands.
The subject held at the center of the bar, palms down, at the level of pubic bone. The testers attached the belt loop to the left end of the bar. The belt was then brought around the lower portion of the sacrum to be attached to the right end of the handle. The knees were flexed, heads up and back straight. The handle was hooked on to the chain so that the subject’s knees were flexed between and the bar was on the subject thigh during the lift and the hands either in the middle or at the ends of the bar. The subjects were directed to lift straight up. At the completion of the lift, the subject’s knee joint was almost completely extended to ensure maximum effort.

**Scoring**

The scores shown by the pointer in the dial during the maximal lift was multiplied into two to arrive at the final score. The best of three trials was recorded in kilograms.

**3.14.3. Cooper’s 12 Minutes Run/Walk Test**

**Purpose**

To measure cardio -respiratory endurance

**Equipment**

A track or an area within a football field or square fifty yards on each side of the play ground and stop-watch.

**Procedure**

Subjects could run individually or in groups of a dozen or more. When subjects ran in groups, they were paired. While 9 students ran, the partners listed the time to call out his time to the scorer. Students entered space running with periods of walking and
Cooper’s 12 minutes run and walk

were encouraged to place themselves. When a group was running, the time was called out as each student crossed the finish line. The score was the time elapsed.

Scoring

The distance covered by each subject was recorded in meters.

3.14.4. Maximal Oxygen Uptake (Vo2 Max)

Purpose

The purpose of the test was to find out the maximal oxygen uptake (vo2 max) capacity (The test was conducted as describes by Astrand – Astrand Nomogram).

Facilities and Equipment

Forty centimetre height bench, stop watch and score sheet.

Procedure

The subject was dressed in-tack – suits without shoes. The subjects weight as measured and recorded. The subjects stepped a 40 cms, bench, left foot – up, right foot – up, left foot – down and right foot down. The subjects were asked to breath fully
throughout the test and strengthened the knees completely on top of the bench. The stepping frequency was thirty steps per minute.

Maximal Oxygen Uptake (Vo2 Max)

**Scoring**

One minute determination of pulse rate after fifth minute of completion of stepping, the pulse rate and weight (L/min) were compared in the Astrand – Astrand nomogram.
3.14.5. Vital Capacity

Purpose

To measure the lungs capacity

Equipment

A six-litre wet spirometer was used for measuring the vitial capacity.

Procedure

The wet spirometer was placed at a height that allowed the subjects to stand correct at the beginning of the test. The subject forcefully inhaled and exhaled twice before the test (hyper-ventilale). The subject is cautioned not to allow air to escape through the nose or around the mouthpiece. The subject at completion should bend slightly forward to blow air as much as possible from the lungs by a forcible expiration after the deepest possible inspiration into the wet spirometer.
Scoring

The tester should watch the needle to obtain the maximum reading (Clarke, 1976).

3.14.6. Shuttle Run

Purpose

To measure the agility of the performer in running and changing direction

Equipments

Measuring tape, Stop watch and two blocks of wood (2” x 2” 4”), Chunnam powder.

Procedure

The performer starts behind the starting line on the signal “go” and runs to the blocks, pick up one, returns to the starting line and places the block behind the line. He then repeats the process with the second block allowing some rest between the two trials.
Scoring

The score for each performer is the length of the time required (to the nearest tenth of second) to complete the course. Record only the best trial.

3.14.7. Reaction Time Ruler Test

Purpose

To measure the reaction time, hand-eye quickness of the subjects.

Equipment

One meter long ruler or Yardstick, Table, chair and calculator.

Procedure

The subject sits near the edge of a table, resting their elbow on the table so that their wrist extends over the side. The assessor holds the ruler vertically in the air between the subject's thumb and index finger, but not touching. Align the zero mark with
the subject's fingers. The subject should indicate when they are ready. Without warning, release the ruler and let it drop - the subject must catch it as quickly as possible as soon as they see it fall. Record in meters the distance the ruler fell. Each subject got three trials.

**Scoring**

The average of three trials measured distance (distance in cm, time in seconds) is taken to calculate with the following formula, where \( d \) = the distance the ruler fell in meters, \( g \) = the acceleration of gravity (9.8 m/s\(^2\)), and \( t \) = the time the ruler was falling (seconds). \( t = \sqrt{\frac{2d}{g}} \)

**3.15 EXPERIMENTAL DESIGN AND STATISTICAL TECHNIQUE**

The experimental design used in this study was random group design involving 45 subjects, who were divided at random into three groups of fifteen each. All the three groups were selected from the same population. No effort was made to equate the groups prior to the commencement of the experimental treatment. The pre-test means of the selected dependent variable was used as a covariate. In order to nullify the initial differences the data collected from the three groups prior to and post experimentation on selected dependent variables were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since three groups were involved, whenever the obtained ‘F’ ratio for adjusted post test means was found to be significant, the Scheffe’s test was applied as post hoc test to determine the paired mean differences. In all the cases the level of confidence was fixed at 0.05 for significance.