Chapter III

PROCEDURE

In this chapter the selection of subjects, selection of variables, criterion measures, experimental design, reliability of data, collection of data, experimental training programme, procedure for administration of the tests and statistical techniques employed for the analysis of data are described.

Selection of subjects

For the purpose of the study 80 male school level players from The Lawrence school, Lovedale, Hebron school, and Laidlaw school, Ooty were randomly selected as the subjects for the study. The age of subjects ranged between 13-18 years. It was ascertained from the health examination reports maintained by school that all the subjects were medically fit. All the subjects were randomly assigned to four groups: three experimental groups viz: plyometric training group (Group A), circuit training group (Group B), and circuit breaker programme group (Group C) and the fourth group served as the control group, each consisting of 20 subjects.

Selection of Variables

Based on the literature reviewed, discussion with experts, scholar’s own experience and keeping the feasibility criteria in mind, the following motor and physiological variables were selected for the present study.
Motor components

1. Power (Leg, Shoulder and Arm)
2. Muscular Endurance
3. Speed
4. Agility
5. Cardio-respiratory endurance
6. Flexibility (Shoulder, Spine, Hip and Back)
7. Balance (Static and Dynamic)

Physiological variables

1. Resting heart rate
2. Exercise heart rate
3. Resting respiratory rate
4. Vo2 max
5. Cardio-pulmonary index

Criterion Measures

Motor components:

1. The distance covered by the subjects in meters for best of the three trials on standing Broad Jump was recorded as the score on leg power.

2. Shoulder and arm power were measured in meters for best of the three trials using Two Hand Medicine Ball Put Test.

3. Muscular endurance for whole body was recorded in numbers of correctly executed squat thrust in one minute using Burpee Test.
4. Speed was recorded to the nearest 1/10th of a second using 50 yard Dash.

5. Agility was assessed by the time taken to the nearest 1/10th of a second to complete the course of the right Boomerang Run.

6. Cardio-respiratory endurance was assessed by the time taken in minutes to complete 1.5 mile Run.

7. Score recorded to the nearest quarter of an inch in Sit and Reach Test indicated the score of hip and back flexibility.

8. Spine flexibility was recorded in inches using Bridge Up Test.

9. Shoulder flexibility was recorded in inches using Shoulder Rotation Test.

10. Static balance was recorded in seconds using Stork Stand Test.

11. Dynamic balance was assessed using Modified Bass Test. The scores were the points obtained by each subject out of a maximum of hundred points.

**Physiological variables**

1. Resting heart rate was assessed by the number of heart beats per minute by palpation at the carotid artery, when the subject was under physical and mental rest.

2. Exercise heart rate was assessed by the number of heart beats per minute, by palpation at the carotid artery, immediately after the exercise.
3. Resting respiratory rate was assessed by the number of respiratory movements per minute, when the subject was under physical and mental rest.

4. $V_{O_2}$ Max was measured with the help of Astrand-Astrand nomogram.

5. Cardio pulmonary index was calculated by using vital capacity (VC) in 100ml unit, maximum expiratory pressure (MEP) in Hg.mm, maximum breath holding (MBH) in seconds, age in completed years, systolic blood pressure(SP) and diastolic blood pressure (DP) in Hg.mm and resting pulse rate (PR) beats per minute, using the following formula derived by Hyman.

$$CPI = \frac{VC + MEP + MBH + Age}{SP + DP + PR}$$

**Experimental Design**

Random group design was employed in this study. Both subjects as well as the experimental treatments were randomly assigned to the three experimental groups and one control group, consisting of 20 subjects each. The subjects were administered the initial test which was followed by 12 weeks of plyometric, circuit, and circuit breaker training programme and after 12 weeks final scores on the criterion variables were recorded.
Reliability of Data

The reliability of data was ensured by establishing the instrument reliability, the tester’s competency, reliability of test and subject reliability in administering the test.

Sphygmomanometer, Stethoscope, Dry Spirometer, Measuring Tape, Medicine Ball, Stop Watches and Yard Stick were all standardised and calibrated instruments available from the medical laboratory of Nilgiri District Medical Hospital and the Health clinic of the Lawrence school, Lovedale, Ooty. The concerned suppliers guaranteed the calibration of the instruments and that ensured instrument reliability for the purpose of the study.

To ensure testers competency in the collection of data the investigator had a number of practice sessions in the testing procedures under the guidance and assistance of experts working at the Nilgiri District Medical Hospital who were well acquainted with the tests and the testing procedures. The tester’s competency was established together with reliability of the test by test-re-test method. The data collected in all the selected tests on 20 subjects for the initial test and the retest were subjected to product moment correlation. The high correlation coefficient obtained for the test-re-test scores (shown in tables 1 and 2) ensured the investigator's competency in the data collection.
### TABLE-1

**Reliability Coefficients for the Test-Re-Test Scores on the Selected Motor Components**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Reliability Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg power (Standing Broad Jump)</td>
<td>0.99</td>
</tr>
<tr>
<td>Shoulder and Arm Power</td>
<td>0.98</td>
</tr>
<tr>
<td>(Two Hand Medicine Ball Put Test)</td>
<td></td>
</tr>
<tr>
<td>Muscular endurance (Burpee Test)</td>
<td>0.99</td>
</tr>
<tr>
<td>Speed (50 yards dash)</td>
<td>0.98</td>
</tr>
<tr>
<td>Agility (Right Boomerang Run)</td>
<td>0.97</td>
</tr>
<tr>
<td>Cardio respiratory endurance (1.5 mile Run)</td>
<td>0.87</td>
</tr>
<tr>
<td>Hip and back flexibility (Sit and Reach Test)</td>
<td>0.97</td>
</tr>
<tr>
<td>Spine flexibility (Bridge Up Test)</td>
<td>0.94</td>
</tr>
<tr>
<td>Shoulder flexibility (Shoulder Rotation Test)</td>
<td>0.97</td>
</tr>
<tr>
<td>Static balance (Stork Stand Test)</td>
<td>0.97</td>
</tr>
<tr>
<td>Dynamic balance (Modified Bass Test)</td>
<td>0.97</td>
</tr>
</tbody>
</table>
TABLE-2
RELIABILITY COEFFICIENTS FOR THE TEST RE-TEST SCORES
ON THE SELECTED PHYSIOLOGICAL VARIABLES

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>RELIABILITY COEFFICIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting heart rate</td>
<td>0.97</td>
</tr>
<tr>
<td>Exercise heart rate</td>
<td>0.96</td>
</tr>
<tr>
<td>Resting respiratory rate</td>
<td>0.98</td>
</tr>
<tr>
<td>VO_2 max</td>
<td>0.96</td>
</tr>
<tr>
<td>Cardio pulmonary index</td>
<td>0.96</td>
</tr>
</tbody>
</table>

The above test-re-test coefficients of correlation also established the reliability of subjects because the same tester used the same subjects under similar conditions and no motivational techniques were used during testing.

**Collection of Data**

The data was collected by administering the tests for the chosen variables such as standing broad jump, two hand medicine ball put test, burpee test, 50 yard dash, right boomerang run, 1.5 mile run, sit and reach test, bridge up test, shoulder rotation test, stork stand test, modified bass test, resting heart rate, exercise heart rate, resting respiratory rate, VO_2 max and cardio pulmonary index.
The tests were administered in the Tennis complex and the science laboratory of The Lawrence School, Lovedale, Ooty. The pre-test data was conducted in first week of February 2001 and post test data was administered at the end of April 2001.

To ensure uniformity, collection of data was performed, only during specific time i.e. between 3.30pm to 5.00pm. 7 days were utilised in the collection of data each time.

The tests used in collecting the data were explained to the subjects prior to the administration of the test. The subjects were given a chance to practice the test, so as to make them familiar with the tests.

**Procedure for Administration of Tests**

The subjects selected for this study were assembled at tennis complex of The Lawrence school, Ooty. They were oriented regarding the objectives and requirements of the test items. The subjects were requested and motivated for whole hearted participation towards success of the study.

For the test administration different stations were formed. Before they were asked to perform the test, the exercises assigned were explained and demonstrated by the research scholar. After demonstration subjects were asked to perform the same.
Motor Components

**Leg power (Standing Broad Jump)**

**Objective:** To assess the Power of the leg\(^1\).

**Equipment and Marking:** A gymnastic mat, a 10mts measuring tape, a take off line was marked in front of the mat, and some coloured chalks.

**Procedure:** The subject stood behind the take off line with feet slightly apart and swung the arms backward, bending the knee. The jump was accomplished by simultaneously extending the knee and swinging the arms forward.

**Scoring:** The maximum distance covered recorded in meters and centimeters between the take off line, and to the nearest mark made on the mat by any part of the subject's body as the performance in standing broad jump. Best of the three trials was recorded as the final score of the subject.

**Shoulder and Arm Power (Two Hand Medicine Ball Put (6lb))**

**Objective:** To measure the power of the arms and shoulder\(^2\).

**Equipment:** A 6lb medicine ball, marking chalks, small rope, chair and a measuring tape.

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\(^1\) L. Johnson and K. Nelson, *Practical Measurements for Evaluation in Physical Education* P. 206.

\(^2\) Ibid P. 208.
Procedure: The subject sat on a chair by holding a medicine ball (6lb) in both the hands close to the chest. Then the performer pushed the ball upward and outward for maximum distance. A rope was placed around the subject's chest and held at rear by a partner in order to eliminate rocking action during push as shown in Figure-1.

Scoring: The distance of the best out of 3 trials measured to the nearest centimeters was recorded as the score. The distance was measured from the forward edge of the chair to the point of contact of the ball with the floor.

Muscular Endurance (Burpee Test)

Objective: To assess the general muscular endurance of the body\(^3\).

Equipment: Stop watch.

Procedure: From standing position the subject, on count one, flexed the knees and hip, placed the hands on the floor in front of the feet, on count two, thrusted the legs backward to front leaning rest position, count three, returned to the squat position as in the first count and count four, stand erect. On signal 'go' the subject repeated all these movements in sequence for one minute as rapidly as possible.

Scoring: Number of correctly executed squat thrusts in one minute out of two trials was considered as the score of the test.

\(^{3}\) L. Johnson and K. Nelson, *Practical Measurements for Evaluation in Physical Education* P. 133.
FIG. 1 – THE SUBJECTS PERFORMING IN MEDICINE BALL PUT TEST

Speed (50 yard Dash)

Objective: The purpose of the test was to measure the speed of the subjects in running.

Equipment and marking: Stop watch, clapper and the distance was marked with two parallel lines of 5mts each 50 yards apart.

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

Scoring: The elapsing time from the starting signal until the runner's torso crossed the finish line was measured to the nearest one tenth of a second as score.

Agility (Right Boomerang Run)

Objective: To measure the agility in running and changing direction.

Equipment and marking: Chair, 4 cones, stop watch, start and finish line. A center point was marked 17 feet away from the starting line with turning points identified at 4 corners 15 feet on each side of the center point. The set up for this test is diagramed in figure-2.

Procedure: The subject stood behind the starting line, on getting the starting signal 'go' the subject ran to the center station took a quarter right turn and completed the course as shown in figure-2.

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5 L. Johnson and K. Nelson, Practical Measurements for Evaluation in Physical Education P.223.
Cardio respiratory Endurance (1.6 mile Run)

Objective: To assess the cardio respiratory endurance of the subject.

Equipment and marking: Stop watches and clapper, 400m track was used to conduct this test.

Procedure: The subjects took standing start position behind the starting line. The starter gave the start by a clapper using command ‘on your mark’ then sounded the clapper. Subjects tried their best to finish the 1.6 mile distance. Few spotters were positioned at the finishing point to watch their runners and record the time.

Note: The drawing is from the starting signal, until the runner completed the 1.6 mile distance was measured in minutes and seconds.

Hip and Back Flexibility (Standing Reach Test)

Objective: To assess the hip and back flexibility of the subject.

Equipment and marking: A plumb bomb, scale, gymnastic mat, cross board, stem board and a piece of plywood 24 by 8 inches; the center is marked 0, inch lines on one side were marked 1, 2, 3, and so on to 12; and those on the other side -1, -2, -3, and so on with the near

FIG. 2 RIGHT BOOMERANG RUN TEST.
Scoring: The score was the time taken to complete the course. The time was recorded to the nearest tenth of second.

**Cardio respiratory Endurance (1.5 mile Run)**

**Objective:** To assess the cardio respiratory endurance of the subjects⁶

**Equipment and marking:** Stop watches and clapper, 400mts track was used to conduct this test.

**Procedure:** The subjects took standing start position behind the starting line. The starter gave the start by a clapper using command ‘on your mark’ then sounded the clapper. Subjects tried their level best to finish the 1.5 mile distance. Few spotters were positioned at the finishing point to watch their runners and record the time.

**Scoring:** The elapsing time from the starting signal, until the runner completed the 1.5 mile distance was measured in minutes and seconds as score.

**Hip and Back Flexibility (Sit and Reach Test)**

**Objective:** To assess the hip and back flexibility of the subjects⁷.

**Equipment and marking:** A plat form scale, gymnastic mat, cross board, stem board and a piece of plywood 24 by 8 inches; the center is marked 0, inch lines on one side were marked 1,2,3, and so on to 12; and those on the other side -1,-2,-3, and so on to -12. The zero line coincided with the near

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⁷ Ibid. P.79.
surface of the cross board and the minus marking towards the subject.

**Procedure:** The subject took a long sitting position on the mat with shoe removed. Feet were placed firmly against the cross board. The arms were extended forward, with hands placed palms down on the upper surface of the scale. In that position, subject bobbed forward 4 times and holds the position of maximum reach on the fourth count. The knees kept straight.

**Scoring:** The maximum reach measured to the nearest half inch was recorded as the score.

**Spine flexibility (Bridge-Up Test)**

**Objective:** The purpose of the test was to measure the spine flexibility of the subject\(^8\).

**Equipment:** Yard stick and a ruler guide.

**Procedure:** The subject took a spine position on the floor and pushed upward arching the back. Subject tried to bring his hands and feet as close together as possible. The zero of the yard stick was placed on the floor vertically and the ruler guide was placed to the maximum point of back arch as shown in Figure-3.

**Scoring:** The best score out of two trials was recorded and then subtracted from the standing height (Naval to the floor)

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\(^8\) L. Johnson and K. Nelson, *Practical Measurements for Evaluation in Physical Education* P.80.
FIG. 3 - THE SUBJECTS PARTICIPATING IN BRIDGE UP TEST.
Shoulder flexibility (Shoulder Rotation Test)

Objective: To assess the shoulder flexibility of the subjects\(^9\).

Equipment: 60 inches rope.

Procedure: Subject grasped one end of the 60 inches of rope with left hand and grasped the rope few inches away with right hand. Both arms were extended fully in front of chest and rotated the rope over the head and back to the starting position as shown in Figure-4. Performance was measured as the distance in inches between the right and left thumbs.

Scoring: Shoulder width was subtracted from the best score of three trials.

Static Balance (Stork Stand Test)

Objective: To measure the static balance of the performer\(^{10}\).

Equipment: Stop watch.

Procedure: The subject stood on the foot of the dominant leg and placed the other foot on the inside of the supporting knee. Hands were kept on the hips. On a given signal 'up' the subject raised the heel from the floor and maintained the balance as long as possible without moving the ball of the foot from its initial position or letting the heel touch the floor.

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\(^9\) L. Johnson and K. Nelson, Practical Measurements for Evaluation in Physical Education P.86.

\(^{10}\) Ibid. P.227.
Dynamic Balance (Modified Bass Test)

Objective: To assess the dynamic balance of the subject.

Equipment: A white plastic mat 2.5 m x 1.5 m, a 2 m long measuring tape, a timer, two wooden blocks.

Procedure: The subject stands on the white plastic mat with their feet shoulder-width apart. They take one foot off the ground and try to remain on the ball of the foot for as many seconds as possible. The test is repeated with the other foot. If the subject maintains balance for 3 seconds, full score is awarded. If the subject maintains balance for 2 seconds, half score is awarded. The number of successful trials is recorded. Each successful trial is worth 5 points.

Scoring: The score for each mark successfully landed was five points. In addition, one point was awarded for each second the balance was held up to 5 seconds per mark. Thus, a performer could score 70 points per mark up to a total of 103 points for the test.

FIG. 4 – THE SUBJECTS PARTICIPATING IN SHOULDER ROTATION TEST

L. Johnson and K. Nilsen, Practical Measurements for Evaluation in Physical Education P. 233
Scoring: The score was, the greatest number of seconds counted between the time the heel raised and the balance was lost by touching the heel on the floor.

**Dynamic Balance (Modified Bass Test)**

**Objective:** To assess the dynamic balance of the subject\(^{11}\).

**Equipment and marking:** Stop watches, 3/4 inch marking tape and yard stick, the marking of the floor was done as per figure-5.

**Procedure:** The subject stood with right foot on the starting mark, the performer then leaped to the first tape mark with the left foot and tried to hold a standing position on the ball of his left foot for as many seconds as possible up to 5 seconds. He then leaped to the second tape mark with right foot and so on, alternate the feet from tape to tape and tried to remain on the ball at each tape for as many seconds as possible up to 5 seconds. With the tape, mark completely covered with the ball of the foot so that it could not be seen.

**Scoring:** The score for each mark successfully landed was five points in addition, one point was awarded for each second the balance was held up to 5 seconds per marks. Thus, a performer could score 10 points per mark or a total of 100 points for the test.

Physiological Variables

**Resting heart rate**

**Objective:** The purpose of the test was to measure the number of heartbeats of the subjects in a minute in resting condition.

**Equipment:** Stop watch

**Description:** Heart rate was obtained in each morning, the scholar attached the hostel where the subjects stayed early in the morning. A stopwatch was used to count the heartbeat for one minute by palpation of the carotid artery. The subjects were requested not to leave their bed and incase somebody moved out she was requested to lie down quietly for ten minutes before taking his heart rate.

**Scoring:** The number of heartbeats per minute was recorded as the score of the subject.

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**Exercise Routine**

**Objective:** The purpose of the test was to measure the number of heart beats of the subjects in a minute immediately after exercise.

**Equipment:** Stop watch

**Description:** Heart rate was recorded after each subject was given a standard exercise on bench step test for 8 minutes.

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FIG. 5 MODIFIED BASS TEST

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Physiological Variables

Resting heart rate

Objective: The purpose of the test was to measure the number of heartbeats of the subjects in a minute in resting condition\textsuperscript{12}.

Equipment: Stop watch.

Description: Heart rate was obtained in early morning, the scholar approached the hostel where the subjects stayed early in the morning. A stopwatch was used to count the heartbeat for one minute by palpation of the carotid artery. The subjects were requested not to leave their bed and incase somebody moved out he was requested to lie down quietly for ten minutes before taking his heart rate.

Scoring: The number of heartbeats per minute was recorded as the score of the subjects.

Exercise heart rate

Objective: The purpose of the test was to measure the number of heartbeats of the subjects in a minute immediately after the exercise.

Equipment: Stop watch.

Description: Heart rate was recorded after each subject was given a standard exercise on bench step test for 8 minutes.

\textsuperscript{12} L. Johnson and K. Nelson, \textit{Practical Measurements for Evaluation in Physical Education} P.159.
Immediately on the cessation of the exercise the heart rate was recorded by palpation of the carotid artery for one minute.

**Scoring:** The number of heartbeats per minute was recorded as the score of the subjects.

**Resting respiratory rate**

**Objective:** The purpose of the test was to measure the number of inhalation and exhalation of air in a minute.

**Equipment:** 8 X 8 inches cardboard, electronic stopwatch.

**Description:** The subject was asked to take relaxed supine lying position on the floor. Investigator placed the cardboard on the abdomen of the subject. The respiration rate was taken by counting the bulging and squeezing movement of the abdomen.

**Scoring:** The number of inhalation and exhalation done in one minute recorded in numbers was the score of the subject.

**Total body weight**

The weight of each subject was taken with the weighing machine, the subject bare footed and wearing minimum clothes stood at the center of the weighing machine. The weight was recorded in kilograms.
Maximal oxygen consumption (Vo₂max)

Maximal oxygen consumption (Vo₂max) was measured by using Astrand-Astrand Nomogram¹³. A wooden bench, 40cm high was used for this test subjects were asked to perform 8 minutes bench stepping. The frequency of the stepping was 30 steps per minute. Exercise heart rate was taken for one minute immediately after the exercise. The heart rate and the total body weight were then applied to the nomogram shown in figure-6 in order to predict the Vo₂max. This was done by connecting with a straight edge, the point on the Vo₂max scale with the corresponding point on the heart rate scale and the body weight, predicted Vo₂max was read from the middle scale.

Hyman’s Cardio Pulmonary Index

Objective: To assess the cardio vascular efficiency of the subjects.

Equipment: Spirometer for vital capacity, sphygmomanometer for measuring blood pressure and maximum expiratory pressure, stethoscope for blood pressure and nasal clips used for breath holding.

Procedure: Hyman’s Index¹⁴ was computed with the help of vital capacity, maximum expiratory pressure, maximum inspiratory breath holding capacity, age, systolic pressure, diastolic pressure and resting pulse rate, using the following formula

¹³ Fox and Bowers. The Physiological Basis of Physical Education and Athletics P.681.
FIG-6 ASTRAND-ASTRAND NOMOGRAM
FOR MAXIMAL OXYGEN CONSUMPTION (\(\text{Vo}_{2}\text{max}\))
CPI = \frac{VC + MEP + MBH + Age}{SP + DP + PR}

The test were administered in the following ways

**Vital Capacity**

The vital capacity of subject was measured with the help of wet spirometer\(^{15}\). The spirometer was placed on such a height that all subjects could be tested in standing position. The indicator of the spirometer was set on zero mark at the beginning of the test. After a couple of normal breaths the subject took a deep breath and exhaled into the spirometer through the mouth piece as forcefully as possible. The subjects were instructed to take care that they blew out only through the mouth and not through the nose even partially. However the nose of each subject was clipped by a nose clip to prevent the air flow through nose. The ejection of water seal drum was read off from the scale attached to the spirometer against the position of the indicator at the top of the drum. Best effort of each subject out of 3 trials was recorded as score in liters.

**Maximum Expiratory Pressure**

Maximum Expiratory Pressure was recorded with the help of a spygmomanometer by removing the rubber bulb from the apparatus and substituting a suitable mouthpiece. The subject was instructed to take deep breath and blow into the manometer as forcefully as possible. The highest pressure maintained for at least three seconds was recorded in Hg.mm as score of the test.

\(^{15}\) David H. Clarke, *Exercise Physiology* P. 159.
Maximum Breath Holding

Maximum Breath Holding was recorded by stopping one's inhalation or exhalation in seconds. The subject sat on a chair and after a deep inhalation the nasal clip was clamped on the nostrils of the subject. The mouth was kept closed by coupling the lips tightly. The time was recorded in seconds as long as the subject inhaled or exhaled through his mouth.

Age

The age was recorded to the full chronological year from the subject's school record book.

Resting Pulse Rate

Resting Pulse Rate was recorded while the subject was lying in supine position early in the morning. The subject was instructed to be in supine position for fifteen to twenty minutes then finger tips were placed on carotid artery and the pulse beats were counted for 60 seconds.

Blood Pressure

Systolic and diastolic blood pressure were measured together using mercury column sphygmomanometer\(^{16}\).

The subject was asked to lie quietly for 3 to 5 minutes. The cuff of the sphygmomanometer was wrapped around the bare left arm above the elbow with the earphones of the stethoscope in the tester's ears. The ball of the stethoscope was placed on the brachial artery, just above the

\(^{16}\) Laurence E. A.T. Miller, *Physiology of Exercise* p.68.
hollow of the elbow. The cuff was pumped up until released as the tester watching the gauge of mercury column as shown in Figure-7. When the first sound of pulse was heard the reading in millimeters of mercury at the instant was recorded as systolic pressure. The tester continued to slow the releasing pressure until a very dull weak beat was noted. At the instant the pressure in millimeters of mercury was noted as diastolic blood pressure of the subject.

**Score:** The recorded seven variables scores were substituted into the above mentioned formula and the Hyman's Cardiopulmonary Index was computed.

**Selection of Exercises For Training Programme.**

Plyometric Training For “A” Group –

1. Single leg hopping
2. Bounding
3. Plyometric pushups
4. Medicine ball throw
5. Depth jumps
6. Box drill
7. Sit ups
FIG. 7 – THE RESEARCH SCHOLAR TAKING THE BLOOD PRESSURE OF THE SUBJECTS.

The subjects randomly assigned to the three experimental groups and a control group namely Plyometric training, circuit training and circuit breaker programme underwent the experimental training programme for 12 weeks. The experimental training programme was administered thrice a week on alternate days. The load for the training programme was progressively increased from starting to end of the training session.
Circuit Training For “B” Group –
1. Step ups
2. Push ups
3. Sit ups
4. Double knee jumps
5. Squat thrust
6. Skipping
7. Interval running

Circuit Breaker Programme for “C” Group –
1. Jump rope
2. Step ups
3. Shuttle run
4. Push ups
5. Jump ups
6. Side jumps
7. Sit ups

**Administration of Training Programme.**

The subjects randomly assigned to the three experimental groups and a control group namely Plyometric training, circuit training and circuit breaker programme under went the experimental training programme for 12 weeks. The experimental training programme was administered thrice a week on alternate days. The load for the training programme was progressively increased from starting to end of the training session.
An outline of training schedule for the three experimental groups has been shown in Table – 3.

**TABLE – 3**

**AN OUTLINE OF TRAINING SCHEDULE FOR THREE EXPERIMENTAL GROUPS**

<table>
<thead>
<tr>
<th>Day</th>
<th>PLYOMETRIC TRAINING</th>
<th>CIRCUIT TRAINING</th>
<th>CIRCUIT BREAKER PROGRAMME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>Warm up, stretching, exercises, plyometric exercises</td>
<td></td>
<td>Warm up, stretching, exercises, Circuit breaker programme</td>
</tr>
<tr>
<td>Tue</td>
<td></td>
<td>Warm up, stretching, exercises, Circuit training exercises</td>
<td></td>
</tr>
<tr>
<td>Wed</td>
<td>Warm up, stretching, exercises, plyometric exercises</td>
<td></td>
<td>Warm up, stretching, exercises, Circuit breaker programme</td>
</tr>
<tr>
<td>Thur</td>
<td></td>
<td>Warm up, stretching, exercises, Circuit training exercises</td>
<td></td>
</tr>
<tr>
<td>Fri</td>
<td>Warm up, stretching, exercises, plyometric exercises</td>
<td></td>
<td>Warm up, stretching, exercises, Circuit breaker programme</td>
</tr>
<tr>
<td>Sat</td>
<td></td>
<td>Warm up, stretching, exercises, Circuit training exercises</td>
<td></td>
</tr>
</tbody>
</table>

The details of the training programme for the three different experimental groups are presented below.
Plyometric Training Programme

Subjects were trained thrice a week i.e. on Mondays, Wednesday and Fridays from 3.30 pm to 4.30 pm for a period of twelve weeks. The subjects performed single leg hopping, bounding, medicine ball throw, box drill and sit ups for 15 times in each set for 2 sets with a recovery period of 3 to 5 minutes in between each set. After the first three weeks the number of repetition of exercise in each set was increased by 5 after every three weeks. The number of sets for first three weeks, second three weeks, next three weeks and last three weeks were 2, 2, 3 and 3 respectively. After six weeks of training the recovery period was increased to 4–6 minutes between the sets. The students performed plyometric pushups and depth jumps for 5 repetitions in each set for 2 sets. With a recovery period of 3–5 minutes in between each set during first three weeks and there-after increased the repetitions by 3 after every 3 weeks. The recovery period after 6 weeks of the training was increased to 4–6 minutes between the sets. To determine the maximum depth jumps height, the subjects were measured on standing jump and reach. The subjects performed depth jump from an 18 inches box height and attained the same standing jump and reach score. The components of training load for Plyometric exercise are shown in Table-4.
<table>
<thead>
<tr>
<th>Sl No</th>
<th>Exercises</th>
<th>1 - 3 weeks</th>
<th>4 - 6 weeks</th>
<th>7 - 9 weeks</th>
<th>10 - 12 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.of Sets</td>
<td>Intensity (in %)</td>
<td>Recovery between sets (in Min)</td>
<td>No.of Sets</td>
</tr>
<tr>
<td>1</td>
<td>Single Leg Hopping</td>
<td>15</td>
<td>2</td>
<td>40-50</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Bounding</td>
<td>15</td>
<td>2</td>
<td>40-50</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Plyometric Push ups</td>
<td>5</td>
<td>2</td>
<td>40-50</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Medicine ball throw</td>
<td>15</td>
<td>2</td>
<td>40-50</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>Depth jumps</td>
<td>5</td>
<td>2</td>
<td>40-50</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Box drill</td>
<td>15</td>
<td>2</td>
<td>40-50</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>Sit ups</td>
<td>15</td>
<td>2</td>
<td>40-50</td>
<td>20</td>
</tr>
</tbody>
</table>
Circuit Training Programme.

Circuit training programme consisted of step-ups, push ups, sit ups, double knee jumps, squat thrust, skipping and interval running. The subjects were trained thrice a week that is on Tuesday, Thursday and Saturday at 3.30 pm to 4.30 pm for a period of 12 weeks. For first three weeks (1 – 3) they were asked to repeat these exercises for 45 seconds, at each station for 2 sets with a recovery of 3 to 5 minutes, in between the sets. For next three weeks (4 – 6) the exercise duration was increased to 60 seconds but the number of sets and recovery period remained unchanged. After 6 weeks of training the duration of exercise was further raised to 75 seconds for each station, the number of sets and the recovery period between sets were also increased to 3 and 4-6 minutes respectively. For last three weeks of training the duration of exercise was further raised to 90 seconds for each station but the number of sets and recovery period remained same. A detailed circuit training programme is shown in Table – 5.

Circuit Breaker Programme.

Circuit breaker programme consisted of Jump Rope, Step Ups, Shuttle Run, Push Ups, Jump Ups, Side Jumps and Sit Ups. A detailed circuit breaker programme is shown in Table – 6.

Subjects were trained thrice a week i.e. on Mondays, Wednesday and Fridays at 3.30 pm to 4.30 pm for a period of twelve weeks. For first
<table>
<thead>
<tr>
<th>SI No</th>
<th>Exercises</th>
<th>1 - 3 weeks</th>
<th>4 - 6 weeks</th>
<th>7 - 9 weeks</th>
<th>10 - 12 weeks</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Duration (in sec)</td>
<td>No. of Sets</td>
<td>Intensity (in %)</td>
<td>Recovery between sets (in Min)</td>
</tr>
<tr>
<td>1</td>
<td>Step - ups</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
</tr>
<tr>
<td>2</td>
<td>Push - ups</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
</tr>
<tr>
<td>3</td>
<td>Sit - Ups</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
</tr>
<tr>
<td>4</td>
<td>Double Knee Jumps</td>
<td>45</td>
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<td>40-50</td>
<td>3-5</td>
</tr>
<tr>
<td>5</td>
<td>Squat Thrust</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
</tr>
<tr>
<td>6</td>
<td>Skipping</td>
<td>45</td>
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<td>40-50</td>
<td>3-5</td>
</tr>
<tr>
<td>7</td>
<td>Interval Running</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
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</tbody>
</table>
### TABLE - 6

**DETAILED WEEKLY SCHEDULE OF THE CIRCUIT BREAKER PROGRAMME.**

<table>
<thead>
<tr>
<th>Si No</th>
<th>Exercises</th>
<th>1 - 3 weeks</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duration (in sec)</td>
<td>No. of Sets</td>
<td>Intensity (in %)</td>
<td>Recovery between sets (in Min)</td>
<td>Duration (in sec)</td>
<td>No. of Sets</td>
<td>Intensity (in %)</td>
<td>Recovery between sets (in Min)</td>
<td>Duration (in sec)</td>
<td>No. of Sets</td>
<td>Intensity (in %)</td>
</tr>
<tr>
<td>1</td>
<td>Jump Rope</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
<td>60</td>
<td>2</td>
<td>50-60</td>
<td>3-5</td>
<td>75</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Step Ups</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
<td>60</td>
<td>2</td>
<td>50-60</td>
<td>3-5</td>
<td>75</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Shuttle Run</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
<td>60</td>
<td>2</td>
<td>50-60</td>
<td>3-5</td>
<td>75</td>
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</tr>
<tr>
<td>4</td>
<td>Push Ups</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
<td>60</td>
<td>2</td>
<td>50-60</td>
<td>3-5</td>
<td>75</td>
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<tr>
<td>5</td>
<td>Jump Ups</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
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<td>2</td>
<td>50-60</td>
<td>3-5</td>
<td>75</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Side Jumps</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
<td>60</td>
<td>2</td>
<td>50-60</td>
<td>3-5</td>
<td>75</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Sit Ups</td>
<td>45</td>
<td>2</td>
<td>40-50</td>
<td>3-5</td>
<td>60</td>
<td>2</td>
<td>50-60</td>
<td>3-5</td>
<td>75</td>
<td>3</td>
</tr>
</tbody>
</table>
three weeks (1 – 3) they were asked to repeat these exercises for 45 seconds, at each station for 2 sets with a recovery of 3 to 5 minutes, in between the sets. For next three weeks (4–6) the exercise duration was increased to 60 seconds but the number of sets and recovery period remained unchanged. After 6 weeks of training the duration of exercise was further raised to 75 seconds for each station, the number of sets and the recovery period between sets were also increased to 3 and 4-6 minutes respectively. For last three weeks of training the duration of exercise was further raised to 90 seconds for each station but the number of sets and recovery period remained same.

**Statistical Techniques for Analysis of Data**

In order to find out the comparative effects of plyometric training, circuit training and circuit breaker programme on related physiological variables and motor components of school level Tennis players, analysis of covariance was employed, the proposed hypothesis was tested at .05 level of confidence.