CHAPTER - III
METHODOLOGY
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This chapter describes in detail the procedures adopted for selection of subjects and experimental variables, pilot study, experimental design and procedure, training programme, criterion measures, reliability of data, test administration, collection of data and statistical treatment of data involved in the study.

SELECTION OF SUBJECTS

The purpose of the study was to find out “Quantify the anthropometric and physiological responses to varied intensity and frequency of plyometric training among college men students”.

One hundred and twenty college men students undergoing degree course in Selvamm Arts and Science College, Namakkal, Tamil Nadu were selected as subjects at random and their age was between 18 to 25 years. They were divided into four equal groups, by adopting random sample method.

EXPERIMENTAL VARIABLES

Based on the relevant literature reviewed and in accordance with views of professional physical educators. the following physiological and anthropometric variables were selected for quantification of their response to varied intensity and frequency of plyometric training in the study.
A. DEPENDENT VARIABLE

i. Anthropometric Variables
1. Body Weight
2. Chest Girth
3. Thigh Girth
4. Calf Girth
5. Biceps Girth

ii. Physiological Variables
1. Resting Pulse Rate
2. Calorie consumption
3. VO₂ max
4. Blood Hemoglobin
5. Anaerobic Power
6. Mean Arterial Pressure
7. Flexibility
8. Fat percentage.

B. INDEPENDENT VARIABLES

1) 80% intensity with 4 days frequency (Exp. Group I)
2) 80% intensity with 2 days frequency (Exp. Group II)
3) 70% intensity with 4 days frequency (Exp. Group III)
4) 70% intensity with 2 days frequency (Exp. Group IV)

PILOT STUDY

A pilot study was conducted for the purpose of finalizing and deciding upon the intensity, frequency of the four training programmes. The subjects of the study were untrained college students and the training programme was to
be fixed with in the limits and capabilities of the subjects. Previous procedure available in guidelines for graded exercise testing and exercise prescription of American College of Sports Medicine (1975) and the recommendation of Fox et.al., (1988) formed the basis for the pilot study as well as the training programmes.

Since the subjects were college males of age group 18 to 25 years with training background, the researcher assumed that if recommendations were strictly adhered to, found end up in overstress.

Five subjects each from four experimental group were utilized for the pilot study.

EXPERIMENTAL DESIGN AND PROCEDURE

The study was formulated as a true random group design, consisting of a pre-test and post-test one hundred and twenty untrained students were randomly divided into four groups. The groups were assigned Experimental Group I, II, III and IV namely.

Experimental Group I – 80% intensity with 4 days frequency
Experimental Group II – 80% intensity with 2 days frequency
Experimental Group III – 70% intensity with 4 days frequency
Experimental Group IV – 70% intensity with 2 days frequency

The four experimental groups were progressively introduced the thirteen dependent variables were complied before the commencement of the six weeks experimental study and final test was taken after six weeks of respective training.
CRITERION MEASURES

In the present study, the criterion chosen for testing the hypotheses were the following.

1. Body Weight

Body weight is the indispensable data in any study involving exercise physiology and training methods. Body weights of subjects is required for assessing the effects of training on the various variables under study.

For the obese and borderline obese, regular endurance exercise causes a reduction in body weight accompanied by decrease in body fat increase in lean body weight often accompany resistance-training programmes. When exercise is used alone or combined with diet, however, more of the weight lost is fat because exercise appears to have a conserving effect on the body’s lean tissues.

In the present quantification study, more than it’s individualized implication, body weight data was required for computing other fitness variables, normally VO₂ max (aerobic power) and anaerobic power, of this study.

To measure the body weight of subjects in this study a plat form – balance was used and the data was recorded in kilograms.

2. Chest Girth

It is one of the girth measurement assisting in the assessment of the subjects anthropometric profile. Anthropometric measurements are one of the three aspects of human body profile. In surface anthropometry twelve measurement sites have been universally identified of which six are muscular sites. Shoulder, chest, biceps, fore-arm, thigh and calf are the muscular anthropometric sites.
Proper training induces specific and identifiable changes in anthropometric girths. The muscles change in girth, cross section and in density because of an increase in sarcoplasm, reduction in the amount of adipose tissue and increase in the development of connective tissue within the muscle bundle.

In the present study, chest girth has rightly been included as a variable for quantification purpose. The chest girth of subjects was measured using a non-elastic cloth tape and the data was recorded and presented in centimeters.

3. Thigh Girth

It is another muscular girth site in anthropometric measurement, chosen for the present quantification study.

The thigh girth of subjects of the study was measured using a non-elastic cloth tape and the data were recorded and presented in centimeters.

4. Calf – Girth

It is yet another muscular girth site chosen for the quantification study by the research scholar. Since leg power of subjects were also ascertained through measurement of anaerobic capacity in the study, the improvements of girths site such as thigh girth and calf girth were doubly relevant.

The calf girth of subjects was measured using a non-elastic cloth tape and the data were recorded and presented in centimeters.

5. Biceps Girth

Another of the muscular girth sites aptly included in the present quantification study to test the hypotheses increase in biceps girth due to
training was of utmost relevance of the youth of today who visit the gymnasium for body – beautification purpose.

Biceps girth of subjects in the present study was measured using a non elastic cloth tape and data were presented in centimeters.

6. Resting Heart Rate

It is the rate of one's heart beats per minute when at physical and mental rest. Training has pronounced effect on heart rate, even at rest. In highly trained athletes of either sex, resting heart rate may be as low as or lower than 40 beats per minute. In contrast, resting heart rate for untrained but healthy individuals may be as high as 90 beats per minute. A relatively show heart rate, coupled with a relatively large stroke volume indicates as efficient circulatory system.

In the present study, Resting Heart Rate was measured using a Teacher – pupil double stethoscope and data were recorded in number of heart beats per minute.

7. Calorie Consumption

It is the energy expenditure incurred by an individual while at work, exercise or training for a given period of time. Humans incur different quantities of energy while performing different kinds of tasks.

In this study the respective calorie consumption of subjects were recorded from the treadmill monitor after each of them had performed sub maximal running on the treadmill for 10 minutes. The data were recorded in calories per minute.
8. **VO₂ Max (or) Aerobic Power**

It is the maximal oxygen uptake and highest oxygen value per unit of time that the human body is capable of when breathing air. VO₂ max deserves special attention since it occupies prominent position in the current exercise physiology, literature. It involves an increase in the oxygen uptake to the highest level of severity, where by the ability of the individual to utilize the greatest amount of oxygen is reached.

In this study, VO₂ max capability expressed in liters / minute was predicted from the Astrand rhyming program using submaximal heart rates recorded from treadmill monitor and the body weights of subjects.

9. **Blood Hemoglobin**

It is the oxygen – carrying pigment in the human blood. Training increase the oxygen carrying capacity of the blood and hence total hemoglobin correspondingly increase with training enhancing the oxygen delivery ability.

Chemically hemoglobin consists of an iron porphywin complex known as reduced hemoglobin, or ‘haem’ united with a protein, globin, haem is closely related chemically to the prosthetic groups of enzymes concerned with oxidation of food stuffs, hemoglobin combines with oxygen to form a scarlette compound, oxyhemoglobin. The blood hemoglobin content of an athlete is usually around 15.6 gms per 100 ml. of blood, Lippold and Winten (1968).

In this study, the subjects hemoglobin content in blood was measured using Sahils Acid Haematin method. Blood samples of subjects were analysed by professional Lab Technicians and total hemoglobin content recorded in gram %.
pressure is somewhat less than half the difference between systolic and diastolic pressures. As an approximation, it is equal to diastolic pressure plus one-third of the pulse pressure. Clarke (1975).

In the present study, the mean arterial pressure of subjects has been computed by using the Clarke formula. Both diastolic and systolic pressures were recorded and mean arterial pressure was computed using the formula (Mean Arterial Pressure – Diastolic pressure + 1/3 pulse pressure) and the data were recorded in mm of mercury.

12. Flexibility

It is the ability of an individual to execute movements with greater amplitude and range and is often equated with stretch ability, elasticity, suppleness and mobility. Stretch ability and elasticity are the special qualities of the muscle and ligaments by which these can be stretched and can regain their normal length without any adverse effect on the concerned tissue.

The AAHPERD (1988) had prescribed the sit and reach test for measuring flexibility in their health related physical fitness test Battery.

In this study, the flexibility of subjects was measured using the sit and reach test for which the ‘AAHPERD’ – prescribed Box was used. The data were recorded in centimeters of reach achieved by each subject.

13. Fat Percentage

The classification of obesity is based on the amount of fat that is contained in the body, standards vary from one authority of another, but is generally felt that men should not exceed 15 to 20% body fat, and women 25 to 30%. Hirsch and Knittle (1970).
Brook et. al. (1972) have expressed their concern over the disturbing finding that obesity in early childhood leads to a greater increase in cell number than obesity beginning later in life.

Most of the research literature substantiates the notion that regular physical exercise has a favourable effect on body composition for individual of all ages. The concern over the increased incidence of obesity in the campus was one of the factors that influenced the researcher to include fat percentage in the present quantification study.

Fat fold measurements can provide consistent and meaningful information concerning body fat and its distribution. The sum of fat folds ‘for example, can also be used to reflect changes in fatness ‘before’ and ‘after’ a physical condition regimen. Studies conducted on subjects have shown that ‘triceps’ showed the largest decrease and sub-scapula the smallest decrease when changes due to training was expressed in percentage. Fat folds can be, in conjunction with mathematical equation, used to ‘predict’ percent body fat. Those ‘population specific equation’ predict fatness fairly accurately for subjects similar in age, gender, state of training, fatness and probably race, McArdle et. al. (1991).

Based on several laboratory findings, a reliable equation to predict body fat for men aged 17 to 26 years was formulated which is as follows.

\[
\% \text{ body fat} = 0.43 (A) + 0.58 (B) + 1.47 \\
\text{where (A) = triceps fat fold and (B) = Sub-scapula fat fold.}
\]

In the present study, the above universally approved formula was utilized to compute body fat percentage of subjects scar-pendent skin fold calyper was used to record skin-folds at the triceps and sub scapular sites and formula applied to compute fat percentage of subjects.
The data were recorded and presented in numerical (%) values.

**RELIABILITY OF DATA**

The reliability of data in this study was ensured by establishing the instruments reliability, tester’s competency and the reliability of the tests.

**INSTRUMENTS RELIABILITY**

Teacher – pupil Double Stethoscope, monotorised treadmill with monitor, margaria stair – sprinting tester with switch, mats and counter, Electronic Digital Blood pressure monitor, Sit and Reach Calibrated Box, Abdominal conditioner with adjustable inclination, scar-pendent skin – fold caliper, platform balance, non elastic cloth, measuring tape and electronic stop watches, used to measure variables in this study, were purchased from reputed firms with ISI specification and government approval. Since all the instruments were new and in fine working condition, their conditions were accepted as accurate enough for the purpose of the study.

**TESTER’S RELIABILITY**

The repeated measurement of individuals on the same test as is done to determine reliability, is a univariate not a bivariate situation it is the distribution of a single variable like a inter class correlation co-efficient Baumgartner and Jocker (1991). The interclass correlation coefficients obtained for test, retest are presented in Table – I.
**TABLE - 1**

**INTRA - CLASS CORRELATION CO-EFFICIENT OF TEST – RETEST**

<table>
<thead>
<tr>
<th>TESTS</th>
<th>INSTRUMENTS</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight</td>
<td>Platform Balance</td>
<td>0.96*</td>
</tr>
<tr>
<td>Chest Girth</td>
<td>Measuring Tape</td>
<td>0.94*</td>
</tr>
<tr>
<td>Thigh Girth</td>
<td>Measuring Tape</td>
<td>0.94*</td>
</tr>
<tr>
<td>Calf Girth</td>
<td>Measuring Tape</td>
<td>0.95*</td>
</tr>
<tr>
<td>Biceps Girth</td>
<td>Measuring Tape</td>
<td>0.91*</td>
</tr>
<tr>
<td>Resting Heart Rate</td>
<td>Teacher pupil Double stethoscope</td>
<td>0.79*</td>
</tr>
<tr>
<td>Calorie Consumption</td>
<td>Treadmill Monitor</td>
<td>0.82*</td>
</tr>
<tr>
<td>VO₂ Max</td>
<td>Astrand - rhyming Nomogram</td>
<td>0.87*</td>
</tr>
<tr>
<td>Blood Hemoglobin</td>
<td>Sahil's Acid Hematin Methon</td>
<td>0.95*</td>
</tr>
<tr>
<td>Anaerobic Capacity</td>
<td>Margariastair - stepper monitor</td>
<td>0.93*</td>
</tr>
<tr>
<td>Mean Arterial Pressure</td>
<td>Blood Pressure Monitor</td>
<td>0.92*</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Sit and Reach Tester Box</td>
<td>0.95*</td>
</tr>
<tr>
<td>Fat Percentage</td>
<td>Scar-pendent skin-fold caliper</td>
<td>0.89*</td>
</tr>
</tbody>
</table>

* Significant at 0.01 level  
Table value $r = 0.561$ at 0.01 level  
(df = 18)

### 3.10. TEST ADMINISTRATION

Sequence of the Items

1. Body weight was recorded in kilograms.
2. Chest girth was recorded in centimeters.
3. Thigh girth was recorded in centimeters.
4. Calf girth was recorded in centimeters.
5. Biceps girth was recorded in centimeters.
6. Age of the subjects were recorded in completed years.
7. Resting heart rate was recorded in beats per minute.
8. Calorie consumption was recorded in calories per minute.
9. VO₂ max was predicted in liters per minute.
10. Blood hemoglobin content was recorded in gram percentage.
11. Anaerobic power was recorded in kg / mts / second.
12. Mean Arterial pressure was computed in millimeters of mercury.
13. Flexibility was recorded in centimeters.
14. Fat percentage was recorded in numerical percentage.

1. Body Weight

Purpose
To accurately measure the body weight of the subjects.

Equipment
Platform balance with ISI specification.

Procedure
The subjects were asked to strip up to their shorts and were instructed to step on the platform balance in base feet.

While the subjects stood still facing the scale of the platform balance, the investigator adjusted the weight plates and measured their body weights as accurately as possible to the nearest hundredth of a gram.

Unit of Measurement
Kilograms.

2. Chest Girth

Purpose
To assess the chest muscular girth of subjects.

Equipment
Non – elastic calibrated cloth tape.
Procedure

The subject with bare torso was required to stand erect, but relaxed after normal inhalation with both arms slightly apart to facilitate easy measurement.

The investigator then wound the subject's chest slightly above his nipples, with the cloth tape. Here the trial and error method was used to adjust the tape for the exact site which measured most.

The calibrated cloth tape provided the chest girth, which was recorded. A duplicate measurement was also recorded. If there was any difference, the average score of the two was recorded as the chest girth.

Unit of Measurement

Centimeters.

3. Thigh Girth

Purpose

To measure the thigh muscle girth.

Equipment

Non-elastic calibrated tape.

Procedure

The subject was required to stand erect in underpants which revealed full thigh muscles to the view of testers.

The investigator would have the tape on the right upper thigh of the subject just below the buttocks.

The readings were taken twice and if difference in readings were noticed, average value was taken as the thigh girth score.
Unit of Measurement
   Centimeters.

4. Calf Girth
Purpose
   To measure the calf muscle girth.

Equipment
   Non-elastic calibrated cloth tape.

Procedure
   The subjects were required to stand erect with their feet slightly apart and wearing only short pants.

   The investigator wound the cloth tape around the right calf. Using trial and error method, the investigator found out the widest girth midway between ankle and knee and measured calf girth.

   Duplicate measure was also taken for consistency of girth measurement, average score was recorded in case of difference.

Unit of Measurement
   Centimeters.

5. Biceps Girth
Purpose
   To assess the biceps muscle girth.

Equipment
   Non-elastic calibrated cloth tape.
**Procedure**

The subjects were required to flex his biceps muscle and hold it for measurement.

The investigator wound the cloth tape around the largest girth area, almost middle of the biceps, and took measurement in centimeters.

Two measurements were taken and average calculated in the case of different values.

**Unit of Measurement**

Centimeters.

**6. Resting Pulse Rate**

**Purpose**

To measure the rate of heart beats per minute while the subjects were at rest.

**Equipment**

Teacher – pupil double stethoscope.

**Procedure**

For accuracy sake, in this study, the resting heart rate was measured in the subjects hostel rooms as soon as they woke up from their sleep in the morning. The subjects were instructed to remain in their beds till the investigator arrived to measure their resting heart rates. Even though measuring thirty subjects on a single morning was a time-consuming exercise, the result produced was worth the effort made.

The advantage of double stethoscope was that it had two sets of car-pieces connected to one diaphragm or sensor.
One set of ear – pieces were used by the subjects while the other set was fixed to the tester’s ears.

The diaphragm was placed on the carotid artery on the right side of the subject’s neck.

The stop-watch was used to count the seconds for starting and ending the heart bent counts.

The subjects also could count his heart beat through the ear – pieces fixed to his ears.

After every minute, when stop – watch was halted, both the subjects and investigator called out the number of beats counted by them simultaneously.

There were five repetitions of such one – minute counts and the highest count was recorded as the subject’s resting heart rate.

**Unit of Measurement**

Number of beats per minute.

**7. Calorie Consumption**

**Purpose**

To ascertain the energy expended by the subjects at the end of the submaximal work out.

**Equipment**

Motorised treadmill at 10 inclination.
Procedure

The procedures adapted were similar to the are used to measure submaximal heart rate, given above at (2).

The monitor attached to the treadmill, in addition to heart rate, speed and distance covered, also accurate information about the calories of energy expended by the subject at the end of the minute work out on the treadmill.

At the end of the ten minute submaximal exercise on the tread mill, the calories consumption of each subject was noted down by the investigator and recorded.

Unit of Measurement

Calories per minute.

8. VO₂ Max

Purpose

To measure the aerobic capacity of the subjects.

Equipment

a. Motorised treadmill to ascertain submaximal heart rate.

b. Platform balance to ascertain body weights.

Procedure

The submaximal heart rate of subjects were recorded from the procedure adopted at (2) above.

The body weight of subjects were recorded from the procedure adopted at (4) above.
The VO2 max of each subject was predicted from the Astrand – rhyming nomogram by drawing a diagonal across their sub maximal heart rates and corresponding body weights on the chart. Astrand and Rhyming (1954).

The VO2 max values thus obtained for each subject was recorded by the investigator.

**Unit of Measurement**

Litres per minute.

**9. Blood Hemoglobin**

**Purpose**

To ascertain the total hemoglobin content in the subjects blood samples.

**Equipment and Method**

Measured by professional medical laboratory technicians.

**Procedure**

The investigator, in consultation with medical experts and practitioners, entrusted the job of measuring the blood hemoglobin content of subjects of the study, to leading diagnostic research centre.

The professional and licensed technicians collected the blood samples of subjects and carried them to their computerized laboratory for analysis to find out the hemoglobin content in the blood.
The investigator in person, assisted the technicians during the collection of blood samples and the analysis and recorded the findings in the research report.

**Unit of Measurement**
Gram percentage.

**10. Anaerobic Power**

**Purpose**
To measure the anaerobic capacity of subjects.

**Equipment**
Margaria Stair sprinting tester with switch beats and time counter.

**Procedure**
The equipment consisted of two switch mate, and a clock or counter. The first switch mat was placed on the third step of the stairs and the second switch mat on the ninth step. The ‘counter’ connected by the 60th the switch mats was placed at an appropriate place outside the stairs between the two switch mats for convenient viewing by researcher and his associates.

The subject was to start at a point 6 mts from the first step of the stairs. He was given strat using ‘on your marks’, ‘get – set’ and Whistle (for 90).

The subject stand towards the stairs look his first step on his strong foot on the first switch mat placed on the third step by skipping first two steps of the stairs.

His first step activated the clock in the counter and his next step was on the sixth step, skipping steps four and five.
Subjects strong foot again landed on the switch mat placed on the nine step. Skipping steps seven and eight, which halted the clock in the counter. The subject continued his sprint beyond ninth step and stopped.

The ‘counter’ should the time taken for the ‘anaerobic sprint’ of the subject from step III to step IX of the stair to the nearest hundredth of a second.

The researcher noted down the timings clocked by the subjects and the aerobic power was computed using the Mathews (1991) formula.

**Unit of Measurement**

Kg/m – mts / second.

11. Mean Arterial Pressure

**Purpose**

To measure the mean arterial pressure of subjects.

**Equipment**

Electronic Digital Blood pressure monitor with manual inflation facility (Omron imported from Japan) to record systolic and diastolic blood pressure.

**Procedure**

The subjects were seated comfortably on a chair facing the investigator by the side of a table high enough to allow the subject to leisurely keep his felt fore – arm (palm upwards) from a low onwards an the table.

The arm – cuff was wound around the left arm of the subject in such a way that the cuff covered lower half on the biceps, the lower edge of the cuff in unison with the elbow joint and the green coff – maker coinciding with the practical artery.
The cuff tube and air tube were non connected at either sides of the
digital monitor in the respective sockets.

The investigator switched on the monitor and waited till its showed
‘Zero’ and ‘Ready’ signs. The investigator started for squeeze the inflation
bulb and monitor started showing increase in pressure.

The investigator stopped squeezing when systolic value reached
approximately 40 mm Hg higher than the normal systolic values.

The subjects were asked sit still and relax through out this process on
stopping the inflation, the cuff started to deflate automatically a monitor
showed the corresponding decrease in pressure.

The decreasing trend stopped and with a musical “beep – sand” the
monitor displayed both the systolic and diastolic pressure of the subjects.

The investigator noted down these reading and computed the mean
arterial pressure of the subject by applying the Clarke (1975) formula.

**Unit of Measurement**

(mm / Hg) millimeters of mercury.

**12. Flexibility**

**Purpose**

To measure the low – back and Harmstring stretch ability.

**Equipment**

Calibrated sit and reach tester box.
**Procedure**

The sit and reach test box was kept on the gymnasium floor of even level. Subjects were asked to sit on the floor facing the box, with their legs and feet stretched. The sole of the subjects feet touched against the vertical base of the box under the calibrated horizontal platform. The subject sit straight and extended both arms straight ahead.

The subject now stretched forward, bending his upper body above the hip, extending both arms across the calibrated plat form of the box.

The print on the scale where the tips of the fingers of the subject reached was noted by the researcher and recorded as the flexibility measure of the subjects.

**Unit of Measurement**

Centimeters.

**13. Fat Percentage**

**Purpose**

To evaluate the percent body fat of subjects.

**Equipment**

Scar-pendent skin fold caliper.

**Procedure**

In order to compute the body fat percentage of subjects in the study, fat folds at two sites, namely triceps and sub-scapular were measured using the skin fold calyper, Montoye (1975).
a. Triceps Skin Fold

The subject was asked to strip to the waist and stand steadily with the right hand extended downwards along his body, but relaxed without any stiffness in the arm.

Ensuring that proper light was available, the investigator with his left thumb and index finger took a vertical fold on the posterior midline of the subject’s right upper arm, halfway between tip of the shoulder and the top of the elbow.

The investigator held the caliper in his right hand, his thumb controlling the ‘jaw - lever’. The jaws of the caliper was opened sufficiently to engulf the fat fold held between the left thumb and index finger. The Jaw - lever was pressed to open the Jaws of little more and then very cautiously released to engulf the fat fold, nothing more and nothing less.

Now the readings on the ‘dial’ was read and announced loudly by the investigator while his assistant took down the respective readings.

b. Sub Scapular Skin Fold

The procedure adopted were similar to the one used to measure triceps skin fold, the site of measurement alone varying.

The subject was asked to stand erect relaxed with his upper torso bare of any clothing.

The investigator reached behind the subject and took a fold of skin between left thumb and index finger at the lower tip of the subject’s right scapula. It was a diagonal fold approximately 45 from horizontal in the natural clearage of the skin at the interior angle of the scapular.
With the Jaws of the calyper controlled by the right hand, investigator measured the skin fold thickness and read out loudly from the dial to be recorded by the assistant.

Computation

The sum of the recorded scores of triceps and sub-scapular fat folds were used to compute fat percentage using McArdle and associates (1991) formula.

Unit of Measurement

Numerical percentage scores.

STATISTICAL TECHNIQUES

The analysis of co-variance statistical techniques was used to find out the effects of varied intensities and frequencies of plyometric training on selected Anthropometric and physiological variables among college men students.

The Scheffe's post hoc test was used to find out the paired mean significant difference. Thirumalaisamy (1995).