CHAPTER - III

METHODOLOGY
CHAPTER 3
METHODOLOGY

In this chapter the selection of the subjects, selection of variables, experimental design, criterion measures, reliability of data, instrument reliability, tester competency and reliability of test, orientation of subjects, pilot study, test administration, training programme, and statistical techniques have been explained.

3.1 SELECTION OF SUBJECTS

To achieve the purpose of the present study, randomly forty-five Basketball players were selected as subjects. The selected subjects were the participants of inter-collegiate level tournament belonging to Nirmala College for Women and Bishop Appasamy College of Arts and Science, Coimbatore, Tamilnadu, India. The age of the subjects for the present study was fixed in the range of 18 to 25 years. The selected subjects hailed from various socio economic conditions.

3.2 SELECTION OF VARIABLES

In the game of Basketball, to develop the skills and components related to skill performance, most widely used system of training is a progressive one. While scanning the literatures related to this, it was observed that to develop the physical and motor components needed for sports, periodization based training is a feasible mean since it underlies the inbuilt recovery (Kraemer, Fleck and Evans, 1996) and easy adaptations. Besides, both anaerobic and aerobic aspects naturally bond all team sports as the volume of training high and low in the case of periodization. Such a value based training when included as a module in the training, specifically
in the game of Basketball, is believed that the player can have adequate rest whereby reduce the rate of incidence in the occurrence of injury during the course of training. Resultant of these increases the efficiency of a player physically and physiologically. Thus, the player can continue the training with out any hindrance due to sports injury physically and mentally.

Having such salient features of periodization, the investigator has intended to implicate the same in the game of Basketball. To develop the required complex skills the Basketball players should include incredible levels of fitness through high intensity activities. The Basketball player must have tremendous cardiovascular endurance and explosive power to be able to execute volatile movements through the entire game. Such an ability to perform explosively, regardless of extreme cardiovascular fatigue lays the foundation for the present study. The abdominal strength helps to keep up the body postures, thus involving in many activities in the field of sports and games. The magnitude of an individual’s VO2 max has been viewed as one of the most important predictors of endurance performance. With the mastery on performance related components a player can have a superior degree on the whole body strength and stamina. The capabilities of a player’s physical and physiological attributes determine the success in execution of the performance related skills in the game of Basketball. Based on the need based performance related components for basketball players the variables selected for the present study were: abdominal muscular strength and endurance, grip strength-right hand, grip strength-left hand, lower extremity strength, upper extremity strength, explosive power, speed, anaerobic capacity (physical variables), maximum oxygen consumption, resting heart rate(physiological variables), dribbling, passing, shooting(skill variables)
3.3 EXPERIMENTAL DESIGN

The study was formulated as a pre and post-test random group design. Forty-five women Basketball players were randomly selected and divided into three groups namely Experimental group-I Low Volume Circuit Type Resistance Training (LVCTRT), Experimental group-II Periodized High and Low Volume Circuit Type Resistance Training (PHLVCTRT), and group III Control Group (CG) each consisting of 15 subjects. The selected subjects were initially tested on criterion variables used in this study and this is considered as the pre-test. After assessing the pre-test, the subjects belonging to experimental group-I were treated with Low Volume Circuit Type Resistance Training (LVCTRT), and subjects belonging to experimental group-II were treated with Periodized High and Low Volume Circuit Type Resistance Training (PHLVCTRT). As far as the subjects in the group III - Control Group (CG) was concerned, they were not given any activity. Subjects in the experimental groups I and II were treated with their respective treatments for three days a week and for a duration of 12 weeks. After completion of the treatment period, all the subjects were again tested on criterion variables and considered this as the post-test.

3.4 CRITERION MEASURES

Having the experts’ consultation in the field of physical education and sports sciences and scanning various literatures related to resistance training and periodization the investigator has selected the following test items as criterion measures. The chosen tests are highly standardized, appropriate, and ideal for the selected variables. The following criterion measures are chosen for this study.
Abdominal muscular strength and endurance

Abdominal muscular strength and endurance was measured by using modified sit-ups. The number of correctly executed sit-ups performed in 60 seconds was recorded as the score.

Grip strength – right and left hands

Grip strength of the right and left hands was measured by using the Biosco-grip dynamometer. The scores were read to the nearest kilograms.

Lower extremity strength

The strength of the lower body muscles was measured by using half squat. The maximum amount of weight lifted by the subjects was measured in pounds.

Upper extremity strength

The strength of the upper extremity was measured by using bench press. The maximum weight lifted by the subjects was recorded in pounds.

Explosive power

The muscular explosiveness and leg strength was measured by using jump and reach test. The distance was measured to the nearest centimeter.

Speed

Speed was measured by using 50 yards dash and recorded to the nearest one-tenth of a second.
Anaerobic capacity

Anaerobic capacity was measured by using Margaria-Kalamen power test and recorded to the hundredth of a second. Then it was converted into kg-meters per sec (A kg-meter per second is the distance through which 1 kilogram (2.2 pounds) moves 1 meter (3.28 feet) per second.

Maximum oxygen consumption

Maximum Oxygen consumption was predicted by using the Queen’s College step test. The measurement was recorded in ml/ kg/min.

Resting heart rate

Heart rate is the rate at which the heart beats per minute. It was measured by using stethoscope and recorded as the number of beats per minute.

3.5 RELIABILITY OF DATA

Establishing the instrument reliability, tester competency and reliability of tests ensured the reliability of data.

3.5.1 Instrument Reliability

In the present study stopwatches, measuring tapes, stethoscopes were used to test the selected variables. They were considered reliable as they were procured from reputed firms and calibrated in ISI units. To determine the reliability of the instrument, measurements on each of the (variables) tests were recorded several times under similar conditions using the same instruments. The scores obtained were compared with other scores
recorded by the instruments from other reputed firms. Hence they were accepted as reliable and precise for the purpose of this study.

3.5.2 Tester Competency and Reliability of Tests

To ensure that the investigator was well versed in the technique of conducting the tests, the investigator had a number of practice sessions in the testing procedures. The investigator took all the measurements with the assistance of persons well acquainted with the tests and their procedures. Tester’s competency and reliability of tests were established by test retest process. As very high correlation was obtained, the tester competency in taking measurements and test reliability were accepted. The intra-class correlation coefficient obtained from selected criterion variables are presented in Table 3.1.

**TABLE – 3.1 INTRACLASS CORRELATION CO-EFFICIENT VALUES ON SELECTED CRITERION VARIABLES**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Tests</th>
<th>Co-efficient of reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Modified sit-ups</td>
<td>0.93</td>
</tr>
<tr>
<td>2</td>
<td>Grip dynamo meter</td>
<td>0.91</td>
</tr>
<tr>
<td>3</td>
<td>Half squat</td>
<td>0.93</td>
</tr>
<tr>
<td>4</td>
<td>Bench press</td>
<td>0.92</td>
</tr>
<tr>
<td>5</td>
<td>Jump and reach</td>
<td>0.96</td>
</tr>
<tr>
<td>6</td>
<td>50 yards dash</td>
<td>0.91</td>
</tr>
<tr>
<td>7</td>
<td>Margaria-Kalaman power test</td>
<td>0.98</td>
</tr>
<tr>
<td>8</td>
<td>Queen’s college step test</td>
<td>0.91</td>
</tr>
<tr>
<td>9</td>
<td>Resting heart rate – stethoscope</td>
<td>0.96</td>
</tr>
<tr>
<td>10</td>
<td>AAHPERD Basket ball Dribbling test</td>
<td>0.92</td>
</tr>
<tr>
<td>11</td>
<td>AAHPERD Basket ball Passing test</td>
<td>0.93</td>
</tr>
<tr>
<td>12</td>
<td>AAHPERD Basket ball Shooting test</td>
<td>0.91</td>
</tr>
</tbody>
</table>
3.6 ORIENTATION OF SUBJECTS

The researcher explained about the purpose of the study to the subjects and their part during the training programme. The testing procedures on selected criterion variables were explained and instructions were given about the procedure to be adopted while measuring. Three instructional training sessions were spent with subjects to ensure the proper techniques involved in various tests used to collect the data. The subjects were verbally motivated to attend the training session regularly.

3.7 PILOT STUDY

Pilot study was conducted to assess the initial capacity of the subjects belonging to the experimental Group-I and Group-II to fix the initial load of the training programme. Group-I was given Low Volume Circuit Type Resistance Training (LVCTRT) and Group-II with Periodized High and Low Volume Circuit Type Resistance Training (PHLVCTRT).

The initial load of the subjects was fixed in the training programme according to the performance in the pilot study. The initial load of the training group subjects was more or less similar. While constructing the training programme, the individual differences were taken into consideration.

3.8 TEST ADMINISTRATION

Modified sit - ups

Purpose

The test aims to measure the abdominal muscular strength and endurance.
Procedure

The subjects were asked to lie in supine with knees bent and feet on the floor with the heels not more than one foot from the buttocks. The angle of the knee was kept at 90 degrees. The hands were crossed across the chest. A partner held the feet securely. The subjects then curls up to a sitting position and touched the elbows to the knees. This 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.

Static strength test

Purpose

The purpose of the test was to determine the grip strength of the right and left hands.

Equipment

Biosco-grip dynamometer.

Procedure

The Biosco-grip dynamometer was used to measure the strength of the finger flexors of the right and left hands. The pointer was set to zero and placed in the subject’s right hand and adjustment was made in the dynamometer so that the thumb touches the first finger. Then the subject was asked to squeeze the dynamometer as hard as possible, keeping the arm and hand away from the body.
Scoring

The scores were read to the nearest kilograms. The left hand was tested next, and then another trial was given for each hand. The better trials were recorded.

**Half squat**

**Purpose**

The purpose of the test was to measure the lower extremity strength.

**Equipment**

The equipment needed for this test was a weight bar (5 or 6 feet in length) and enough weight plates to be more than sufficient for the strongest student.

**Procedure**

The subjects were asked to stand with their feet at shoulder width apart with toes pointed slightly outward. The head should be kept up and the shoulders unrounded to prevent under strain on the lower back. They had to lower the body by bending their knees until their buttock was about the height of the seat of a chair.

**Scoring**

The maximum amount of weight squatted by the subject was recorded in pounds.

**Bench press**

**Purpose**: The purpose of the test was to measure the strength of the upper extremity.
Equipments

The equipment needed for this test was a bench, a weight bar (5 or 6 feet in length) and enough weight plates to be more than sufficient for the strongest student.

Procedure

The subjects were made to lie on their back on a bench that was approximately 10 to 14 inches wide. Partners helped them to lower the weight slowly to their chest and then attempt to raise the weight until their arms were straight.

Scoring

The maximum weight lifted by the subject was recorded in pounds.

**Jump and reach test**

Purpose

The test was to measure the explosive power of the legs in jumping vertically upward.

Equipment and facilities

A measuring tape, several pieces of chalk and a smooth wall surface of at least 12 feet from the floor were required.

Procedure

The subjects stood with one side towards the wall, heels together and held a one-inch piece of chalk in the hand nearest to the wall. Keeping the heels on the floor, they reached high and made a reach mark on the wall.
Then they resumed their position, jumped as high as possible and made a jump mark on the wall.

Scoring

The number of centimeters between the reach and the jump mark measured to the nearest half centimeter was the score. Two trials were allowed and the best trial was recorded as the score.

50 yards dash

Purpose

The purpose of the test was to measure the speed of the subjects.

Equipments and Facilities

Stopwatches, clappers and the distance was marked with 50 yards.

Procedure

The subjects (two at a time) stood behind the starting line. On getting the signal (the clap), the subjects ran as fast as possible across the finishing line.

Scoring

The amount of time elapsed between the start and the moment the subjects crossed the finish line was recorded to the nearest tenth of a second.

Margaria-Kalamen power test

Purpose: To measure the anaerobic power.
Equipments and Facilities

Stopwatch, stairs (an average stair is about 174 mm high)

Procedure

The subjects stood 6 meters in front of a staircase. At the signal they ran up the stairs as rapidly as possible, taking three steps at a time (Figure-3.1). The switch mats were placed on the third and ninth stairs. A clock was started as the subjects stepped on the first switch mat (on the third step) and stopped as they stepped on the second switch mat (on the ninth step).

Scoring

Time was recorded to a one-hundredth of a second. Three trials were given to each subject and the best was considered for computing anaerobic power by using the following formula:
\[ P = \frac{W \times D}{T} \]

\( W = \) Weight of the subject (Kg)
\( D = \) Vertical height between first and last stairs (m).
\( T = \) Time from first to last stairs (sec).

**The Queen’s College step test**

**Purpose**

The purpose of the test was to determine maximum oxygen consumption.

**Equipment**

Stepping bench (41 cm high), stop watch and metronome.

**Procedure**

The test was conducted with a bench 41 cm high. To establish step cadence the metronome was set at 28 beats/min. The subjects were allowed to practice a brief period of 5 to 10 seconds the step rhythm to adjust to the cadence of the metronome. The sequence was left up, right up, left down and right down each element to a single metronome beat. The subjects performed the step-ups for exactly 3 minutes. At the end of the 3 minutes exercise period the subjects remained standing for 5 seconds. Then the pulse was counted at the carotid artery for 15 seconds. This was multiplied by four to give the heart rate score in beats/minutes (bpm). The maximum oxygen consumption in ml/kg/min was calculated according to the following equation:
Maximum oxygen uptake = 65.81 - 0.1847 x recovery heart rate in beats per minute (bpm)

**Resting heart rate**

**Purpose**

To record the resting heart rate of each subject per minute

**Equipment**

Stethoscope

**Procedure**

To determine the resting heart rate, the subject was asked to lie down on the table comfortably. The chest piece of the stethoscope was applied on the 5th left intercostals space of the body. The heart rate was recorded by hearing the sound lub-dub which was taken as one beat.

**Scoring**

The number of beats per minute was recorded as the resting heart rate.

**AAHPERD (American Alliance of Health Physical Education Recreation and Dance) BASKETBALL SKILL TEST**

The AAHPERD (American Alliance of Health Physical Education Recreation and Dance) basketball skill tests are Speed spot shooting test, passing test, Control dribble test and Defensive movement test. The following skill tests were considered in this study.
Speed spot shooting test

Purpose

To measure skill in rapidly shooting from specific positions and to a certain extent and ball handling.

Equipments and Facilities

Basketballs, half of a regulation size Basketball court, stop watch, measuring tape and score cards.

Procedure

The subjects began the test with one foot behind anyone of the five markers. The 15 foot markers were appropriate for college students. The
The examinee took the first of the three 60 seconds trial. The ball was shot, retrieved, dribbled to the next marker and shot again. At least one spot was taken from the marker, four lay-ups were permitted during the testing period but no two should be taken consecutively. Two points were awarded for each shot made. One point was given for each unsuccessful shot that hit the rim. The total test score was the sum of scores for the two trials.

**Passing test**

**Purpose**

To measure skill in passing and recovering the ball accurately while moving.

**Equipments and Facilities**

Smooth wall surface of 30 feet, Basketballs, stop watch, floor tape, wall tape and score cards.

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The diagram illustrates the passing test setup with markers spaced at intervals. The examinee starts at point A and follows the sequence through points B, C, D, E, and F, passing through each marker in order.

![Diagram](image-url)

Figure 3.3
Procedure

The subjects held the ball and assumed a ready position behind the restraining line opposite the target. On hearing the signal the ball was passed to the first target. After a rebound it was recovered while moving in line with the second target. The sequence was continued while the last target was reached. The ball was passed twice to the last target and then the subjects moved back towards the first target attempting to hit each target in succession. The trial was terminated at the end of 30 seconds. Three trials were taken and the first was a practice trial. Only chest pass was allowed throughout the test. Two points were awarded for each pass hitting within the target or on the target. Each pass hitting the wall between targets scored one point. The total test score was the sum of scores for the two trials.

**Control dribble test**

Purpose: To measure skill in dribbling the ball while the body is moving.

Equipments and Facilities

Half of a regulation-size Basketball court, Basketballs, six cones, stop watch and score cards.

Procedure
The subjects began the test at cone A as shown in the Figure. On hearing the signal the ball was dribbled with the non-dominant hand to the non-dominant side of cone B. Then the preferred hand could be used to dribble the ball. The watch was stopped as the subjects crossed the finish line. The first trial was a practice trial and the next two trials were recorded. The trial score is the time required to complete the course legally. Each trial score was recorded to the nearest tenth of a second. The total test score was the sum of the times for two trials.

3.9 TRAINING PROGRAMME

The procedure adopted in the training programme for the present study is described below:

1. During the training period, Group-I underwent Low Volume Circuit Type Resistance Training (LVCTRT) programme and Group-II underwent Periodized High and Low Volume Circuit Type Resistance-Training (PHLVCTRT) programme, Group-III served as Control Group (CG) who were not inducted into any specific training programme.
2. The intensity for the Low Volume Circuit Type Resistance Training (LVCTRT Group I) and Periodized High and Low Volume Circuit Type Resistance Training (PHLVCTRT Group II) was fixed on the basis of the results of the pilot study.

3. The training programme for Group-I (LVCTRT) and Group-II (PHLVCTRT) was carried out at Nirmala College for Women, Coimbatore. The subjects of Group-I (LVCTRT) and Group-II (PHLVCTRT) underwent their respective training programme as per schedules under the supervision of certified personal trainers who provided motivation, advice and encouragement to the subjects. Each day the training schedule was conducted only in the morning session that lasted for fifty minutes. Prior and after every training session subjects of experimental groups had ten minutes of warm up and ten minutes of warm down exercises involving jogging, mobility and stretching exercises.

**Warm up exercises**

The first phase of preparing the body for strenuous training activity is to warm-up. Stretching exercises increases readiness to perform and helps prevent injuries. Care should be taken to prevent injury by moving slowly, focusing on the muscle when changing the stretching position from one position to another. Go to the point where there is moderate amount of tension holding the position for 10 to 15 seconds mentally and then relax. To develop the flexibility throughout the body the following exercises were done in sequence from upper body to lower body. Neck stretch, arm stretch, pec stretch, camel stretch, shoulder stretch, triceps stretch, side
bend, supine trunk stretch, knee roll, double leg hug, quadriceps stretch and back saver stretch.

**Warm down exercises**

After every training session subjects of experimental groups had ten minutes warm down exercises by performing simple stretches, without bouncing or a slow aerobic routine similar to a warm up. Warming down exercise is also necessary to remove waste products that accumulate in the muscles as result of exertion. Stopping exercises abruptly can cause a sudden drop in blood pressure because when the heart stops pumping hard, the blood can pool in the veins.

### 3.9.1 LOW VOLUME CIRCUIT TYPE RESISTANCE TRAINING (LVCTRT) PROTOCOL - Group - I:

The following schedule was followed for Group I (LVCTRT)

**Table 3.2 TRAINING SCHEDULE**

<table>
<thead>
<tr>
<th>Training factors</th>
<th>Twelve weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>Three days per week</td>
</tr>
<tr>
<td>Warm up</td>
<td>10 minutes (before every training session)</td>
</tr>
<tr>
<td>Warm down</td>
<td>10 minutes (after every training session)</td>
</tr>
<tr>
<td>Duration of the circuit exercise</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Rest in between exercises</td>
<td>1-2 minutes</td>
</tr>
<tr>
<td>Duration of training session</td>
<td>Fifty minutes</td>
</tr>
<tr>
<td>Intensity</td>
<td>50% to 90% of 1RM progressive method</td>
</tr>
</tbody>
</table>
Table 3.3 reveals the description of training intensity and number of repetitions for Low Volume Circuit Type Resistance Training (LVCTRT Group I). The subjects in the LVCTRT Group I were trained on 3 alternated days per week. Their workouts were done in a single-set fashion with 1 to 2 minutes rest between exercises. During the sets the subjects performed 8-12 repetitions. If the individual was able to perform 12 or more repetitions for a set without assistance, the resistance was increased for the following session. To reduce training boredom, the subjects alternated between two

<table>
<thead>
<tr>
<th>week</th>
<th>Low Volume Circuit Type Resistance Training</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intensity</td>
<td>Repetitions</td>
</tr>
<tr>
<td>1</td>
<td>50%</td>
<td>8-12</td>
</tr>
<tr>
<td>2</td>
<td>50%</td>
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</tr>
<tr>
<td>3</td>
<td>55%</td>
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<td>60%</td>
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<td>10</td>
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<tr>
<td>11</td>
<td>75%</td>
<td>8-12</td>
</tr>
<tr>
<td>12</td>
<td>80%</td>
<td>8-12</td>
</tr>
</tbody>
</table>
different circuits (circuits A and circuits B) in the same exercise order throughout the twelve weeks period.

TABLE – 3.4

RESISTANCE EXERCISES FOR CIRCUITS

<table>
<thead>
<tr>
<th>S. No</th>
<th>Exercises for Circuit - A</th>
<th>Exercises for Circuit - B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arm curl</td>
<td>Hammer curl</td>
</tr>
<tr>
<td>2</td>
<td>Half squat</td>
<td>Lunges</td>
</tr>
<tr>
<td>3</td>
<td>Triceps push down</td>
<td>Triceps extension</td>
</tr>
<tr>
<td>4</td>
<td>Calf raise</td>
<td>Seated calf raise</td>
</tr>
<tr>
<td>5</td>
<td>Military press</td>
<td>Shoulder press</td>
</tr>
<tr>
<td>6</td>
<td>Leg extension</td>
<td>Bench steps</td>
</tr>
<tr>
<td>7</td>
<td>Up right row</td>
<td>Seated row</td>
</tr>
<tr>
<td>8</td>
<td>Leg curl</td>
<td>Leg press</td>
</tr>
<tr>
<td>9</td>
<td>Rotator cuff</td>
<td>Dumbbell Fly</td>
</tr>
<tr>
<td>10</td>
<td>Modified sit-ups</td>
<td>Prone trunk extension</td>
</tr>
</tbody>
</table>

The description of the resistance exercises are presented below:

CIRCUIT ‘A’ EXERCISES

Arm curl

Subjects were asked to stand with legs slightly bent, feet hip-width apart, arms straight and close to the body. The elbows should be up to the chest. They had to straighten the arms with palms up or facing the ceiling and lower the weights to the starting position.
**Half squat**

The subjects were asked to stand erect with the weight balanced comfortably across the top of the shoulders. Using an overhand grip, hands spread shoulder width apart; the weight was lowered by bending the knees to a 90-degree angle and returned to the starting position by keeping the back straight. This exercise was repeated for 30 seconds.

**Triceps push down**

Using a high-cable pulley, the subjects were asked to grasp a short straight bar with an overhand grip with hands about 10 inches apart, forearms positioned parallel to the floor and feet shoulder width apart, knees bent slightly and elbows locked in close to the body and wrists straight. Keeping the whole body steady, the bar had to be pushed down as far as possible towards legs, locking arms and feeling the triceps full contract with the upper arms close to the body. They had to return to the starting position using the same motion. They had to stand straight up without moving their elbows or torso.

**Calf raise**

The subjects had to flex the feet to lift the body. A weight rested upon the shoulders, or held in the hand(s). This is an isolation exercise for the calves, and particularly emphasizes the gastrocnemius muscle.

**Military press**

The subjects were asked to perform while seated, by lowering a weight held above the head just above the shoulders, and then raising it again. It can be performed with either arms or both at a time.
**Leg extension**

The subjects were asked to sit with their feet under the padded lever and raise the weight with their quads. The leg extensions are an excellent quad developer.

**Up right row**

Subjects were asked to hold dumbbells about 10 inches apart, thumbs facing in, hanging, against upper thighs. They had to lead with the elbows and raise the arms until the upper arms are shoulder height with elbows up and out. After a pause for 1 second, they had to slowly return to the starting position. This exercise was repeated for 30 seconds.

**Leg curl**

The leg curl was performed while lying face down on a bench, by raising a weight with the feet towards the buttocks. This is an isolation exercise for the hamstrings and is very important in the prevention of hamstring pulls.

**Rotator cuff**

The subjects performed a series of lateral raises, slightly altering the hand position for each one. By holding a light dumbbell in their hand, they can use three different hand grips, thumbs facing the ceiling (palms facing inwards), palms facing the ground, and thumbs facing the ground, the dumbbell had to be raised up to shoulder level. Subjects had to perform 8-12 repetitions per arm and per hand position. This really helps to target their shoulder muscles from a variety of different angles.
**Modified sit-ups**

The subjects were asked to lie down on the floor with upper knees bent, balls of their feet and heels placed flat on the ground. They crossed their arms across their chest and touch their shoulders. They tightened their abdominal muscles by drawing in their belly button to their spine. With the heels and toes flat on the ground, the head has to be lifted first, followed by the shoulder blades all the while contracting the abdominal muscles. After holding the position for a second, the torso was slowly brought back slightly elevated off the ground. This means they were not allowed their back flat to the ground but to keep slightly off the ground.

**CIRCUIT ‘B’ EXERCISES**

**Hammer curl**

The subjects performed the hammer curl while standing or seated, with hands hanging down holding weights, palms turned inwards by curling them up to the shoulders. It can be performed with either arms or both at a time. This is an isolation exercise for the biceps and forearms.

**Lunges**

The subjects were asked to stand with a dumbbell in each hand, feet 8 inches apart toes pointing straight ahead, step about 2-3 feet forward with their left leg. They had to lower the body until the right knee is about 3 to 4 inches from the ground and step back with left leg and return to the starting position, then repeat. This exercise should be done slowly and completely in about three to five seconds.
**Triceps extension**

The subjects were asked to sit erect and palms facing up, bar resting behind neck on shoulder, hands near center of the bar, feet shoulder width spread apart, tighten abdominal and back muscles. The bar was raised over the head and returned to the original position. This exercise was repeated for 30 seconds.

**Seated calf raise**

The subjects were asked to flex their feet to lift a weight held on the knees. This is an isolation exercise for the calves, and particularly emphasizes the soleus muscle performed on a seated calf raise machine.

**Shoulder press**

The subjects were asked to sit erect bending their elbows, with palms facing forward at chest level, and hands spread shoulder width apart and feet spread. They also tightened the abdominal and back muscles. The bar was moved to overhead position (arms straight) and then lowered to chest position. This exercise was repeated for 30 seconds.

**Bench steps**

The subjects were asked to stand in front of the bench with dumbbells and step up with the right foot per count one step up with the left foot per count two, step down with the left foot per count three and then with the right foot per count four. In this exercise one step was completed after both feet were on the ground in the starting position. They performed at a pace of 25-30 steps per minute for up to three minutes depending on the level of fitness. After every five steps the subjects changed their lead leg.
**Seated row**

The subjects took position on the seat of the rowing machine with their knees slightly bent and their back straight. They reached forward to grab the handle. Exhaled as they pulled their hands back towards their chest, pulled their shoulder blade back. Inhaled as they returned the weight to the starting position.

**Leg Press**

The subjects were asked to sit on the seat with the back resting on the back seat and the seat was adjusted so that the thigh touches the abdominal region. They had to keep the feet on the pressing pedal and press the leg against the body. Then they extended the legs with slight knee bending, lowered the feet to rest slowly and evenly towards the body without moving the pelvis. They stopped the movement when the knee was 45° angle to the hip. This exercise develops the Quadriceps, Gluteus, Hamstring and Gastrocnemius muscles.

**Dumbbell Fly**

This exercise is done lying on a flat bench. The subjects had to take two dumbbells and extend to full extensions over the face and then bend the elbows slightly and slowly lower the dumbbells down away from the body. To get a good stretch they brought the dumbbells up with the same plane of motion. This exercise works the chest.

**Prone trunk extension**

The subjects had to begin by lying face down on the floor with the legs straight and arms extended straight forwarded. Slowly raise the chest shoulder and arms up toward the ceiling as high as they can, keeping the
toes in contact with the floor at all times. They slowly lowered the chest, shoulder and arms down to the floor, but not to rest on the floor. They maintained some muscle tension throughout their back for the entire exercise and slowly repeated this up and down action for the maximum number of repetitions. The prone trunk extension strengthens the muscles of the upper and lower back. These muscles coordinate with the abdominal and oblique to stabilize the trunk during all running activities.

3.9.2 PERIODIZED HIGH AND LOW VOLUME CIRCUIT TYPE RESISTANCE TRAINING (PHLVCTRT) PROTOCOL – Group – II

This study focused on periodization within a mesocycle. A mesocycle, which includes 12 weeks of training period, is frequently prescribed to increase the basic strength and power of athletes (Beachle and Earle, 2000). Most strength professionals agree that strength training programme should be periodized (Plisk and Stone, 2003). Undulating periodization is a form of periodization, characterized by more frequent changes in intensity and volume. In undulating programme, the volume and intensity are acutely varied by workouts (daily) (Hoffman ET, 2003). In undulating programme the subjects in the first phase (1,2,3,4,5 and 6th week) performed 3 sets with 16-18 repetitions of 50% of 1 RM load on the first training day of the week (Monday), three sets with 14-16 repetitions of 60% of 1 RM load on the next training day (Wednesday) and 3 sets with 12-14 repetitions of 70% of 1 RM load on the next training day (Friday).

In the second phase (7, 8, 9,10th week) the subjects performed 3 sets with 10-12 repetition of 70% of 1 RM on the first training day of the week (Monday) three sets with 8-10 repetitions of 75% of 1 RM load on the next
training day (Wednesday) and 3 sets with 6-8 repetitions of 80% of 1 RM load on the next training day (Friday)

In the third phase (11th and 12th week) the subjects performed 3 sets with 4-6 repetitions of 80% of 1 RM load on the first training day of the week (Monday), three sets with 3-4 repetitions of 85% of 1 RM load on the next training day (Wednesday) and 3 sets with 2-3 repetitions of 90% of 1 RM load on the next training day (Friday).

The daily undulating periodization programme provides daily changes and this provides a frequent change in neural stimulation. This frequent change in stimulation is thought to be highly beneficial for strength gains. It is also speculated that during the frequent light workouts common to the undulating model, the slow twitch fibers will be exercised while the fast twitch fibers are afforded rest, thus preventing overtraining (Brown, 2001).

The training period of 12 weeks was divided into three phases. The first phase was the hypertrophy phase (1, 2, 3, 4, 5, 6 weeks) where the primary goal is to increase muscular development or a strength endurance phase. During this phase training volume was very high (3 sets of 12-18 repetitions) and intensity was very low (50-70% of the 1 RM) which is conducive for increasing lean body mass and muscular endurance. This muscular strength endurance development will provide a base for more intense training in later phases (Beachle and Earle, 2000; Graham, 2002).

The second phase was for basic strength, which aims to increase the strength of the muscles vital to the primary sport movement. During the basic strength phase the intensity was high (70-80% of the 1 RM) and volume was moderate (3 sets of 6-12 repetitions).
Lastly is the strength/power phase. During this phase, the primary goal was to increase the speed of the free development of the muscles or increase muscle power (Graham, 2002). Here the intensity was increased to near a competition level that is 80-90% of the 1 RM. The volume during this phase was low (3 sets of 2-6 repetitions (Beachle and Earle 2000)). The following schedule was followed for Group II (PHLVCTRT)

**TABLE 3.5**

TRAINING INTENSITY AND NUMBER OF REPETITIONS PERFORMED BY THE PERIODIZED HIGH AND LOW VOLUME CIRCUIT TYPE RESISTANCE TRAINING (PHLVCTRT GROUP II)

<table>
<thead>
<tr>
<th>Week</th>
<th>Training Session</th>
<th>Repetitions</th>
<th>Sets</th>
<th>%1RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>16-18</td>
<td>3</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>14-16</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12-14</td>
<td>3</td>
<td>70%</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>16-18</td>
<td>3</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>14-16</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>12-14</td>
<td>3</td>
<td>70%</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>16-18</td>
<td>3</td>
<td>50%</td>
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<tr>
<td></td>
<td>8</td>
<td>14-16</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>12-14</td>
<td>3</td>
<td>70%</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>16-18</td>
<td>3</td>
<td>50%</td>
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<td></td>
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<td>14</td>
<td>14-16</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>12-14</td>
<td>3</td>
<td>70%</td>
</tr>
</tbody>
</table>

96
The subjects in the periodized resistance training group were trained on 3 alternate days per week. Their workout was done in a three set fashion with 1-2 minutes rest between exercises during the sets. If the subjects were able to perform concerned repetitions without assistance, the resistance was increased for the following session. To reduce training boredom the subjects alternated between two different circuits in the same exercise order.
as administered for the low volume circuit type resistance training through out twelve weeks period.

3.10 COLLECTION OF DATA

At the end of the treatment period, as post-test, the subjects belonging to the treatment groups namely Low Volume Circuit Type Resistance Training (LVCTRT Group I), Periodized High and Low Volume Circuit Type Resistance Training (PHLVCTRT Group II) and Control Group (CG Group III) were tested on criterion variables of abdominal muscular strength and endurance, grip strength-right hand, grip strength-left hand, lower extremity strength, upper extremity strength, explosive power, speed, anaerobic capacity (physical variables), maximum oxygen consumption, resting heart rate (physiological variables), dribbling, passing, shooting (skill performance variables) as in the pre-test. The collected data were processed with appropriate statistical tools and the detailed procedure of the same is given below.

3.11 STATISTICAL ANALYSIS OF DATA

The present study pays attention mainly on testing the means differences of three groups and secondarily deals with the increase of means differences in each group from baseline to post treatment for various measures. The statistical tool used for these are described here. Analysis of covariance was applied to determine whether the three programmes of training produced significantly different improvements in selected variables after 12 weeks of training. Since the initial means were not matched, comparisons between actual means could not be made, so all the means were adjusted by regression to a common mean. The adjusted means equaled the actual means minus the product of the regression coefficient
and the difference between the initial group mean and initial common mean of all groups. The significance of difference of pairs of adjusted final group means was tested for significance by applying Scheffe’s post hoc test.

Further, the group mean gains (pre and post-test) recorded by three groups during the experimental period of twelve weeks to the criterion measures were tested for significance by applying student’s ‘t’ – test.