Chapter - III

Methodology
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In this chapter, the selection of subjects, selection of variables, selection of tests, reliability of the instruments, reliability of the data, competence of tester, orientation to the subjects, estimating 1 RM, pilot study, training programme, detraining programme, retraining programme, collection of the data, tests administration, experimental design and statistical procedure have been explained.

Selection of Subjects

The purpose of the study was to find out the effects of maximal power and plyometric trainings on selected strength and power parameters such as leg strength, back strength, strength endurance, elastic power, explosive power in terms of vertical distance and explosive power in terms of horizontal distance, their states after four cessations of training (detraining programme) and after four weeks of retraining programme at different stages. To achieve this purpose of the study, forty five sports hostel boys in Tiruchirapalli, Tamil Nadu, India, during the academic year 2006-2007 were randomly selected as subjects by lot method from a total of 103 students. The age, height and weight of the selected subjects were ranged from 15 to 17 years, 159 to 163 cm and 50 to 60 kilogram
respectively. The selected subjects were divided into three equal groups of fifteen subjects each at random. Group I underwent maximal power training, Group II underwent plyometric training and Group III acted as control. The maximal training group (Group I) and plyometric training group (Group II) underwent their respective training programmes for three days per week for twelve weeks. Group III acted as control which did not undergo any special training programme apart from their regular physical education programme of the curriculum. Before any new training technique incorporated in to the programme, serious considerations should be given to the potential for injury that accompanies with new training method.

While plyometric training are demanding and place considerable stress on the body. The volume and intensity of plyometric training within each of these categories can be regulated from low to high stress exercise. The subjects of plyometric training group cleared the minimum strength requirement test and demonstrate both static and dynamic control test of their own body weight with single leg squat, low intensity in place plyometric training [Voight and Draovitch, (1990)]. All the subjects gave a written informed consent and no compulsion was made to take part in the training programme. A qualified physician examined the subjects and declared that they were medically and physically fit to participate in the training programme. Since, all the subjects were hostlers of sports hostel, Tiruchirapalli,
they had a similar academic work and a regular activities in accordance with the requirements of the sports hostel, Tiruchirapalli curriculum.

**Selection of Variables**

Weight training is a type of eccentric based training that produces rapid adaptations in the neuromuscular system. The concept of weight training has assumed new importance in all strength based explosive and team oriented sports, due to the competitive pressures in today's society. Both male and female athletes have recognized the performance advantages associated with increased muscular strength and power. The popularity of weight training with free weights in many disciplines and varied sports has increased dramatically in the past two decades. Hence, maximal power training was selected as one of the independent variables.

Power can be enhanced by increasing the amount of time required to produce the force. The overload principle provides the athlete with a means of improving strength levels, practice of skill pattern and hence components can increase the speed and efficiency of practical movement patterns. The amount of time required to produce muscular force is the important variable for increasing power. One of the forms of training that theoretically proposes to bridge
between speed and strength is plyometrics. Hence, plyometric training was selected as one of the independent variables.

Strength is the key to success in modern sports. It is the fundamental to all sports and games. The lack of reasonable strength obviously cannot ensure the expected performance in sports and games. Thus, strength is one of the important bio motor abilities, and it is often of paramount importance. Hence, the following strength parameters such as leg strength, back strength and strength endurance were selected as criterion variables for this study.

Power produces momentum, and momentum becomes the striking force when contact is made. Thus, power has many applications in a variety of athletic events. Hence, the power parameters namely elastic power, explosive power in terms of vertical distance and explosive power in terms of horizontal distance were also selected as criterion variables.

**Selection of Tests**

The purpose of the study was to find out the effects of maximal power and plyometric trainings on selected strength and power parameters such as leg strength, back strength, strength endurance, elastic power, explosive power in terms of vertical distance and explosive power in terms of horizontal distance, their
states after four cessations of training (detraining programme) and after four weeks of retraining programme at different stages. The researcher had consulted with the experts, physical education professionals, reviewed various literatures accessible to him and selected the following test items, which were standardized, appropriate and ideal for the selected variables. The criterion variables 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>Leg strength</td>
<td>Leg lift with dynamometer</td>
<td>Kilograms</td>
</tr>
<tr>
<td>2.</td>
<td>Back strength</td>
<td>Back lift with dynamometer</td>
<td>Kilograms</td>
</tr>
<tr>
<td>3.</td>
<td>Strength endurance</td>
<td>Bend Sit ups</td>
<td>Counts</td>
</tr>
<tr>
<td>4.</td>
<td>Elastic Power</td>
<td>Bunny Hops</td>
<td>Meters</td>
</tr>
<tr>
<td>5.</td>
<td>Explosive power in terms of vertical distance</td>
<td>Sargent jump</td>
<td>Centimeters</td>
</tr>
<tr>
<td>6.</td>
<td>Explosive power in terms of horizontal distance</td>
<td>Standing broad jump</td>
<td>Centimeters</td>
</tr>
</tbody>
</table>

**Reliability of the Instruments**

The following instruments which were required to test the selected criterion variables such as leg dynamometer and measuring tape were procured from the Human performance laboratory of the H.H. The Rajah's College, Pudukottai, Tamil Nadu, India. All the
instruments used in this study were in good condition and purchased from reputed and reliable companies. Their calibration were tested and found to be accurate enough to serve the purpose of the study.

Reliability of the Data

The reliability of the data was established through test and retest method. Ten subjects were randomly selected from the sports hostel, Tiruchirapalli, Tamil Nadu, India and they were tested twice by the same testers under similar conditions on each criterion variable. The intra class correlation was used to find out the reliability of the data with test-retest scores on each criterion variables separately and they are presented in Table II.

TABLE II

INTRACLASS CORRELATION CO-EFFICIENT VALUES ON SELECTED CRITERION VARIABLES

<table>
<thead>
<tr>
<th>Tests / Variables</th>
<th>'R' Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg strength</td>
<td>0.94*</td>
</tr>
<tr>
<td>Back strength</td>
<td>0.93*</td>
</tr>
<tr>
<td>Bend Sit-ups</td>
<td>0.89*</td>
</tr>
<tr>
<td>Bunny Hops</td>
<td>0.92*</td>
</tr>
<tr>
<td>Sargent jump</td>
<td>0.91*</td>
</tr>
<tr>
<td>Standing broad jump</td>
<td>0.88*</td>
</tr>
</tbody>
</table>

* Significant at .05 level of confidence.
(The table value required for significance at .05 level of confidence is 0.767).
Competence of the Tester

The data were collected by the researcher with the help of physical education professionals and coaches near by Tiruchirapalli, Tamil Nadu, India. The researcher, the physical education professionals and coaches had learnt the procedures and methods to administer the tests on selected criterion variables. Three sessions were spent to familiarize the testing procedures.

Orientation to the Subjects

The researcher explained about the purpose of the study to the subjects and their part during the training programme. The investigator had also explained the testing procedures on selected criterion variables and gave instructions to the subjects about the procedures to be adopted while measuring. Three sessions were spent to familiarize the subjects with the techniques involved in executing the maximal power and plyometric exercises, which helped them to perform exercises properly and avoid injuries. The subjects were verbally motivated to attend the training session regularly.
Estimating 1 RM

Before training, the maximum load that can be lifted once, the one repetition maximum (1 RM) was established by increasing the load gradually over a series of lifts with sufficient periods of rest in between lifts. Once established, the 1 RM was used as a measure of the maximal concentric force of the muscle or a group of muscles [Reilly et al. (1990)].

Pilot study

Pilot study was conducted to assess the initial capacity of the subjects to fix the initial load and design the training programme. For this purpose, twenty men subjects studying sports hostel, Tiruchirapalli, Tamil Nadu were randomly selected and divided into two equal groups. Group I was given different kinds of maximal power exercises and Group II with various plyometric exercises under the supervision of the researcher.

During the pilot study, the subjects of maximal power training group and plyometric training group underwent many exercises and only limited exercises which were closely related to develop the criterion variables were located and selected to design the training programme. The initial loads of the subjects were fixed according to the performance in the pilot study. The initial loads of
the experimental groups were more or less similar. While constructing the training programme, the individual differences were taken into consideration.

**Training Programme**

During the training period, Group I underwent maximal power training and group II underwent plyometric training. The subjects of both the groups underwent their respective training programme for three days per week for twelve weeks. The principle of overload for group I and group II was applied at every four weeks up to twelfth week to reach high intensity. In every day training session, the workout lasted approximately between 45 minutes and an hour, which included warming up and limbering down. Group III acted as control that did not participate in any special training programme or strenuous physical exercises apart from their regular physical education activities as per the curriculum.

The experimental groups underwent their respective training programme under the supervision of the researcher. The subjects were carefully monitored and questioned about their health status throughout the training programme. None of the subjects have reported any injury. However, in the early weeks of the training period, muscle soreness appeared and subsided in due course.
The training schedule for the experimental groups were designed as per the results of the pilot study and also based on the guidelines given by [Thomas R. Baechle (1994)] and [Donald A. Chu, (1998)] and are presented in appendix I and appendix II respectively.

**Detraining Programme**

After the completion of the twelve weeks of training programme, the subjects of group I and group II were physically detrained for forty days as four cessations. During this period, the subjects of the maximal power training group and plyometric training group were stopped with the training. And these experimental groups were strictly instructed, not to participate in any special training throughout the detraining period apart from their regular activities as per the curriculum.

**Retraining Programme**

After forty days (four cessations) of detraining period, the subjects of group I and group II were retrained for four weeks duration. However, the overload principle was followed in every week and attained high intensity at the end of the fourth week of retraining programme. The retraining schedules for experimental groups are presented in Appendix III and IV respectively.
Collection of the Data

The data were collected on selected criterion variables such as leg strength, back strength, strength endurance, elastic power, explosive power in terms of vertical distance and explosive power in terms of horizontal distance by using leg dynamometer, sit ups, bunny hops, sargent jump and standing broad jump respectively at prior and immediately after the training programme as pre and post tests respectively.

During the detraining period, the data were collected on all the criterion variables once in ten days for forty days (four cessations).

In the retraining period, the subjects were tested on selected criterion variables at the end of the four weeks of retraining period. While collecting data at pre, post, detraining period and retraining periods, the criterion variables were tested on two consecutive days. On the first day, strength parameters were tested and on the second day, power parameters were tested.
Tests Administration

Leg Lift with Dynamometer

Purpose

To assess the leg strength.

Equipment

Leg dynamometer.

Procedure

The subject stood on the dynamometer base, with feet placed parallel and body weight equally balanced on both feet. A belt was used around the subject’s hip to stabilize the bar, since, the lifting force of the legs was too great to be held by the hands. The subject held the centre of the bar, palms down, at the level of the pubic bone. The tester 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, head up and back straight. The handle was hooked on to the chain so that the knees of the subject were flexed between 115 to 125 degrees. The bar was on the subject’s thigh during the lift and hands either in the middle or at the end of the bar. The subject was directed to lift straight up. At the completion of the lift the knee joint of the subject was almost completely extended to ensure maximum effort.
Scoring

As instructed in the back and leg dynamometer manual, the score shown 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.

Back Lift with Dynamometer

Purpose

To assess the back strength.

Equipment

Leg dynamometer.

Procedure

The subject stood on the dynamometer base, with feet placed parallel with head erect, back straight and fingers extending down the thigh. The bar was placed at the tip of the fingers of the subject to obtain proper adjustment. The bar was then connected to the chain. The subject bent slightly forward, with knees straight and grasped the bar firmly at the end with pronated grip. The subject was directed to lift straight up while the tester spotted by placing his hands over the subject in order to prevent the hands of the latter from slipping.
Scoring

As instructed in the back and leg dynamometer manual, the score shown 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.

Bend Knee Sit-ups Test

Purpose

To measure the strength of the abdominal muscle.

Equipment

A clear floor and a stop watch.

Procedure

The subject lied down on his back with the knees bent, heels more than 12 inches from the buttocks. The ankle at the knees was less than 90 degree. The subject put his hands on the back of the neck with fingers clasped and placed the elbows squarely on the floor. The feet were held by a partner to keep them in touch with the floor. The subjects tightened his abdominal muscles and brought the head and elbows forward, finally touching the elbows to the knees. This action constituted one sit-up. The subject returned to the starting position with the elbows on the surface before performing the sit-up again. The timer gave the signal “ready”, “go” and the sit-up
performance was started on the word “go”. The number of correctly executed sit-ups performed in 60 seconds was recorded as the score.

Scoring

The score was the number of correctly executed sit up performed in a minute. No sit up was counted when the subjects did not

1. keep the fingers clasped behind neck,

2. bring both elbows forward in starting to sit up without pushing off the floor with an elbow or

3. return to the starting position with elbows flat on the surface before sitting up again.

Bunny Hops

Purpose

To measure the elastic power.

Equipment

Measuring tape.

Procedure

The procedure prescribed by [Loren Seagrave, (1996)] was employed to measure the elastic power. The subject took the position
on the take off line. When he completed the five stride bounding (Bunny hops) the performance was measured from the nearest break to the take off line. Three trials were given. The five stride bounding test (Bunny hops) for distance will provide the best assessment of an individual’s power capacity.

**Scoring**

The best performance was recorded to the nearest 0.01 metres.

**Sargent Jump**

**Purpose**

To measure the explosive power in vertical direction.

**Equipment**

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

**Procedure**

A plywood board (Blackened one centimetre thick, 1.50 mts. long and 50 cm wide) with lines marked horizontally one 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 towards wall and reached as high as
possible with heels on the floor and made mark on the wall with chalked fingers.

The subject then swings arms downward and backward assuming a crouched position with the knees bend at about right angles. He then jumped as high as possible, swinging the arms upward, as the highest point of jump was reached, another mark was made above the initial one. Three trials were allowed with a minute rest in between.

Scoring

The score was recorded to the nearest centimetre between the reach and jump mark. The best performance was recorded as the test score.

Standing Broad Jump

Purpose

To measure the explosive power in horizontal direction.

Equipment

Steel measuring tape.
Procedure

A take off line was marked on the runway at a distance of one metre from the nearer edge of pit. The subjects stood behind the line facing the pit, feet parallel, swung his arms forward and backward assuming a crouched position with knees bent at about right angles. He then jumped forward as far as possible. Three trials were allowed with a minute rest in between.

Scoring

Distance between the nearest break point to the horizontal line was recorded as his performance in the nearest centimetre. The best performance was recorded as the test score.

Experimental Design and Statistical Procedures

The pre and post test random group design was used as experimental design in which forty five men subjects were randomly selected and divided into three groups of fifteen each. Group I underwent maximal power training, Group II underwent plyometric training and Group III acted as control that did not undergo any special training programme.

The subjects were tested on selected criterion variables at prior and immediately after the twelve weeks of training programme, after every ten days of detraining programme for forty days (four
cessations), and after the four weeks of retraining programme. The collected data from all the groups on selected criterion variables were statistically analysed by using $3 \times 7$ 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. Since, three groups and seven different stages of tests 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 which of the paired mean had significant differences.

In all the cases, .05 level was fixed to test the significance which was considered as an appropriate.