CHAPTER III

METHODOLOGY

In this chapter, the procedures followed in the Selection of subjects, Experimental design, Selection of Variables, Pilot study for the construction of training program, Orientation of the subjects, Training program, Collection of data, Reliability of data and Statistical procedure adopted to analyse the data are presented.

Selection of Subjects

For the purpose of the study forty-five college male students were selected at random from Govt. college boy's hostel, Lawspet, Puducherry. They were studying in the colleges around Puducherry and their age ranges from 18 to 25 years. They are divided into three groups namely the Control group, the Yogic group and the Aerobic group. These groups were undergone 14 weeks of progressive training. The Control group consists of 15 subjects, who were not undergone any training. The Yogic group consists of 15 subjects who undergone the practice of Asanas and Pranayama. The Aerobic group consists of 15 subjects who undergone rhythmic Aerobic exercises. A qualification criterion for the experimental group was some participation in school or college level sports and games in order to sustain the training process. The same criterion was also used for control group.
**Experimental Design**

The Experimental design used for this study was similar to random group design by selecting 45 college students residing in Govt. hostel, who were divided into fifteen subjects in each group. The Experimental groups namely the yogic group and the aerobic group underwent training for fourteen weeks in their respective discipline. The yogic group dealt with Asanas and Pranayama practices. The aerobic group deals with rhythmic Aerobic exercises. But the control group did not involve in any training.

**Selection of Variables**

For the purpose of this study, the research scholar reviewed the available scientific literature pertaining to the somato type anthropometric measurements, Health related physical Fitness variables and Biochemical variables from books, journals, periodicals, magazines and research papers. The following variables and tests were selected:

1. **Somatotype**
   1. Endomorphic component
      (i) Triceps skinfold (Skinfold caliper)
      (ii) Subscapular skinfold
      (iii) Suprailium skinfold
      (iv) Calf skinfold
2. Mesomorphic component
   (i) Height (Stadiometer)
   (ii) Humerus width (Vernier caliper)
   (iii) Femur width
   (iv) Bicep girth (Measuring tape)
   (v) Calf girth

3. Ectomorphic component
   (i) Height
   (ii) Weight (Weighing machine)

II. Health related Physical Fitness Components

1. Physical Strength Endurance
   (i) Push ups
   (ii) Pull ups
   (iii) Bent Knee sit ups
   (iv) Extended knee sit ups

2. Muscular Flexibility
   (i) Sit and reach test
   (ii) Truck extension Test
   (iii) Upward backward arm movement test

3. Cardiovascular Endurance
   (i) Twelve minutes run/walk (Cooper Test)
4. Body composition

(i) Triceps skinfold
(ii) Subscapular skinfold
(iii) Suprailium skinfold
(iv) Midaxillary skinfold
(v) Abdominal skinfold
(vi) Thigh skinfold
(vii) Chest skinfold

III. Biochemical Variables

1. Lipid test

(i) Low density lipoprotein (LDL),
(ii) High density lipoprotein (HDL),
(iii) Triglycerides (TG),
(iv) Total cholesterol (TC) and
(v) Very low density lipoprotein (VLDL).

2. Blood test

1. Fasting blood sugar (FBS),
2. Hemoglobin (Hb)

**Selection of Test**

In the present study the researcher selected some of opted test for the purpose on assessment of their existence and performance.
Experimental Variables

Anthropometric Measurement

Height  Weight  Bicep Girth  Calf Girth

Humerus width  Femur width

Skinfold Measurements

Triceps skinfold  Sub scapular skinfold  Abdominal skinfold  Chest skinfold

Midaxillary skinfold  Thigh skinfold  Supra ilium skinfold  Supra ilium skinfold

Health Related Physical Fitness Test

Pull-up Test  Push-up Test  Extended Knee sit ups Test  Bent Knee sit-up

Flexibility Tests

Sit & Reach Test  Trunk Extension test  Upward Backward Arm movement Test  Twelve minutes run Test

Collection of Blood Samples for Biochemical Variables
Somatotype Parameters

Early in this centuries and anthropologists readily accepted the existence of discrete types and tried to find them in what we recognize today as the complex as the complex continuum of human variation. Sheldon’s Somatotype concept of continuous variation was a striking advance over precious system of classification. He recognized that every individual instead of being of a particular type was mixture of all the three basic components of physique, but that there were present in varying degrees in different individuals. Tucker & Lessa (1940) originally called pyknosomic, somatosomic and leptosomic, but then named by Sheldon endomorphy, mesomorphy and ectomorphy.¹ In the modern study lot research have been done on somatotype. So in this study to asses’ somatotype of the subjects Sheldon classification supported by Heath carters’ rating form was used to find the Endomorphy, Mesomorphy and Ectomorphy.

Physical Fitness Parameters

The health related components of physical fitness include cardiovascular endurance, muscular strength and endurance muscular

flexibility and body composition. To improve overall fitness an individual has to participate in specific programs to develop one of the four components. The term wellness in all-inclusive umbrella composed of a variety of activities aimed at helping individual recognize components of lifestyle that are detrimental to their health. This concept goes far beyond absence of disease and optimal physical fitness. So, in this study to asses the cardiovascular endurance the Cooper's 12 minutes run/walk test, to asses the Muscular strength and endurance Arm strength and abdominal tests, to find the Muscular flexibility sit and reach, trunk extension and upward backward arm movement test and finally the body composition skinfold measurement were taken to predict the body fat.

**Biochemical Parameters**

Since lot of studies have been done related to the analysis of biochemical variable, The investigator like to analyse the changes between the biochemical variable between the experimental groups. The selected biochemical variables on Lipid test were Low density lipoprotein (LDL), High density lipoprotein (HDL), Triglycerides (TG), Total cholesterol (TC) and Very low density lipoprotein (VLDL). Blood test such as Fasting blood sugar (FBS), Hemoglobin (Hb)

---

Pilot study

A Pilot study was conducted before finalizing the training program to ensure the intensity and duration of Yogic practices and Aerobic exercises. Ten students were randomly selected for pilot study from each group. They were asked to practice their respective training. The average performances of the ten students from each group were calculated and that was fixed as an initial load for the Experimental group.

Orientation of the subjects

The researcher explained to the subjects for the study about the purpose of the training program and their part in the research programme. A week was spent to teach on Yogic practices and Aerobic exercises for the respective groups before commencement of training program.

Training Program

During the training period the Yogic and the Aerobic group underwent fourteen weeks of training on their respective program. The Yogic group was trained on Asanas and Pranayama. The Aerobic group was trained on Aerobic exercises with rhythmic music for 60 minutes with an intensity that elicited heart rates of 160-180 b·min⁻¹ (80-90 % of peak HR). The Progressive load method was used up to fourteen
weeks for the respective groups. The training was given between 5.P.M to 6.30 P.M every day for 5 days a week with warming up, experimental training and warming down. The training schedule is enclosed in appendices.

The following Asanas and Pranayama were practiced:

<table>
<thead>
<tr>
<th>Yogic practices</th>
<th>Asanas</th>
<th>Pranayama</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asanas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Tatasana.</td>
<td>18. Uthita Badmasana.</td>
<td>33. Dhanurasana</td>
</tr>
<tr>
<td>13. Swatikasana</td>
<td>29. Supta vairasanas</td>
<td>44. Parivurta Trikonasan..</td>
</tr>
<tr>
<td><strong>Pranayama</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Yogic Practices
Asanas
Suriya namaskar

Pose-1   Pose-2   Pose-3   Pose-4   Pose-5   Pose-6

Pose-7   Pose-8   Pose-9   Pose-10  Pose-11  Pose-12

Tatasana  Artha kati Chakrasana  Artha Chakrasana  Virabhaddarasana-I  Parivurtha Trikonasan

Virabhadarasana-II  Virabhadarasana-III  Trikonasan  Prasarita pada uthanasana

Swatikasana  Uthita Badhmasana  Uthanasan  Badakonasana

Patchimuthasana  Poorva Uthanasan  Navasana  Halasana

Matchiasana  Suptha vajirasana  Salabasana  Uthanapadasana
Yogic Practices
Asanas

Utkatasana  Badhmasana  Sarvangasana  Sirasasana  Virksasana

Dhanurasana  Mahamudra  Chakarasana  Janu sirasasana

Vakarasana  Majariasana  Ustrasana  Vajirasana

Yogamudra  Bujangasana  Bharathvajasana  Brhamari pranayama

Pranayama

Sheetkari (inhale mouth exhale nostril)

Sheetali (inhale mouth exhale nostril)

Nadisudhi (inhale Left - exhale Right nostril)

Chandra pranayama (inhale Left - exhale right nostril)

Vibharithakarani

Sugapurva pranayama (inhale Right - exhale Left nostril)

Suriya pranayama (inhale Right - exhale Left nostril)

Kaphalabathi (Forceful exhale both nostril)

Chandra bhedana (Slow & Rhythmic inhale Left - exhale right nostril)

Suriya bhedana (Slow & Rhythmic inhale Right - Exhale Left nostril)

Baathrika (Forceful Inhale & Exhale - both nostril)
The following rhythmic aerobic Exercises (Low impact):

<table>
<thead>
<tr>
<th>Medium phase</th>
<th>Aerobic Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shift weight side move left and right.</td>
<td>24. Walk front &amp; back elbow bent</td>
</tr>
<tr>
<td>4. Two step side move.</td>
<td>27. Sidestep bicep curls.</td>
</tr>
<tr>
<td>5. Forward backward move with crossing hands.</td>
<td>28. Step and cross.</td>
</tr>
<tr>
<td>Medium fast phase</td>
<td>31. Press and move forward and backward.</td>
</tr>
<tr>
<td>10. Sideward thigh lift hands forward.</td>
<td>34. Step and reach.</td>
</tr>
<tr>
<td>11. Sideward thigh lift with click.</td>
<td>35. Side move arm over the head pull.</td>
</tr>
<tr>
<td>12. March forward and backward with elbow up &amp; down.</td>
<td>36. Walk front and back elbow bent up.</td>
</tr>
<tr>
<td>15. Walk forward backward kick.</td>
<td>39. Side move elbow up.</td>
</tr>
<tr>
<td>16. Cross moves crossing hands.</td>
<td>40. Side launch with arm stretch up</td>
</tr>
<tr>
<td>17. Sunshine movements.</td>
<td>41. Side launch with arm stretch forward</td>
</tr>
<tr>
<td>Faster phase</td>
<td>43. Step side forward upward move.</td>
</tr>
<tr>
<td>19. Chicken arms.</td>
<td>44. Moving march stretch.</td>
</tr>
<tr>
<td>20. Reach up.</td>
<td>45. Side step kick.</td>
</tr>
<tr>
<td>22. Great biceps.</td>
<td>47. Ankle arm touch.</td>
</tr>
</tbody>
</table>
Aerobic Exercises
Collection of Data

The primary purpose of this study was to analyze the somatotype or body type components of the control group, Yogic group & Aerobic Group using Heath- Carter\(^3\) Anthropometric somato rating method. The following procedures and scoring methods and equipments were used and followed to find out the Heath-Carter Anthropometric Somatotype test, Health related Physical Fitness Variables and Bio Chemical Variables.

1. Heath-Carter Anthropometric Somatotype

Ten anthropometric dimensions are needed to calculate the anthropometric somatotype: stretch stature, body mass, four skinfold sites (Triceps, Subscapular, Supra-iliac Medial calf), two bone breadths (bipicondylar humerus and femur), and two limb girths (arm flexed and tensed, calf). The following descriptions are adapted from Carter and Heath (1990). Further details are given in Ross and Marfell- Jones (1991), Carter (1996), Ross, Carr and Carter (1999), Duquet and Carter (2001) and the ISAK Manual (2001).

---

\(^3\) Edward L. Fox and Donald K. Matthew’s, \textit{The Physiological Basis of Physical Education and Athletics}, (Philadelphia: Saunders, 1976), pp.516-520.
Although much of the previous description deals primarily with males, reliably Health and Carter have contributed extensively to the field of Somato typing for both men and women. They suggested that there are essentially three methods of obtaining a Somatotype rating.\(^4\)

1. Rating an Anthropometric without a Somatotype photograph
2. Photoscopic or inspection rating by experienced Somatotype with photo
3. Combination of the above two type of study.

From the above said methods, the first method is used to find out the Somatotype of the athletes. The Heath-Carter Somatotype Rating Form was used to find the Endomorphic component, Mesomorphic Component and Ectomorphic Component.

1. Record pertinent identification data in top section of rating form

**Measuring procedures of Somato type component variables**

(A) **Endomorphic Component**

Objective: Estimation of body fat by skinfold measurement thickness.

\(^4\) Ibid.
Materials & Equipment: Skinfold caliper should have upscale inter-jaw pressures of 10 gm/mm² over the full range of openings. The Harpenden Skinfold caliper (Manufactured by British Indicators & distributed by United States by Quinton Equipment) was used to calibrate for correct jaw tension and gap width.

Direction & Scoring method: Estimation of body fat by skinfold thickness measurement. Measurement can use from 3 to 9 different standard anatomical sites around the body and only the right side is usually measured (for consistency). The tester pinches the skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calipers are then applied 1 cm below and at right angles to the pinch, and a reading in millimeters (mm) was taken two seconds later. The mean of two measurements should be taken. If the two measurements differ greatly, a third should then be done, then the median value taken. There are many common sites at which the skinfold pinch can be taken. The sites are followed

(i) Triceps: This measurement was taken at a site halfway between hip of the acromial process and tip of elbow. The measurement is taken with the arms hanging freely. The skinfold measure is taken on the backside of the right arm parallel to the long axis of the arm.
(ii) **Subscapular:** The skinfold is lifted at the tip of right scapula on the diagonal plane about 45 degree from Horizontal plane. The caliper is placed about one centimeter in a laterally downward angle.\(^5\)

(iii) **Suprailium:** The skinfold is cited diagonally following natural line of iliac crest, just above crest of ileum at the mid-auxiliary line.

(iv) **Calf:** The subjects sit or stand with right knee bent about 90 degree and right foot resting. The caliper site was at the level of medial site of maximum calf circumference. The investigator grabs the fold parallel to the long axis of the calf on its medial aspects.\(^6\)

**Endomorphy rating**\(^7\) (steps 2-5)

(2) Record the measurements for each of the four skinfolds.

(3) Sum the triceps, subscapular, Suprailium & calf skinfold. Record the sum in the box opposite SUM3 SKINFOLDS (Triceps, Subscapular, Suprailium). Correct for height by multiplying this sum by \((170.18/\text{height in cm})\).

---


(4) Circle the closest value in the SUM3 SKINFOLDS table to the right. The table is read vertically from low to high in columns and horizontally from left to right in rows. "Lower limit" and "upper limit" on the rows provide exact boundaries for each column. These values are circled only when SUM3 SKINFOLDS are within 1 mm of the limit. In most cases circle the value in the row "midpoint".

(5) In the row for Endomorphy circle the value directly under the column for the value circled in number (4) above.

**B) Mesomorphic Component**

Objective: Estimation of Anthropometric measurements like height, weight, width, girth.

Materials and Equipment: Anthropometric equipment includes a stadiometer, weighing scale, small sliding caliper and fiberglass tape measure. The small sliding caliper is a modification of a standard anthropometric caliper or engineer’s vernier type caliper. For accurate measuring of biepicondylar breadths the caliper branches must extend to 10 cm and the tips should be 1.5 cm in diameter.

Direction & Scoring method: The following directions were followed to measure height, weight, humerus width, Femur width, Bicep girth and Calf girth.
(i) Height: Taken against a height scale or stadiometer. Take height with the subject standing straight, against an upright wall or stadiometer, touching the wall with heels, buttocks, back and the heels together. Instruct the subject to stretch upward and to take and hold a full breath. Lower the headboard until it firmly touches the vertex. Reading is noted on top of the head.

(ii) Humerus width: Bipicondylar breadth of the humerus, right. The width between the medial and lateral epicondyles of the humerus, with the shoulder and elbow flexed to 90 degrees. Apply the caliper at an angle approximately bisecting the angle of the elbow. Place firm pressure on the crossbars in order to compress the subcutaneous tissue. Reading is noted to the nearest 0.5 mm when two blades compressed on either side.

(iii) Femur Width: Bipicondylar breadth of the femur, right. Seat the subject with knee bent at a right angle. Measure the greatest distance between the lateral and medial epicondyles of the femur with firm pressure on the crossbars in order to compress the subcutaneous tissue. Reading is noted to the nearest 0.5 mm when two blades compressed on either side.

(iv) Bicep girth: Upper arm girth, elbow flexed and tensed, right. The subject flexes the shoulder to 90 degrees and the elbow to 45 degrees,
clenches the hand, and maximally contracts the elbow flexors and extensors. Take the measurement at the greatest girth of the arm. Greatest girth when arm is maximally flexed at elbow at right angle. Reading is noted to the nearest 0.5 mm.

(v) Calf girth: The subject stands with feet slightly apart. Place the tape around the calf and measure the maximum circumference. Reading is noted to the nearest 0.5mm.

**Mesomorphy rating (steps 6-10)**

(6) Record height and breadths of humerus and femur in the appropriate boxes. Make the corrections for skinfolds before recording girths of biceps and calf. (Skinfold correction: Convert triceps skinfold to cm by dividing by 10. Subtract converted triceps skinfold from the biceps girth. Convert calf skinfold to cm, subtract from calf girth.)

(7) In the height row directly to the right of the recorded value, circle the height value nearest to the measured height of the subject. (Note: Regard the height row as a continuous scale.)

(8) For each bone breadth and girth circle the number nearest the measured value in the appropriate row. (Note: Circle the lower value if the measurement falls midway between two values. This
conservative procedure is used because the largest girths and breadths are recorded.)

(9) Deal only with columns, not numerical values for the two procedures below. Find the average deviation of the circled values for breadths and girths from the circled value in the height column as follows:

(a) Column deviations to the right of the height column are positive deviations. Deviations to the left are negative deviations. (Circled values directly under the height column have deviations of zero and are ignored.)

(b) Calculate the algebraic sum of the ± deviations (D). Use this formula: \( \text{Mesomorphy} = (D/8) + 4.0 \). Rounding the obtained value of mesomorphy to the nearest one-half (½) rating unit.

(10) In the row for mesomorphy circle the closest value for mesomorphy obtained in number 9 above. (If the point is exactly midway between two rating points, circle the value closest to 4 in the row. This conservative regression toward 4 guards against spuriously extreme rating).

(C) **Ectomorphic Components**

Objective: Estimation of Anthropometric measurements like height, weight.
Materials & Equipment: Anthropometric equipment includes a stadiometer, weighing scale

Direction & Scoring method: The height-weight ratio (HWR), or height divided by the cube root of weight.

(i) Height: Taken against a height scale or stadiometer. Take height with the subject standing straight, against an upright wall or stadiometer, touching the wall with heels, buttocks, back and the heels together. Instruct the subject to stretch upward and to take and hold a full breath. Lower the headboard until it firmly touches the vertex. Reading is noted on top of the head.

(ii) Body mass (weight): The subject, wearing minimal clothing, stands in the center of the scale platform. Record weight to the nearest tenth of a kilogram. A correction is made for clothing so that nude weight is used in subsequent calculations.

**Ectomorphy rating** (steps 11-14).

(11) Record weight (kg).

(12) Obtain height divided by cube root of weight (HWR). Record the values of HWR in the appropriate box.

(13) Circle the closest value in the HWR table to the right. (See note in number (4) above.)
(14) In the row for ectomorphy circle the ectomorphy value directly below the circled HWR.

Move to the bottom section of the rating form. In the row for Anthropometric Somatotype, record the circled ratings for Endomorphy, Mesomorphy and Ectomorphy.

Health related Physical Fitness Variable

1. Muscular strength & Endurance

(a) Arm Strength

Arm Strength\(^8\) (actually arm-shoulder muscular endurance) is scored accordingly to the following formula:\(^9\)

\[
\text{Arm strength} = \frac{(\text{Pull-ups} + \text{Push-ups}) \times (W/10 + H/60)}
\]

In which \(W\) represents the weight in pounds and \(H\) represents the Height in inches. Fraction scores are corrected to the nearest whole numbers at the end.

---


**Push ups**

Objective: To measure the endurance of the arm and shoulder girdle.

Equipment and material: A floor mat.

Direction: From a straight arm front leaning rest position, the performer lowers the body until the chest touches the mat and then pushes upward to the straight arm support. The exercise is to be continued for as many as repetition possible without rest. The body must not sag or pike upward but maintain a straight line throughout the exercise.

**Pull-ups**

Objective: To measure the muscular endurance of arms and shoulder girdle in pulling the body upward.

Equipment and Material: The equipment needed is horizontal bar (1½ inches in diameter raised to a height). So the tallest performer cannot touch the ground from the hanging position. If standard equipment is not available a piece of pipe or the rugs of a ladder can be used.

Direction and Scoring method: The performer should assume the hanging position with the overhand grasp (palm forward) and pull his body until the chin is over the bar. After each chin-ups, he should return to fully extended hanging position. The exercise should be repeated as many times as possible.
(b) Abdominal Strength

**Abdomen plus Psoas**

Objective: To measure the muscular Strength endurance of abdomen with the influence of Psoas muscle.

Equipment and Material: Floor mat

Direction and Scoring method: The Subject in supine lying position with knees extended, hands behind neck and holding the feet by another person. The head should reach near the knee and come back to original position, is scored as one count. The maximum number of complete sit up is noted.

**Abdomen minus Psoas**

Objective: To measure the Muscular Strength Endurance of abdomen without the influence of Psoas muscle.

Equipment and Material: Floor Mat.

Direction and scoring method: The Subject in supine lying position with knees in bent position, buttocks and heals close together, hands behind neck and holding the feet by another person. The head should reach near the knee and come back to original position is scored as one count. The maximum number of complete sit up is noted.

---

2. Muscular Flexibility

The flexibility measures taken at back, shoulder, trunk and hip.

To measure the flexibility or extensibility of the back, the shoulder, the trunk and the hip flexion, the following tests were used.\textsuperscript{11}

   i. Sit and Reach test,

   ii. Trunk Extension and

   iii. Upward Backward arm movement test.

These tests were selected because they were found to assess the extent of flexibility of therefore mentioned body parts in the absence of valid testing apparatus. According to Jenson and Hirst\textsuperscript{12} these tests measure the flexibility of the specific regions of the body.

The selected flexibility tests are easy to administer and are described below:

(i) \textbf{Sit and Reach Test}

Objective: To measure trunk flexion and ability to stretch back and thigh muscles.


Equipment: Sit & reach box, Meter scale

Direction: The subject assumed a sitting position on floor with knees fully extended and toes of feet facing forward. The subject flexed the knees with arms fully extended and with hands placed on top of each other. Three trials will be given to each subject. Each attempt is held for one second and the measurement is taken to the nearest centimeter. The investigator placed a meter to the inner side of the ankle joint. If subject is not able to reach the scale, no score was given.13

(ii) Trunk Extension Test

Objective: To test the flexibility in the region of spine and back extension

Equipment and Materials: Meter scale and Yard stick

Direction & Scoring method: The subject is asked to take prone position on the table with hands closed together near the small of the back with a partner pressing downward on the back of the legs. The subject is asked to lift his chest from the table as high as possible. The distance from the table to the suprasternal bone notch will be measured in centimeters.14

14 Jensen and Hirst, Loc. cit.
(iii) **Upward Backward Arm Movement Test**

**Objective**: To measure flexibility of the shoulder and shoulder girdles.

**Equipment and Material**: Meter Scale and stick (2 feet long and 2 centimeter width)

**Direction**: The subject lies in a prone position on a table with the chin touching the table and the arms reaching forward directly in front of the shoulder. The subject held a stick horizontally with both hands by keeping the arms straight and held it firmly. Then the subject raised the arm upward as far as possible. The vertical distance from the bottom of the stick to the table will be measured to the nearest centimeter.\(^{15}\)

3. **Body Composition**

**Percent Body Fat**

**Objective**: Estimation of Body Density and then calculating the Percent body fat using skinfold measurement thickness.

**Materials & Equipment**: Skinfold caliper should have upscale inter jaw pressures of 10 gm/mm² over the full range of openings. The Harpenden Skinfold caliper (Manufactured by British Indicators & distributed by United States by Quinton Equipment) was used to calibrate for correct jaw tension and gap width.

\(^{15}\) Ibid.
Direction & Scoring method: Estimation of body fat by skinfold thickness measurement. Measurements were taken in seven different anatomical sites around the body. The right side is usually only measured (for consistency). The tester pinches the skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calipers are then applied 1 cm below and at right angles to the pinch, and a reading in millimeters taken two seconds later. The mean of two measurements should be taken. If the two measurements differ greatly, a third should then be done, then the median value taken. There are many common sites at which the skinfold pinch can be taken.

To Predict Body Density from the Sum of Skinfold fat, Generalized Regression equation was used. The sites are followed

(i) Triceps: This measurement was taken at a site halfway between hip of the acromial process and tip of elbow. The measurement is taken with the arms hanging freely. The skinfold measure was taken on the backside of the right arm parallel to the long axis of the arm.

(ii) Subscapular: The skinfold is lifted at the tip of right scapula on the diagonal plane about 45 degree from Horizontal plane. The caliper was placed about one centimeter in a laterally downward angle.\(^\text{16}\)

(iii) Suprailium: The skinfold was cited diagonally just above crest of ilium at the spot where an imaginary line would come down from anterior axillary line.

(iv) Midaxillary: The Subject stands on his feet. The skinfold was cited vertically on the midaxillary line at the level of the xiphoid process of the sternum.

(v) Abdominal: The Subject stands on his feet. The skinfold was cited vertically taken at a lateral distance of approximately 2cm from the umbilicus.

(vi) Thigh: The Subject stands with right leg forward. The skinfold was cited vertically on the anterior aspect of the thigh midway between hip and knee joints.

(vii) Calf: The subjects sit or stand with right knee bent about 90 degree and right foot resting. The caliper site was at the level of medial site of maximum calf circumference. The investigator grabs the fold parallel to the long axis of the calf on its medial aspects.\(^{17}\)

Calculating Percent Body Fat\(^{18}\) from Body Density

Specific Formula for Percent Body Fat from Body Density is

\[
\text{Percent body fat} = [\left(\frac{4.95}{BD} - 4.50\right) \times 100]
\]

Calculating Body Density from Skinfold Measurements

Calculation of body density\(^{19}\) from Seven-Site Formula for male (Chest, Midaxillary, Triceps, Subscapular, Abdomen, Suprailiac, Thigh).

\[
\text{Body density} = 1.112 - (0.00043499 \times \text{Sum of seven skinfolds}) + (0.00000055 \times [\text{Sum of seven skinfolds}]^2) - (0.00028826 \times \text{Age})
\]

4. Cardiovascular Endurance

(viii) **Twelve Minutes Run.**\(^{20}\)

Objective: To measure Cardiovascular Endurance.

Equipment and Material: Stop watch, whistle, clapper, etc...

Direction: The subjects are asked to stand on start line of 400m track. The subject will start running after the command “on your mark” & “Clap” with Clapper. The stop watch will start to see the subjects to run


twelve minutes. The distance an individual can run in Twelve minutes is to be measured as soon as a long whistle.

**Bio-Chemical variable**

The following Biochemical parameters (Fasting lipid profile) were analyzed through the experienced Computerized Clinical lab in Puducherry.

1. Hemoglobin.

2. Fasting blood sugar.

3. Low density lipoprotein.

4. High density lipoprotein.

5. Triglycerides

6. Total cholesterol.

7. Very low density lipoprotein.

**Reliability of data**

Reliability was established by test and retest method. Fifteen subjects were tested on selected variables. The reliability coefficients obtained for test and retest data are presented in Table I.
### TABLE - I

**Reliability Coefficient of test retest method**

<table>
<thead>
<tr>
<th>S.N</th>
<th>Variables</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Height</td>
<td>0.995</td>
</tr>
<tr>
<td>2.</td>
<td>Weight</td>
<td>0.987</td>
</tr>
<tr>
<td>3.</td>
<td>Humerus width</td>
<td>0.983</td>
</tr>
<tr>
<td>4.</td>
<td>Femur width</td>
<td>0.923</td>
</tr>
<tr>
<td>5.</td>
<td>Bicep girth</td>
<td>0.921</td>
</tr>
<tr>
<td>6.</td>
<td>Calf girth</td>
<td>0.899</td>
</tr>
<tr>
<td>7.</td>
<td>Sit and reach test</td>
<td>0.841</td>
</tr>
<tr>
<td>8.</td>
<td>Trunk extension test</td>
<td>0.881</td>
</tr>
<tr>
<td>9.</td>
<td>Upward backward arm Movement</td>
<td>0.817</td>
</tr>
<tr>
<td>10.</td>
<td>Push ups</td>
<td>0.775</td>
</tr>
<tr>
<td>11.</td>
<td>Pull ups</td>
<td>0.789</td>
</tr>
<tr>
<td>12.</td>
<td>Bent Knee sit ups</td>
<td>0.842</td>
</tr>
<tr>
<td>13.</td>
<td>Extended knee sit ups</td>
<td>0.850</td>
</tr>
<tr>
<td>14.</td>
<td>Twelve minutes run/walk</td>
<td>0.91</td>
</tr>
<tr>
<td>15.</td>
<td>Triceps skinfold</td>
<td>0.832</td>
</tr>
<tr>
<td>16.</td>
<td>Sub scapular skinfold</td>
<td>0.899</td>
</tr>
<tr>
<td>17.</td>
<td>Supraillium skinfold</td>
<td>0.851</td>
</tr>
<tr>
<td>18.</td>
<td>Midaxillary skinfold</td>
<td>0.885</td>
</tr>
<tr>
<td>19.</td>
<td>Abdominal skinfold</td>
<td>0.901</td>
</tr>
<tr>
<td>20.</td>
<td>Thigh skinfold</td>
<td>0.945</td>
</tr>
<tr>
<td>21.</td>
<td>Calf skinfold</td>
<td>0.842</td>
</tr>
<tr>
<td>22.</td>
<td>Chest skinfold</td>
<td>0.898</td>
</tr>
</tbody>
</table>
**Statistical Analysis**

The statistical tests used for analysis of data are given below.

An analysis of co-variance was used to determine, if any, significant difference were present among the Control group, the Yogic group and the Aerobic group on the Experimental Variable such as Somatotype components (Endomorphic, Mesomorphic and Ectomorphic Components), the Health related Physical fitness Variables (Arm strength, Abdominal Strength, Total flexibility measures, Percent Body fat and Twelve minutes run) and Bio-Chemical Variable such as Fasting Blood Sugar (FBS), Low Density Lipoprotein (LDL) High Density Lipoprotein (HDL), Triglycerides (TG), Total Cholesterol (TC) and Very low Density Lipoprotein (VLDL). The level of Significance used to test the F ratio\(^\text{21}\) was at 0.05. For test of significance for ANCOVA Scheffe’s post hoc test\(^\text{22}\) was calculated.

To determine the relationship between the Somatotype Components such as Endomorph, Mesomorph and Ectomorph on the Health related Physical fitness such as Muscular strength Endurance, Flexibility measures, Percent Body fat and Cardiovascular Endurance

---


\(^{22}\) Ibid., P.39.
and Bio-Chemical Variable such as FBS, LDL, HDL, TG, TC and VLDL was derived by Pearson product moment Correlation.

The partial relationship \( r_{12,3456} \) between Somatotype Component and Experimental Variables were derived by Fourth order Partial Correlation.\(^{23}\)

The combined relationship between Somatotype Component and Experimental Variables such as Health related physical fitness component and biochemical variables separately calculated by Multiple Correlation.\(^{24}\)

To determine the significance between pre-test and post test Correlations\(^{25}\) Fourth order Partial Correlation\(^{26}\) and Multiple Correlations\(^{27}\) of Somatotype Component on Experimental Variables is tested by the application of ‘t’ ratio. A standard error of the difference between z’s was also calculated.

\(^{23}\) Ibid., P.55.

\(^{24}\) Ibid., P.61.


\(^{26}\) H. Harrison, Ibid., P.57.

\(^{27}\) Ibid., P.63.