Chapter - III

Methodology
CHAPTER - III
METHODOLOGY

In this chapter 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 the tests, training schedule, bicycle ergometer training, experimental design and the statistical techniques used have been explained.

3.1 SELECTION OF SUBJECTS

The purpose of present study was to find out the effects of varied intensities and frequencies of bicycle ergometer training on selected physiological, kinanthropometric and performance variables.

Male students undergoing degree course at Ayya Nadar Janaki Ammal College, Sivakasi were asked to assemble in a hall. The investigator explained the proposed research work, nature of the study and subjects involvement. All the students volunteered to serve as subjects. Out of which, 120 students were selected at random their age was between 18 and 25 years. They were segregated into four groups, by adapting random procedure. The investigator did not make any attempt to equate the groups. All the groups served as experimental groups. Group I underwent a training of 50 revolutions per minute for 15 minutes for 3 days per week of bicycle ergometer training, Experimental group II underwent 50 revolutions per minute for 15 minutes for 5 days per week. Experimental group III underwent 60 revolutions per minute for 15 minutes for 3
days per week and experimental group IV underwent 60 revolutions per minute for
15 minutes for 5 days per week of bicycle ergometer training.

3.2. SELECTION OF VARIABLES

The research scholar reviewed the available scientific literature pertaining to the bicycle Ergometer training from books, journals, periodicals, magazines and research papers. Taking into consideration 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

There is a positive relationship between heart rate and maximal oxygen consumption. Heart rate (HR) increases linearly with increasing oxygen consumption. The maximal heart rate of a well-trained person is consistently lower at any given workload. Endurance training tends to lower the resting heart rate. The resting heart rate and maximal oxygen consumption have been accepted as the best measures of the individual’s cardio respiratory capacity. Aerobic power is considered as the best measure of cardio respiratory endurance. Just like it anaerobic power is considered as a valid measure of anaerobic capacity of the individual. Power is defined as the rate at which the work is done. Anaerobic power indicates the rate of work done using relatively higher amount of ATP and CP system and anaerobic glycolysis. So, the physiological variables such as resting heart rate, maximal oxygen uptake (VO₂ Max), and anaerobic power are found to be highly associated with bicycle ergometer training and hence they were selected as dependent variables.
The smaller the fat content of the body, the larger so-called “fat free” or lean body mass (LBM). The relatively higher degree of fat free body weight is not only valuable from a health point of view, but also it is an important factor contributing to higher levels of physical performance. Physical training increases the amount of the active tissue (LBM) while decreasing the amount of adipose tissue. Hence, in kinanthropometric lean body mass, body fat and body weight were selected as dependent variables.

Athletic event is not a single entity; it involves running, jumping and throwing events. The standard running events for male are 100, 200, 400 and 800, 1500, 5000 and 10000 metres running etc. Though the 100m, 400m and 800 metres running events are classified as anaerobic activities, this is applicable only at higher level of competitions. At college level most of the subjects’ performance would be greater than 2 minutes. So out of all the athletic events 100m, 400m and 800 metres running were selected as dependent variables. Thus, the present study consists of 9 dependent variables.

3.2.2 INDEPENDENT VARIABLES

The effect of training depends upon the intensity and frequency of training. These two loads are modified to get the desired result. Bicycle ergometer and treadmill are used not only as testing instruments, but also as training equipments. The speed of contraction of the muscles, aerobic and anaerobic type load can be given easily by using these equipments.

Sixty revolutions per minute may produce a somewhat higher maximal O₂ uptake than 50 revolutions per minute. Thus one should change 50
revolutions per minute to 60 revolutions per minute in the case of heavy work rate, if the object is to measure maximal oxygen uptake (Hermansen et al. 1969).

The present investigator was interested to know whether 50 revolutions per minute or 60 revolutions per minute is effective to bring out changes in physiological, kinanthropometric and performance variables. Further the investigator was also interested to know whether 3 days or 5 days per week is the apt training to bring out the desired result. In the present study there are four independent variables. They are

- Pedal at cadence of 50 revolutions per minute of bicycle ergometer training for 3 days per week
- Pedal at cadence of 50 revolutions per minute of bicycle ergometer training for 5 days per week
- Pedal at cadence of 60 revolutions per minute of bicycle ergometer training for 3 days per week
- Pedal at cadence of 60 revolutions per minute of bicycle ergometer training for 5 days per week

3.3 PILOT STUDY

A pilot study was conducted to assess initial capacity of the subjects, in order to fix the load. For this, ten subjects were selected at random, and divided into two groups of five each. In which, group I underwent 50 revolutions per minute and group II underwent 60 revolutions per minute of bicycle ergometer training under the watchful eyes of the experts and researcher. Based on the response of the subjects in the pilot study, the training schedule for the
experimental groups was constructed, while constructing the training program the basic principles of training (progression, over load and specificity) were followed. After completion of the pilot study, the present study was carried out with 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 to this study for testing the hypothesis.

For measuring resting pulse rate, bio-monitor was used and the unit of measurement was number of beats per minute.

For measuring anaerobic power, Margaria-Kalamen test was used and the unit of measurement was kilogram/meter/seconds.

For measuring VO$_2$ Max, Bench step and “Astrand Nomogram” test were used and the unit of measurement was liters/kg/min.

For assessing lean body mass, body fat was subtracted from total body weight and the unit of measurement was kilograms.

For measuring body fat, skinfold caliper was used and the unit of measurement was in millimeters and thereafter it was converted into body fat by using standard procedure.

For measuring body weight, the standard weighing machine was used and the unit of measurement was kilograms.

For measuring athletic performance 100m run, 400m run and 800 meters run were used, and the unit of measurement was 1/100 of seconds.
3.5 ORIENTATION OF SUBJECTS

Before collection of data, the subjects were oriented about the purpose of the study. The investigator explained the procedure of assessing physiological variables by using bio monitor for resting pulse rate, Margaria – Kalamen test for anaerobic power and bench step test for VO2 Max. The investigator had given explanations to the subjects about the procedures to be adopted by them for measuring the kinanthropometric variables such as lean body mass, body fat and body weight.

The investigator had given instructions to the subjects about the procedures to be followed for athletic events such as 100 metres run, 400 metres run and 800 metres run.

The subjects had a standard warm-up prior to the test and during a preliminary visit to the laboratory, they had been familiarised with the test protocol.

3.6 RELIABILITY OF DATA

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

3.7 INSTRUMENT RELIABILITY

Instruments such as bio-monitor, stopwatch, skinfold caliper and measuring steel tape were used for this study. All instruments were in good working condition. Their calibrations were tested and found to be accurate enough to serve the purpose of the study. The stopwatch, which was used in this study, complied with International Amateur Athletic Federation specification and found reliable.
3.8 TESTER'S RELIABILITY

The investigator learned the procedures and methods to handle and operate the instruments to administer the test. Measurements were taken by the investigator himself using bio-monitor, stopwatch, skinfold caliper and steel tape. Services of qualified assistants were used for taking other measurements.

Reliability was established by test-retest process. Ten men students were tested and retested on selected dependent variables.

The repeated measurement of individuals on the same test, as is done to determine reliability, a univariate, not a bivariate. It is the distribution of a single variable. The intra class correlation co-efficient obtained for test-retest data are presented in Table I.

**TABLE - I**

**INTRA CLASS CORRELATION COEFFICIENTS OF TEST-RETEST SCORES**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Tests</th>
<th>Correlation Co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pulse rate</td>
<td>0.97</td>
</tr>
<tr>
<td>2.</td>
<td>Anaerobic power</td>
<td>0.98</td>
</tr>
<tr>
<td>3.</td>
<td>VO₂ Max</td>
<td>0.96</td>
</tr>
<tr>
<td>4.</td>
<td>Lean body mass</td>
<td>0.98</td>
</tr>
<tr>
<td>5.</td>
<td>Body fat</td>
<td>0.96</td>
</tr>
<tr>
<td>6.</td>
<td>Body weight</td>
<td>0.98</td>
</tr>
<tr>
<td>7.</td>
<td>100 metres run</td>
<td>0.96</td>
</tr>
<tr>
<td>8.</td>
<td>400 metres run</td>
<td>0.98</td>
</tr>
<tr>
<td>9.</td>
<td>800 metres run</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Significant at P < 0.01 level of confidence
3.9 SUBJECT RELIABILITY

The intra class correlation values of the above tests and retest also indicated subject, tester and instrument reliability as the same subjects, and instruments were used under similar conditions by the same testers. The coefficients of reliability were significant at the P < 0.01 level for the above tests under investigation.

3.10 ADMINISTRATION OF THE TESTS (TEST PROCEDURE OF DEPENDENT VARIABLE)

Resting pulse rate

Objective

To measure the resting pulse rate of the subject.

Equipment

Bio-monitor was used to measure the resting pulse rate.

Procedure

The resting pulse rate of the subject was monitored by bio-monitor. It monitored the resting pulse rate using the method of finger plyphthesmography with the help of an opto – electric transducer on finger. The subject was asked to sit and rest himself comfortably on a chair. The investigator fixed an optosensor unit to the thumb of the right hand of the subject using velcrostraps. It was fixed in such a way that the light on the optosensor unit was at distal end of the fingertips and LDR was nearer to the fingertip. The velcrostrap on the LDR side was fastened firmly while the strapo on the lamp side was loosely fastened.

The PCG / pulse ON – OFF switch of the bio-monitor was kept in the pulse position. Then the heart rate monitor was kept in the pulse push button
switch. After 30 seconds, the pulse LED indicator flashed and the beeps started and stabilized. After that, flashes and beeps occurred rhythmically with respect to the subject’s pulse. The pulse rate per minute was indicated by the three digital meters. After about a minute the digital meter showed the subject’s pulse rate under rest. The accuracy of equipment was ±3 percentage of reading. (Authors’ Guide, 1984).

**ANAEROBIC POWER**

**Objective**

To measure the subject’s anaerobic power. For assessing anaerobic power, Margaria – Kaleman anaerobic power test was administered.

**Equipment**

To measure the time lapse between the third and the ninth step, a digital timer was used. The digital timer worked on the basis of the principle that the power supplied in India for domestic purpose was 50 cycle per second. The digital timer was connected with two switch mats. One to switch ‘on’ the timer and the other to switch off. The switch mats were constructed in such a manner that when the subject placed his foot on the mat the switch would get operated. The sensitivity of the mat was 15 kg. It means that the switches could be operated by keeping minimum 15 kg weight on the mat.

A concrete staircase with 12 steps was constructed for administrating Margaria – Kaleman Anaerobic power test. The width and perpendicular height of the staircase were 125 cm and 210 cm respectively. The angle of the staircase with respect to the ground was approximately 45 degrees. The average perpendicular
distance of consecutive steps was 17.4 cm. The perpendicular height between the third and ninth step was 105 cm.

**Procedure**

The subject stood 6 metres in front of the staircase. At their pleasure, they ran up to the staircase as rapidly as possible taking three steps at a time. The clock started as the person stepped on the first switch mat (on the third step) and stopped as he stepped on the second switch mat [on the ninth step]. The time recorded by the clock represents the time required to move the body at a height of 1.05 meters. The time it took to travel the distance between stairs 3 and 9 was recorded in 0.01 second. The anaerobic power is generated as a product of the subject’s weight (W) and the vertical distance between the third and ninth step (D) divided by time. The test was repeated for several times for each subject to record the best score. (William, 1986)

\[
\text{Power} = \frac{(W \times 1.05)}{T}
\]

Where,

- \(W\) - the weight of the subject in kilograms
- 1.05 - is the height in the meters
- \(T\) - elapsed time

**VO₂ Max**

**Objective**

To find out the VO₂ Max of the subjects

**Equipment**

Stopwatch and 18 inches high bench
Procedure

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 process in four counts as follows.

   a) Left foot was placed on the bench.
   b) Right foot was placed on the bench
   c) Left foot was placed on the floor, and
   d) Right foot was also placed on the floor.

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 stopped their step-ups when they heard the command ‘stop’ from the investigator.

1. The stepping exercise continued for three minutes, in which each minute the subject 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 in to recovery. (Astrand, 1998)

2. To predict the maximal oxygen up-take (VO₂ Max) by step test the “Astrand nomogram” was used
BODY FAT

Objective

To measure the body fat of the subjects

Equipment

Standard skinfold caliper was used to assess the body fat.

Procedure

The investigator grasped the skin fold between thumb and index finger and attached the jaws of the calipers about 1cm from the thumb and finger.

Measurements of skin fold thickness taken from the following sites.

1. Abdomen – At the midaxillary line at waist level, adjacent to the umbilicus.

2. Chest – over the lateral border of the pectoralis major muscle just medical to the axilla.

3. Triceps – Midway between the acromian and olecranon process on the posterior aspect of the arm, with the arm held vertically.

Each site was pinched up with a fold of fat encased between two thicknesses of the skin. The fold was pulled up and away from the muscle to ensure only fat is being measured. The subject was asked to contract the underlying muscle. Measurements are taken on the right side of the body with subject standing. The reading was taken for each site between 2 and 5 seconds after the caliper was placed. And the measurement was taken early in the morning to eliminate the diurnal variation in the state of hydration. Measurements are taken in millimeter. (Shaver, 1981)
LEAN BODY MASS

Objective

To measure the lean body mass of the subjects

Equipment

Standard skinfold caliper was used to assess the lean body mass.

Procedure

Lean body mass (LBM) includes all of the body tissue such as bone, muscle, nerve fibre coverings etc. Lean body mass was calculated using the following equation.

\[
LBM \text{ (kg)} = \text{Total body weight} - \text{total weight of fat (kg)}
\]

BODY WEIGHT

Objective

To measure the body weight of the subjects

Equipment

Standard lever scale was used.

Procedure

Subject was asked to step on the scale with minimum clothing, gym shorts. Actually no appreciable accuracy is lost if the amount of clothing is consistent. The subject was weighed at the same time of day and to the same degree of accuracy the nearest half kilogram. The hair was pressed down to avoid the variation in weight, since the hairstyle may variate the body weight. The
investigator controlled the weighing situations to reduce the embarrassment on the
part of the subjects. The measurements are taken in kilogram. (Yobu, 1988).

**ATHLETIC PERFORMANCE VARIABLES**

**100 and 400 metres Running**

**Objective**

To measure the speed performance of 100 and 400 metres run.

**Facilities and equipment**

Standard track, stopwatches, starting blocks, spikes and starting gun
were used.

**Procedure**

The investigator conducted 100 and 400 metres run as per rules and
regulations of the International Amateur Athletic Federation. The time was
recorded as 1/100 of the seconds.

**800 m Run**

**Objective**

To measure the performance of 800 metres run of the subjects.

**Facilities and Equipments**

Standard track, stopwatches, spikes and starting gun were used.

**Procedure**

The investigator conducted 800 metres run, as per the rules and
regulations of the International Amateur Athletic Federation. The time was
recorded in minutes and seconds.
3.11. TRAINING SCHEDULE

One hundred and twenty college men students studying degree course, aged 18 to 25 years were selected at random as subjects. They were divided into four groups each consisting of 30, such as experimental group I, II, III and IV. All the four groups were given bicycle ergometer training with varied intensities and frequencies for 8 weeks. After 8 weeks of training the post test was conducted. The training schedule for four experimental groups are detailed below:

Experimental group I – Experimental group I was given 50 revolutions per minute for 15 minutes for three days per week of bicycle ergometer training.

Experimental group II - Experimental group II was given 50 revolutions per minute for 15 minutes for five days per week of bicycle ergometer training.

Experimental group-III - Experimental group III was given 60 revolutions per minute for 15 minute for three days per week of bicycle ergometer training.

Experimental group IV – Experimental group IV was given 60 revolutions per minute for 15 minutes for five days per week of bicycle ergometer training.

During the training period the experimental groups underwent training as per the training schedule for eight weeks. Every day the bicycle ergometer exercise lasted for about 15 minutes including warm-up (three minutes) time.
The subjects underwent their respective training programs under strict supervision. All the subjects involved in the training program were questioned about their stature throughout the training period. None of them reported injuries, however, muscle soreness was reported in the early weeks, but subsided later. On the basis of pilot study, the initial load and their further progression was fixed for this study, which was explained in load dynamics.

INDEPENDENT VARIABLE

3.12 BICYCLE ERGOMETER TRAINING

Facilities

Standard Electrical Bicycle Ergometer and stopwatches were used.

Instructions

1. The subjects were explained about the procedure of the test and need for assessment. Also the subjects were given a chance to practice the prescribed test.

2. The subjects were instructed to maintain the cadences of pedaling, at a given rate of revolutions per minute, by watching the rate meter.

3. The subjects were instructed to raise the hand, when they feel an undue discomfort in the chest or feeling of dizziness.

Test administration

The subject was asked to sit on the bicycle ergometer and height of the seat and the handle bar were adjusted according to his height. Care was taken
in this, so that when the pedal was at its lowest level, the corresponding knee of the subject was not fully extended. The subject was asked to pedal at cadence of given revolutions per minute.

**Assessment of Maximum work**

The subject was asked to pedal at the cadence of 60 revolutions per minute with a load of 50 Watts as a warm-up procedure. At the end of two minutes with the same cadence, the load was increased to 5/2 of his body weight. This load and cadence was maintained for six minutes. Thereafter for every minute of exercise, this load was increased at the rate of 15 Watts per minute at the same cadence until the subject was unable to maintain the cadence. This was considered as the maximal work. (Karel Podlesak, 1982)

**Load Dynamics**

The percentage of intensity (Watts) variations in eight weeks training for both 50 revolutions and 60 revolutions groups are given below:

<table>
<thead>
<tr>
<th>Week</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Intensity</td>
<td>60</td>
<td>65</td>
<td>70</td>
<td>75</td>
<td>80</td>
<td>85</td>
<td>90</td>
<td>95</td>
</tr>
</tbody>
</table>

(Watts)

In the first week, experimental groups were asked to pedal at the cadence of 50 revolutions and 60 revolutions per minute with an initial load of 50 Watts. At the end of 3 minutes, with the same cadence the load was increased to 60 % of the individual's maximum work and asked to continue the exercise for 15 minutes (3 + 12 min.) Thereafter, for every week the intensity of load was increased by five percent.
3.13 EXPERIMENTAL DESIGN AND STATISTICAL TECHNIQUE

The experimental design used in this study was 2x2 factorial design involving 120 subjects. The subjects were divided at random into four groups of 30 each. This study consisted of four experimental groups.

The experimental group I underwent 50 revolutions per minute for 3 days per week of bicycle ergometer training, experimental group II underwent 50 revolutions per minute for 5 days per week, experimental group III underwent 60 revolutions per minute for 3 days per week and experimental group IV underwent 60 revolutions per minute for 5 days per week of bicycle ergometer training. All the subjects were tested prior to and after the experimental treatment on resting pulse rate, anaerobic power, VO2 Max, body weight, fat, lean body mass, 100, 400 and 800 metres running. This design was used to find out the influence of each factor independently and also their combined influence on each of the selected dependent variables.

Two way analysis of variance (ANOVA) was applied for the mean gain scores. The pretest scores were subtracted from the respective posttest scores. It is referred as mean gain score. This study involves two factors intensities (revolutions) and frequencies (days). The first factor was intensities consisting of two groups that are 50 revolutions per minute and 60 revolutions per minute of bicycle ergometer training. The second factor was the frequencies consisting of two groups that are 3 days per week and 5 days per week, of bicycle ergometer training.
The mean gain scores on the selected dependent variable were subjected to two-way analysis of variance (ANOVA). It resulted in three F-ratios, first one for intensities, second for frequencies and third one for interaction. If the obtained F-ratios for interaction were significant then the simple effects tests were applied to find out whether there exist significant difference among the dependent variables, for different intensities and frequencies. Since, each cell consists of two groups the post hoc test was not applied though the obtained F-ratios for simple effects test were significant. The level of significance was set at \( P < 0.05 \) level of confidence.