CHAPTER III

METHODOLOGY

In this chapter the procedures adopted for the selection of subjects, selection of variables, pilot study, criterion measures, orientation of subjects, reliability of data, instrument reliability, tester’s reliability, subject reliability, administration of tests, training programme, collection of data, experimental design and statistical techniques for the analysis of the data have been explained.

3.1 SELECTION OF SUBJECTS

The study was designed to find out the effects of varied combinations of continuous running on different terrains on motor fitness, physiological and athletic performance variables of high school boys.

To achieve this purpose 120 high school boys from Perunthalaivar Kamarajar Government Boys High School and Sri Aravindhar higher secondary school, Muthialpet, Puducherry during the year 2011- 12 were randomly selected as subjects. Their age ranged from 14 to 16 years. Only the students who were willing to participate in the experimental study were included in this study. The selected subjects were segregated into four equal groups consisting of 30 each by adopting random procedure. Experimental group I (n=30) was treated with a combination of track and sand running, experimental group II (n=30) underwent the track and water running, experimental group III (n=30) was given a combination of track, sand and water running and group IV (n=30) acted as control group, which did not undergo any special training programme apart from their regular work. All the subjects gave a
written 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.

3.2 SELECTION OF VARIABLES

The research scholar reviewed the available literature pertaining to the track running, sand running and water running from books, journals, periodicals, magazines and research papers. Taking into consideration the feasibility criteria, availability of instrument and the relevance of the variables of the present study the following variables were selected.

3.2.1 DEPENDENT VARIABLES

Sand running improved speed and cardio-respiratory endurance (Rao, 2010). Sand dune running benefits in speed, strength and endurance for athletes (Lejeune, et al., 1998). Running in different surfaces increases speed, strength and endurance. The improvement in motor fitness variable particularly speed, explosive power, leg strength and strength endurance are found to be highly associated with running surfaces. Hence they were selected as dependent variables.

Sand running programme results in physiological changes in young men (Yigit, 1998). Deep water running is effective in maintaining Vo$_2$ max (Hertler et al., 1992). Bench stepping in water increases cardio-respiratory fitness (Ellen, 1998). Physiological parameters such as pulse rate, Vo$_2$ max and cardio-respiratory endurance may improve due to continuous running in different surfaces. Hence,
anaerobic power, Vo$_2$ max, resting pulse rate and cardio-respiratory endurance were selected as dependent variables.

The performance in athletic events mostly influenced by motor fitness variable and physiological factors, and they may alter the functions of the systems in particular the body in general. Training (Plyometric) in water can be an effective technique to improve sprint in young athletes (Hamid and Abbas, 2011). Short and middle distance running may be affected by continuous running in different surfaces. Therefore the athletic performance variables such as 100 mts run, 400 mts run, 1500 mts race and long jump performance were selected as dependent variables. Totally this study consists of twelve dependent variables.

3.2.2 INDEPENDENT VARIABLES

There are numerous references supporting that any form of systematic training would be an effective programme to improve the performance. Regular continuous running increases power by improving the capacity of the muscles and tendons to capture elastic energy and by enhancing the efficiency of communication between the brain and the muscles.

The surfaces which athletes run, play a large role in determining the performance. There was a significant difference in the performance of athletes due to training in different surfaces (Karve and Tiwari, 2010). Running on sand suggests a greater muscle loading effect (Harrison, 2004). Aquatic training produces significant difference in physiological variables (Kamalakannan, et al., 2010). Hence, track running, sand running, and water running were selected as independent variables.
The investigator was interested to know whether the continuous running on track, sand and water were effective to bring out positive changes in motor fitness components, physiological and athletic performance of high school boys. Further, an attempt was also made to find out whether the combination of track running, sand running and water running were an appropriate training protocol to bring out the desired results. In this study there were three independent variables.

1. Track and sand running (TSR)
2. Track and water running (TWR)
3. Track, sand and water running (TSWR)

3.3 PILOT STUDY

A pilot study was conducted to assess the initial capacity of the subjects in order to fix the load and to make sure that the duration of exercise included in the programme was within the limits of the subjects to ensure the satisfactory effect. For this, fifteen subjects were selected at random and divided into three groups of five each, of which group I underwent track and sand running (TSR), group II underwent track and water running (TWR) and group III underwent track, sand and water running (TSWR) for a period of 4 weeks under the supervision of the investigator. After the period of 4 weeks the subjects were post tested. Based on the response of the subjects in the pilot study the training load for the experimental groups to the main study was fixed for a period of 12 weeks. After the completion of the pilot study the present study was conducted on 120 subjects.
3.4 CRITERION MEASURES

By glancing the literature and in consultation with the professional experts the following variables were selected as the criterion measures for testing hypothesis.

Table - 2

<table>
<thead>
<tr>
<th>Sl no.</th>
<th>Criterion Variables</th>
<th>Test items</th>
<th>Unit of measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Motor fitness components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Speed</td>
<td>50 Mts dash</td>
<td>Seconds</td>
</tr>
<tr>
<td>2.</td>
<td>Explosive Power</td>
<td>Vertical Jump</td>
<td>Centimeters</td>
</tr>
<tr>
<td>3.</td>
<td>Leg Strength</td>
<td>Leg dynamometer</td>
<td>Kilograms</td>
</tr>
<tr>
<td>4.</td>
<td>Strength endurance</td>
<td>Sit Ups</td>
<td>Counts</td>
</tr>
<tr>
<td></td>
<td>Physiological variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Anaerobic Power</td>
<td>Margaria Kalamen Test</td>
<td>Kilogram/meter/seconds</td>
</tr>
<tr>
<td>2.</td>
<td>Vo\textsubscript{2} max</td>
<td>Bench Step and Astrand nomogram</td>
<td>Liters/kg/min</td>
</tr>
<tr>
<td>3.</td>
<td>Resting Pulse rate</td>
<td>Bio Monitor</td>
<td>Beats/Minutes</td>
</tr>
<tr>
<td>4.</td>
<td>Cardio respiratory</td>
<td>Cooper’s 12 minutes run and</td>
<td>Meters</td>
</tr>
<tr>
<td></td>
<td>endurance</td>
<td>walk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Athletic performance variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>100 mts. Run</td>
<td></td>
<td>Seconds</td>
</tr>
<tr>
<td>2.</td>
<td>400 mts. Run</td>
<td></td>
<td>Seconds</td>
</tr>
<tr>
<td>3.</td>
<td>1500 mts. race</td>
<td></td>
<td>Seconds</td>
</tr>
<tr>
<td>4.</td>
<td>Long Jump</td>
<td></td>
<td>Meters</td>
</tr>
</tbody>
</table>
3.5 ORIENTATION OF SUBJECTS

Before the collection of data, the subjects were oriented about the purpose of the study. The investigator explained the procedure of assessing motor fitness components such as speed, explosive power, leg strength and strength endurance. The procedure of assessing physiological variables such as anaerobic power, Vo₂ max, resting pulse rate and cardio respiratory endurance was also explained. The investigator gave instructions to the subjects about the procedures to be followed for testing athletic events such as 100 meters run, 400 meters run, 1500 meters race and long jump.

3.6 RELIABILITY OF DATA

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

3.6.1 INSTRUMENT RELIABILITY

Leg dynamometer, digital electronic stop watch, bio monitor and measuring tape were used to measure the selected variables. 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. To determine the reliability of instruments, measurement on each of the tests of the variables were recorded five times under similar conditions using the same instrument. Hence, their calibrations were accepted as accurate enough for the purpose of the study.
3.6.2 TESTER’S RELIABILITY

To ensure the uniformity and reliability of testing technique, the investigator had a number of practice sessions in the testing procedure with the guidance of the respective experts. The investigator took all the measurements for the study with the assistance of professional experts.

Tester’s reliability was established by test-re-test process. To determine the reliability of the measurement involved in the study, the tester correlated the data from ten subjects. Care was taken to ensure the fitness of each subject before the administration of each test, so that the consistency of the result could be ensured.

The intra class correlation co-efficient obtained for test-retest data was presented in Table – 3

Table – 3
Intra class correlation co-efficient obtained for test-retest scores

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Tests</th>
<th>Correlation Co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Motor Fitness Components</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speed</td>
<td>0.91*</td>
</tr>
<tr>
<td></td>
<td>Explosive power</td>
<td>0.87*</td>
</tr>
<tr>
<td></td>
<td>Leg strength</td>
<td>0.90*</td>
</tr>
<tr>
<td></td>
<td>Strength endurance</td>
<td>0.86*</td>
</tr>
</tbody>
</table>
### 2. Physiological Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaerobic power</td>
<td>0.89*</td>
</tr>
<tr>
<td>$\text{Vo}_2\text{ max}$</td>
<td>0.86*</td>
</tr>
<tr>
<td>Resting pulse rate</td>
<td>0.90*</td>
</tr>
<tr>
<td>Cardio respiratory endurance</td>
<td>0.92*</td>
</tr>
</tbody>
</table>

### 3. Athletic performance

<table>
<thead>
<tr>
<th>Event</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 M run</td>
<td>0.87*</td>
</tr>
<tr>
<td>400 M run</td>
<td>0.89*</td>
</tr>
<tr>
<td>1500 M race</td>
<td>0.91*</td>
</tr>
<tr>
<td>Long jump</td>
<td>0.93*</td>
</tr>
</tbody>
</table>

*Significant at 0.05 level of confidence

### 3.6.3 SUBJECT RELIABILITY

The intra-class correlation values of the above tests and re-test also indicated the subject, tester and instrument reliability and the instruments were used under similar conditions by the same tester. The co-efficient of reliability was significant at the $P<0.05$ level for the above tests under investigation.

### 3.7 ADMINISTRATION OF THE TESTS

The investigator held a meeting with the subjects prior to the administration of the tests. The purpose, the significance of the study and the requirements of the
testing procedure were clearly explained to them in detail so that there would be no ambiguity in their minds, regarding the efforts which they had to put for the successful completion of the tests. The subjects were very enthusiastic and cooperative throughout the training period and test administration period.

3.7.1 MOTOR FITNESS COMPONENTS TEST

50 METERS RUN

50 meters run was used to assess the speed of the subjects. Measuring tape, starting clapper and digital electronic stop watch were used to measure the speed. The subjects were instructed to start the race by standing start method. The time elapsed from the ‘clap’ to the runner crossing the finish line was taken as the test score. The fractions were rounded to the next largest one tenth of a second. Two trials were conducted with sufficient rest in between. The better of the two trials was recorded, and scores were in seconds.

VERTICAL JUMP

Vertical jump was used to assess the explosive power of the subjects. Measuring tape, marked wall and chalk for marking wall (or jump mat) were used to measure the distance. The subject stood side on to a wall and reached up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips was marked or recorded. The subject then stood away from the wall, and leap vertically as high as possible using both arms and legs to assist in projecting the body upwards. Attempt to touch the wall at the highest point of the jump was
marked. The difference in distance between the standing reach height and the jump height was the score. The best of three attempts was recorded in centimeters.

**LEG DYNAMOMETER TEST**

Leg dynamometer test was used to assess the leg strength of the subjects. 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 subjects 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 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. 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.

**SIT-UP TEST**

Sit up test measures the abdominal muscular strength and endurance of the abdominal and hip-flexors, important in back support and core stability. Flat and clean surface, stopwatch, recording sheets and pen were used for measurement. The
subjects were asked to lie in supine position 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 curl up to a sitting position and touched the elbows to the knees. This exercise was repeated as many times as possible in one minute. One point was scored for each correct sit up. The score was the maximum number of sit-ups completed in one minute.

### 3.7.2 PHYSIOLOGICAL VARIABLES TEST

**MARGARIA KALAMAN TEST**

Margaria kalaman test was used to assess the anaerobic power (lower extremity) of the subjects. Stopwatch, timing mats (optional), and tape were used to measure, the flight of 12 steps with a starting line of 6 meters in front of the first step. Each step was approximately 17.5 cm high with the 3rd, 6th and 9th step clearly marked. The vertical distance between the 3rd and 9th step must be accurately measured for use in the results formula. The weight is determined in kilograms. The subject was given a few practice runs up steps to warm up. The subject stood ready at the starting line 6 meters in front of the first step. On the command "Go", the subject sprints to and up the flight of steps, taking three steps at a time (stepping on the 3rd, 6th and 9th steps), attempting to go up the steps as fast as possible. The time to get from the 3rd step to the 9th step was recorded (either using a stopwatch or using switch mats placed on the 3rd and 9th steps), starting when the foot was in first in contact with the 3rd step, and stopped when the foot contacted the 9th step. Three trials of the test were allowed, with 2-3 minutes recovery between each trial. Power
(Watts) was calculated from the formula, \( P = (M \times D) \times 9.8 / t \) where \( P \) = Power (Watts), \( M \) = Body mass (kg), \( D \) = Vertical distance, between steps 3 & 9 (meters), \( t \) = Time (seconds). 9.8 is the constant of gravity. The score was recorded in kg/mts/sec.

**RESTING PULSE RATE**

Resting pulse rate of the subjects was measured by using bio monitor. The resting pulse rate of the subjects was monitored using the method of finger pulynamography with the help of an auto-electronic transducer on finger in the morning time between 6.00 am to 6.30 am. Before taking the pulse rate, the subjects were asked to sit comfortably on a chair for fifteen minutes. The investigator fixed the sensor unit to the finger of the subject, the bio monitor was switched on and the pulse rate per minute was shown by the digital meter. The score was recorded in beats per minute.

**CARDIORESPIRATORY ENDURANCE**

Cooper’s 12 minutes run/walk test was used to measure the cardio respiratory endurance of the subjects. The test was administered in 400 meters track. Stopwatch and whistle were used to administer the test. For this test a 400 meters track was prepared with marking at every ten meters intervals with flags for correct calculation of the distance covered. Twelve subjects (three from each group) ran at a time. The subjects stood on the arc starting line in athletic costume. They were instructed to cover as much distance as possible by running/walking till hearing the final whistle. The race started with a whistle. The number of laps covered and number of minutes left were informed to the subjects by the respective lap scorer, when they crossed the
starting line. At the end of twelfth minute a long whistle was blown and the subjects stopped instantly and stood on the spot. The distance covered by each subject in twelve minutes was recorded in meters.

**VO₂ MAX**

To find out the VO₂ max of the subjects, stopwatch and 18 inches height bench were used. After hearing the command ‘start’ from the investigator, the subjects stepped up and down on a bench of 18 inches high. All the time the subjects stepped the alternate leg up and down process in four counts.

The subjects were allowed to load off with the same foot each time or to change the foot as he desired but the four counts were maintained, by the help of the metronome. The counting was done as “up, up and down, down”. The subjects stoped their steps- ups when they heard the command ‘stop’ from the investigator. The stepping exercises continued for three minutes, in which each minute the subjects covered twenty five step ups and at the completion of stepping the students remained standing and the pulse rate was measured for a 15 seconds period from 5 to 20 seconds into recovery. To predict the maximal oxygen up-take (VO₂ max) by step test the “Astrand nomogram” was used. The scores were recorded in lit/kg/min.

**3.7.3 ATHLETIC PERFORMANCE VARIABLES**

**100 MTS RUN, 400 MTS RUN AND 1500 MTS RACE**

To measure the speed performance of 100 meters run, 400 meters run and 1500 meters race of the subjects, standard track, digital electronic stop watches, starting blocks, spikes and starting clapper were used. The investigator conducted
100 meters run, 400 meters run and 1500 meter race as per rules and regulations of the International Association of Athletic Federation (IAAF). The time was recorded as 1/100 of the seconds. For 1500 meters race the time was recorded in minutes and seconds.

**LONG JUMP**

The purpose of this test was to determine the acceleration, maximum jumping speed and endurance, depending on the distance covered through the jump. Measuring tape, mark pad and long jump pit were used. The participants ran down on runway and jumped as far as they could from a wooden board 20 cm/8 inches wide that is built flush with the runway into a pit filled with finely ground gravel or sand. The best of the three trials was measured in meters and recorded as the performance of the subjects.

**3.8 TRAINING PROGRAMME**

One hundred and twenty school boys were randomly selected from Perunthalaivar Kamarajar Government Boys high school, Muthialpet and Sri Aravindhar higher secondary school, Muthialpet, Puducherry and their age ranged between 14 and 16 years. The selected subjects were divided into four equal groups, consisting of 30 each, such as experimental Group I, II, III and control group IV. All the three groups were treated with continuous running in different terrains for a period of 12 weeks. After the training period the post test was conducted. The training schedule for the three different experimental groups are detailed below,
Experimental group I underwent combination of track and sand running.

Experimental group II underwent combination of track and water running.

Experimental Group III underwent combination of track, sand and water running

Group IV acted as the control group.

In each training session, the training was imparted for a period between 45 and 50 minutes, which included 5 minutes warming up and 5 minutes warm down procedure, after the training programme for a period of 12 weeks. The training sessions were held between 6.30 am to 7.30 am, Monday through Saturday. The length of the training intervention for this study was based on the fact that twelve weeks has been shown to be sufficient to provide significant changes in college men students. (Rice et al., 1999)

The experimental groups underwent their respective training programmes under the supervision of the investigator. The subjects were carefully monitored and questioned about their health status throughout the training period. None of them have reported any injury and however muscle soreness was reported in the early weeks, but subsided later complication; further all the participants were instructed neither to change their life style nor to change their dietary intake for the entire duration of the training. The training schedule for the experimental groups was designed as per the results of the pilot study and also based on the guidelines given by (Bacchle, 1994).
Flow chart 1

FLOW CHART SHOWING THE METHODOLOGY ADOPTED IN THIS STUDY

High school boys
N = 120; No Equated Groups

Control group (CG); N = 30
Pre-test
No treatment
Post-test

Experimental group I (TSRG); N = 30
Pre-test
Experimental treatment
Post-test

Experimental group II (TWRG); N = 30
Pre-test
Experimental treatment
Post-test

Experimental group III (TSWRG); N = 30
Pre-test
Experimental treatment
Post-test

Statistical analysis
FLOW CHART SHOWING THE EXPERIMENTAL TREATMENT ADOPTED FOR EXPERIMENTAL GROUP-I

COMBINED EFFECTS OF TRACK AND SAND RUNNING (TSR) ON HIGH SCHOOL BOYS

EXPERIMENTAL GROUP-I (TSRG)

Monday: Track running
Tuesday: Sand running
Wednesday: Track running
Thursday: Sand running
Friday: Track running
Saturday: Sand running
FLOW CHART SHOWING THE EXPERIMENTAL TREATMENT ADOPTED FOR EXPERIMENTAL GROUP-II

COMBINED EFFECTS OF TRACK AND WATER RUNNING (TWR) ON HIGH SCHOOL BOYS

EXPERIMENTAL GROUP-II (TWRG)

Monday: Track running
Tuesday: Water running
Wednesday: Track running
Thursday: Water running
Friday: Track running
Saturday: Water running
FLOW CHART SHOWING THE EXPERIMENTAL TREATMENT ADOPTED FOR EXPERIMENTAL GROUP-III

COMBINED EFFECTS OF TRACK, SAND AND WATER RUNNING (TSWR) ON HIGH SCHOOL BOYS

EXPERIMENTAL GROUP-III (TSWRG)

Monday
- Track running

Tuesday
- Sand running

Wednesday
- Water running

Thursday
- Track running

Friday
- Sand running

Saturday
- Water running
### Table-4

#### TRAINING PROGRAMME FOR EXPERIMENTAL GROUPS

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Continuous running on track</th>
<th>Continuous running on sand</th>
<th>Continuous running on water (knee level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I - III</td>
<td>Continuous run for 20 minutes with 50-55% intensity (Heart rate 130 – 140 per minute)</td>
<td>Continuous run for 20 minutes with 50-55% intensity (Heart rate 140 – 150 per minute)</td>
<td>Continuous run for 20 minutes with 50-55% intensity (Heart rate 135 – 145 per minute)</td>
</tr>
<tr>
<td>IV - VI</td>
<td>Continuous run for 25 minutes with 50-55% intensity (Heart rate 130 – 140 per minute)</td>
<td>Continuous run for 25 minutes with 50-55% intensity (Heart rate 140 – 150 per minute)</td>
<td>Continuous run for 25 minutes with 50-55% intensity (Heart rate 135 – 145 per minute)</td>
</tr>
<tr>
<td>VII - IX</td>
<td>Continuous run for 30 minutes with 55-60% intensity (Heart rate 140 – 150 per minute)</td>
<td>Continuous run for 30 minutes with 55-60% intensity (Heart rate 150 – 160 per minute)</td>
<td>Continuous run for 30 minutes with 55-60% intensity (Heart rate 145 – 155 per minute)</td>
</tr>
<tr>
<td>X - XII</td>
<td>Continuous run for 30 minutes with 60-65% intensity (Heart rate 150 – 160 per minute)</td>
<td>Continuous run for 30 minutes with 60-65% intensity (Heart rate 160 – 170 per minute)</td>
<td>Continuous run for 30 minutes with 60-65% intensity (Heart rate 155 – 165 per minute)</td>
</tr>
</tbody>
</table>

For continuous run on track, sand and water the load and intensity were increased every three weeks.
3.9 COLLECTION OF DATA

The data on motor fitness components, physiological and athletic performance variables were collected by various tests explained above. The pre-test and post-test data were collected before and after the training programme for a period of 12 weeks. All the data were collected on the same day.

3.10 EXPERIMENTAL DESIGN

The collected data when in number, though it is valid and reliable, would not give us useful meaning in terms of what we need. The data has to be processed with the help of statistics, analyzed scientifically, interpreted and intelligently concluded. In this study the data have been collected on variables such as motor fitness components of speed, explosive power, leg strength and strength endurance, physiological variables of anaerobic power, VO₂ max, resting pulse rate, cardio respiratory endurance and athletic performance of 100 m run, 400 m run, 1500 m race and long jump. Experimental design is a blue print of the procedure that enables the researcher to test the hypothesis by reaching valid conclusions in testing the relationship between independent variables and dependent variables. The investigator used pre and post test random group design in this study. This procedure involved dividing a sample into two or more groups based on random selection. The investigator did not make any attempt to equate the groups in this study. The selected one hundred and twenty subjects were divided into four equal groups consisting of 30 each such as experimental group I (n = 30), experimental group II (n = 30), experimental group III (n = 30) and a control group (n = 30). The treatment was administered to all the experimental groups for a period of 12 weeks. At the end of twelfth week the post test was administered to all the groups.
3.11 STATISTICAL TECHNIQUES

The pre-test and post-test data of the experimental and control groups on the respective variables were analyzed with various statistical techniques. The following statistical techniques were used for analyzing the data of variables.

Descriptive statistics such as mean and standard deviation were found in order to get the basic idea of the data distribution. ‘t’ test was done for finding whether there is any statistically significant pre-test to post-test mean differences in their respective variables of each groups.

It is to be noticed that the individuals in the experimental and control groups may vary widely in the initial pre-test scores. By using the analysis of variance (ANOVA) for testing the significance of the difference between the post-test means of the experimental and control groups, the influence of the initial pre-test scores to the final post-test scores were ignored. These pre-test scores are called ‘covariates’. Therefore we have to eliminate or to keep under control the effect due to these covariates (pre-test scores) from the final scores (post-test scores). Hence, the data should be analyzed by the technique of analysis of covariance (ANCOVA) rather than analysis of variance (ANOVA). ANCOVA tests the significance of ‘adjusted post test mean’ differences between the experimental and control groups for each variable. Adjusted post-test means are the post test means after eliminating the effect due to the pre-test (initial) scores. The adjusted technique serves to remove from the final scores that portion which is due to the relation between covariate (pre-test scores) and the final scores.

Whenever the ‘F’ ratio for adjusted post test was found to be significant, Scheffee’s post hoc test was applied to test the significant difference between the paired adjusted means. 0.05 level of confidence was fixed for motor fitness, physiological and athletic performance variables to test the level of significance.