Chapter III

PROCEDURE

In this chapter the selection of subjects, selection of variables, collection of data, reliability of data, administration of tests and statistical technique for analyzing the data are described.

Selection of Subjects

The subjects for the study were male professional students of Rajasthan University and affiliated colleges. Two hundred male subjects were randomly selected, with age ranging from 17 to 25 years. The health records maintained by the department/college administration were checked by the investigator to ensure that subjects selected were physically and mentally sound to undergo motor fitness test chosen for this study.

Prior to the testing in different motor fitness components and anthropometric measurements for rating somatotype components, a meeting of all the subjects for this study with their head/principal was convened in which the purpose of the study requirements of testing procedure, demonstration of various motor fitness test items were explained to them in details to take them aware of the actually
requirements of the research study. All the subjects agreed voluntarily to cooperate with the scholar in the study and the testing procedure explained to them. The head/principal of concerned departments/colleges also exhorted them to put in their best efforts in the interest of the scientific investigation.

**Selection of Variables**

From the scholar's own understanding of the problem and as gleaned through the literature, following dependent and Independent variables were selected.

**Dependent Variables**

The rating for the three-somatotype components, were selected as dependent variables.

1. Endomorhpy
2. Mesomorhpy
3. Ectomorhpy

**Independent variables**

The following motor fitness variables were selected as independent variables.
1. Strength
   (a) Explosive leg strength
   (b) Abdominal strength
   (C) Shoulder strength
2. Cardio-respiratory endurance
3. Speed
4. Dynamic balance
5. Agility
6. Flexibility
7. Two-hand coordination

**Reliability of Data**

The reliability of data was ensured by establishing the instruments reliability, tester reliability, reliability of tests and subjects reliability.

**Instrument Reliability**

To record motor fitness components, the instrument like stop watches, tape, yard stick, two hand coordination apparatus, sit and reach flexibility measurement instrument and to rate the components of physique, the instruments like skinfold caliper, wall scale, weighing scale, modified sliding caliper and flexible steel tape, used in this study were
arranged by scholar from research laboratory of Lakshmibai National Institute of Physical Education Gwalior, and Department of Physical Education, University of Rajasthan, Jaipur. The instruments/equipment were supplied by none standard firms and hence their calibration was accepted as accurate enough for the purpose of the study.

**Tester Reliability**

To ensure that the investigator was well acquainted with the techniques of conducting the tests, the investigator had a number of trials/practice sessions with respective experts. The scholar took all the measurements with the assistance of his colleagues, who were all acquainted with the tests and their testing procedures.

Reliability of the investigator in measuring the anthropometric variables and motor fitness components was tested by computing co-efficients of correlation between the scores obtained by an expert on 20 subjects. The co-efficients related to Anthropometric variables are presented in table I and related to motor fitness components are presented in table II.
TABLE - I

COEFFICIENTS OF CORRELATION FOR TESTER RELIABILITY
OF ANTHROPOMETRIC VARIABLES

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variables</th>
<th>Coefficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Weight</td>
<td>96*</td>
</tr>
<tr>
<td>2.</td>
<td>Height</td>
<td>98*</td>
</tr>
<tr>
<td>3.</td>
<td>Calf circumference</td>
<td>98*</td>
</tr>
<tr>
<td>4.</td>
<td>Upper arm circumference</td>
<td>97*</td>
</tr>
<tr>
<td>5.</td>
<td>Biepicondylar diameter of femur</td>
<td>98*</td>
</tr>
<tr>
<td>6.</td>
<td>Biepicondylar diameter of humerus</td>
<td>99*</td>
</tr>
<tr>
<td>7.</td>
<td>Calf skinfold</td>
<td>95*</td>
</tr>
<tr>
<td>8.</td>
<td>Suprailiac skinfold</td>
<td>94*</td>
</tr>
<tr>
<td>9.</td>
<td>Sub scapular skinfold</td>
<td>95*</td>
</tr>
<tr>
<td>10.</td>
<td>Triceps skinfold</td>
<td>97*</td>
</tr>
</tbody>
</table>

N = 20
r-value (18) = 0.56

* Significant at 0.01 level of significance.
Reliability of Tests

Reliability of tests was also established by the test-retest method. The data were collected by the investigator on twenty subjects randomly selected from the total group of two hundred. Co-efficients of correlation were computed for each test, which are presented in table I and II.
### TABLE II

**RELIABILITY COEFFICIENTS OF TEST RETEST SCORE**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Tests</th>
<th>Coefficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Standing broad jumps</td>
<td>.92*</td>
</tr>
<tr>
<td>2.</td>
<td>Push ups</td>
<td>.89*</td>
</tr>
<tr>
<td>3.</td>
<td>Sit ups</td>
<td>.90*</td>
</tr>
<tr>
<td>4.</td>
<td>50 yard Run</td>
<td>.90*</td>
</tr>
<tr>
<td>5.</td>
<td>Cooper's 9 minute run/walk test</td>
<td>.89*</td>
</tr>
<tr>
<td>6.</td>
<td>Sit and Reach flexibility test</td>
<td>.93*</td>
</tr>
<tr>
<td>7.</td>
<td>Two hand coordination test</td>
<td>.93*</td>
</tr>
<tr>
<td>8.</td>
<td>Shuttle run test</td>
<td>.91*</td>
</tr>
<tr>
<td>9.</td>
<td>Johnson modified bass test</td>
<td>.89*</td>
</tr>
</tbody>
</table>

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N = 20

r .01 (18) = .56

* Significant at 0.1 level of significance.
Subjects Reliability

The above test re-test co-efficients of correlation also established that subjects reliability which was significant at .01 level of confidence as the same subjects were used under similar conditions by the same tester and no motivational techniques were used nor any training.

Administration of Tests and Collection of Data

The data were collected by administering the respective tests for the chosen variables. Before the administration of tests the subjects were given a chance to practice the prescribed tests to make them familiar with the tests and to know exactly what was to be done. The methodology for each apparatus was explained to the subjects prior to the administration of tests. To ensure uniformity in testing conditions. The data was collected for the chosen independent and dependent variables as per the procedure mentioned below.

Somatotype Components

The ratings for the three-somatotype components were obtained by
the Heath Carter Anthropometric Somatotyping Method.¹

Height

Objective:

To measure standing height.

Equipment:

Stadiometer.

Procedure:

The subject were assembled in the indoor hall of Rajasthan University, Jaipur, where explained the tests and its procedure. The subject erect stood position without shoes, feet together with heels, buttocks, back and rear head in contact with the scale. The subject was instructed to take breath and hold, head level without tilting while the measurement was taken.

Scoring:

Height was recorded to the nearest one tenth of cm.

Weight

Objective:

To measure body weight.

Equipment:
    Weighing scale.

Procedure:
    The subject stood on center of the scale platform. The subject wore only shorts.

Scoring:
    Weight to the nearest half pound was recorded.

Humerus

Objective:
    To measure humerus bone diameter.

Equipment:
    Sliding caliper.

Procedure:
    The arm of the subject was raised forward to approximately the level of the shoulder and the forearm was flexed upward at a right angle to the arm. The caliper was applied to the epicondyles, bisecting the angle of the elbow and lying in the same plane as the arm and forearm.

Scoring:
    Measurement was recorded to the nearest .05 centimeter.
Femur

Objective:
To measure femur bone diameter.

Equipment:
Sliding caliper.

Procedure:
The subject sat on a chair with his foot on the floor and the lower leg vertical. The researcher came in a kneeling position in front of the subject and applied the caliper branches to the epicondyles, bisecting the knee angle and keeping the branches in a plane parallel to the thigh and lower leg.

Scoring:
Measurement was recorded to the nearest .05 centimeter.

Biceps

Objective:
To measure biceps muscle girth.

Equipment:
Flexible steel tape.

Procedure:
The arm of the subject was horizontal. The forearm supinated and the elbow fully flexed. The subject was instructed to clench his fist and contract his biceps as strongly as possible. The steel tape was
Fig. 1 - Measurement of Biceps Girth
passed around the arm approximately midway between the acromion and the elbow, at right angles to the long axis of the arm (Fig.-1).

**Scoring:**

The tape was in the light contact with the skin and maximum girth was recorded to the nearest one tenth of centimeter. Measurements were taken on both limbs, and the larger girths were recorded.

**Calf**

**Objective:**

To measure calf muscle girth.

**Equipment:**

Flexible steel tape.

**Procedure:**

The subject stood on a table with his feet six to nine inches apart and his weight equally distributed through both lower limbs. The steel tape was passed around the calf muscle until the greatest girth was located, at right angles to the long axis of the leg.

**Scoring:**

The tape was in the light contact with the skin and maximum girth was recorded to the nearest one tenth of centimeter. Measurements were taken on both limbs, and the larger girths were recorded.
Sub-cutaneous fat

Objective:

To measure the thickness of a complete double layer of skin and subcutaneous tissue without including any underlying muscle tissue.

Equipment:

Skinfold caliper.

Procedure:

A double layer of skin and sub-cutaneous tissue was grasped with the thumb and forefinger, the fold being large enough to get a complete double layer, but not so large as to get so much skin and fat as might cause excessive amounts of tension beyond the finger tips. The fold of the skin was held somewhat loosely while the center of the caliper faces were one centimeter from the edges of the thumb and forefinger.

Scoring:

The readings on the dial of the caliper were taken after applying full spring pressure of the instrument for all measurements. Time was allowed for the full pressure of the caliper to take effect, but not so long that the fat could be “Squeezed out” of the skinfold. The measurement was recorded to the nearest one tenth of a millimeter.
Fig. 2 - Measurement of Triceps Skinfold
(a) Triceps

The subjects stood with the arm by side and elbow extended. The skinfold was raised with thumb and forefinger of the left hand over the triceps muscle on the back of the right arm, half way between the acromion and the elbow, the skinfold running parallel to the long axis of the arm. The muscles fibers were excluded, whenever necessary, by locking the elbow joint momentarily in full extension (Fig.-2).

(b) Sub scapular

The subject stood with shoulders erect but relaxed and arms by the sides. The skinfold was raised with the thumb and forefinger of the left hand lateral to the interior angle of the right scapula, the skinfold running downward and outward in the direction of the ribs (Fig.-3).

(c) Suprailiac

The subject stood in normal erect posture. The subject was instructed to draw in a medium breath and hold it. The skinfold was raised with the thumb and forefinger of the left hand in a position one to two inches above the right anterior superior iliac spine so that the fold runs forward and slightly downward.
Fig.3 - Measurement of Sub-Stapular Skinfold.
(d) Calf

The subject sat on the chair with his foot on the floor and lower leg vertical. The skinfold was raised with the thumb and forefinger of the left hand on the medial side of the right calf just above the level of the maximum calf girth, the fold running vertically.

Procedure of Ratings for Somatotype Components

From anthropometric variables, ratings for the somatotype components were obtained by using the Heath and Carter somatotype rating method. The Heath and Carter somatotype rating form was used as shown in Fig. 4. The procedure adopted for rating all the subjects in the somatotype components was as follows.

Procedure for Rating Endomorphy

(Step. 1 – 5)

1. Record pertinent identification data at top of form.
2. Record the measurements from each of the four skinfolds.

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3. Sum the triceps, calf, sub scapular and suprailiac skin folds and record in the box opposite total skinfold. The sum in example equals 43.4 mm.

4. Circle the closest value in the total skinfolds scale to the right. (Note: The scale reads horizontally left to right in rows). The rows, "Lower limit" and "Upper Limit" are to provide exact boundaries for each column and these values should only be circled when the total skinfolds are within a few millimeters of the limit. In most cases the value in the row "mid point" was circled.

5. Circle the value in the row first component, which is directly under the column circled in number 4 above.

Procedure for Rating Mesomorphy

(Step. 6 – 12)

6. Place an arrow above the column containing the subject's height (or closest approximation). The height in example is 64.8 inches; therefore, the arrow has been placed between 64.0 and 65.5.

7. For the two bone measurements (humerus and femur breadth), circle the closest figure in the appropriate row. Where a decision must be made to circle either or a lower number, circle the one which is closer to the height column (noted by arrow). For example,
### Heath-Carter Somatotype Rating Form

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leanest</td>
<td>The leanest state of development.</td>
</tr>
<tr>
<td>Average</td>
<td>The average state of development.</td>
</tr>
<tr>
<td>Heaviest</td>
<td>The heaviest state of development.</td>
</tr>
</tbody>
</table>

**Example:**
- Leaning towards the leanest state.
- Average state.
- Heavily built.
6.07 cm. width of the humerus occurs at the mid-point between 5.93 and 6.07; consequently, 6.07 cm., the upper limit, was circled.

8. Subtract the triceps skinfold from the biceps circumference. To do this, first convert the triceps to centimeters by moving the decimal point one place to the left; e.g., 29.8 cm. – 2.4 cm. (24 mm.) = 27.4 cm.

9. Now subtract the calf skinfold from the calf circumference. Again, change the calf skinfold to centimeters by moving the decimal point one place to the left; e.g., 38.1 cm. – 1.7 cm. (17 mm.) = 36.4 cm.

10. Circle these two corrected measurements (27.4 and 36.3).

11. Used the arrow marked in the height row as the starting column (in our example, both 6.07 and 27.7 appear in the most extreme left column), count the number of columns each other circled or value deviates from this starting point (each column equals one-half unit). In our example, both the humerus and the biceps measurements deviate zero unit (since they are immediately next to the arrow column), while the femur measurements deviates + 1.5 units and the calf measurement deviates + 2.5 units. The average deviation of these measurements equals the total divided by four:

\[
\frac{0 + 0 + 1.5 + 2.5}{4} = 1.0
\]
This represents the average deviation from the height column.

12. Take the average deviation from the height column (+1.0 in example) and add 4. This value gives the obtained final value of 5.0 for the second component. Next, circle 5.0 in the second component row of Figure 4.

Procedure for Ratings Ectomorphy
(Step 13 – 16)

13. Record the weight (in pounds).

14. Refer to the monograph to find out the height: weight ratio (H.W.R. or height/ cube root of weight). Record height weight ratio in the box.

15. Circle the closest value in the H.W.R. scale.

16. Locate the third component value below the column of the circled H.W.R. and circle it.

The somatotype components for each subject were calculated and the data pertaining to this is presented in Appendix.

**Motor Fitness Tests**

The procedure for each motor fitness test is given below.
50 Yard Run

Objective:

To measure speed ability\(^3\)

Equipments:

Five stop watches and a wooden clapper.

Procedure:

The subjects were assemble on the 400 m. sinder track of Rajasthan University, Jaipur and where explained the tests and its procedure. The subjects wore sports kit (T-shirt, shorts and sports shoes) 50 yard starting and finishing line was marked on the eight-lane track. Five subjects were started made to run at one time performance. The subjects were asked to stand on the starting line and to take a standing start. The clapper was clapped after the caution "ready" was given to the subjects. The starter stood in such a position so that the "V" of the clapper, (opened capper) was visible to the timekeepers. As the “V” closed when the clap was executed, the five time keepers (experienced) at the finish line started the stop watches. The subjects sprinted as fast as possible across the finishing line according time was recorded.

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Scoring:

The elapsed time, from the starting signal (clap) until the subject crossed the finish line was recorded to the nearest one tenth of a second as the score.

Bent Knee Sit Ups

Objective:

To measure abdominal strength.\(^4\)

Equipment:

Yard stick & mat.

Procedure:

From a lying position on the back, the subject flexed his knees over the yardstick while sliding his heels as close to his seat as possible. The yardstick was held tightly under the knees until the subject was instructed to slowly slide his feet forward. At the point where the yardstick dropped on the mat, the tester would mark the heel line and seat line in order to indicate how far the feet remained from the seat during the bent knee sit up exercise. The fingers of the subjects were intered locked behind the neck and performed sit-ups alternating a left elbow touch of the inside right knee and a right elbow touch of the inside left knee. The movement was performed as many times as possible.

\(^{4}\) Ibid, p. 120.
Scoring:

The total numbers of repetitions were recorded as score of the subjects. However, repetitions were not counted when finger tips did not maintain contact behind the head, when the knees were not touched, or when the subject push off the floor the elbow.

Push Ups

Objective:

To measure shoulder strength.\(^5\)

Equipment:

Stopwatch and a mat on the floor.

Procedure:

The subject assumed front leaning rest position on the mat the signal 'go' he flexed his elbows and lowered body horizontally, so that his chin almost touched the ground. He returned back to the starting position by pushing up the body and extending the elbows straight. He repeated this movement as fast as possible.

Scoring:

Completed numbers of correct push-ups were recorded.

\(^5\)Ibid., pp. 101–102.
Standing Broad Jump

Objective:

To measure the explosive leg strength.\(^6\)

Equipment:

A measuring tape.

Procedure:

The subject stood behind the marked line with his feet slightly apart and parallel. He took a crouch position by bending his knees and swinging his arms, back wards. He jumped forward as far as he could at a stretch. With maximum effort along with forward arm swing and landed in front. One-meter take-off line was marked in an outdoor area.

Scoring:

The distance between the nearest heel mark and the starting line was recorded. Three trails were given and the best of the trails was recorded in meters.

Cooper's 9 Minute run/walk test

Objective:

To measure cardio-respiratory endurance.\(^7\)

\(^6\) Ibid. , pp. 202 – 203.

\(^7\) Ibid. , pp. 143-145.
Equipment:

Stop watches & whistle.

Procedure:

The runners started behind a line, upon the starting signal, run/walk as many laps as possible around the track within the nine minutes. The official maintained a count of each lap, and when the signal to stop was given, they immediately ran to place at which their runners were at the instant when the whistle was blown. For this test, the 400-meter track was marked into eight divisions of 50 meters each.

Scoring:

The score in meters was determined by multiplying the number of completed laps with the distance of each lap plus the distance of number of segments of an incomplete lap.

Shuttle Run

Objective:

To measure the agility of the performer in running and changing direction.  

Equipments:

A measuring steel tape, stop watches and two blocks of wood were used in this test.

\footnote{Ibid., p. 217.}
Procedure:

Each subject started behind the starting line, on the signal "go", the subject ran to the blocks, which were placed exactly ten meters from the starting line and picked one of the blocks, returned to the starting line and placed the block behind the line. The same process was repeated with the second block. Three trials were given to each subject.

Scoring:

The score for each subject was the length of time that was taken by the subject to complete the distance of 4 x 10 meters, recorded to the nearest tenth of a second. The best of the three trials was taken as score for analysis. Two experienced time keeper taken time.

Modified Bass Test of Dynamic Balance

Objective:

To measure the ability of dynamic balance during movement and after movement.9

Equipments:

The equipment and materials needed were stop watches, ¾ inches marking tape, and yard sticks.

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9 Ibid., p. 233.
Procedure:

The subject stood with his strong foot on the starting mark and leaped to the first mark with his left foot and tried to hold a steady position on the ball of his left for as many seconds as position up to 5 seconds (both the stop watch and counts were used). The subject then leaped into second mark with right foot and so on, alternating the feet from tape to tape. The subject was asked to remain on each tape mark for as many seconds as possible up to a maximum of 5 seconds and the foot must completely cover the tape so that it can not be seen.

Scoring:

The score for each mark successfully landed on was five points, and in addition, one point was awarded for each second the balance was held up to 5 seconds per mark. Thus, a subject may earn a maximum of ten points per mark or a total of 100 points for the test. The performer sacrifices five points for improper landing, failing to stop upon landing from the leap, or touching the heel or any other part of the body to the floor other than ball of the supporting foot upon landing or failing to completely cover the marker with the ball of the foot.
Sit and Reach Test

Objective:

To measure the flexibility of low-back/hamstring.\textsuperscript{10}

Equipment:

One ply wood cube with 30 cm. sides. The topside is extended 20-cm. part the edge of the cube. The topside was marked in cm. The plywood cube was locally prepared.

Procedure:

The subject sits on the mat with legs fully extended and pressed firmly against the front edge of the cube. The subject stretches his hands forward as far as possible on the scale, holds his hands for one second from this position his maximum reach is recorded. The subjects were warned not to bend their knees and use jerking action.

Scoring:

The score is maximum reach was recorded in cm. in the best three trails was taken.

Two Hand Coordination

Objective:

To measure the two hand coordination ability\textsuperscript{11}.

\textsuperscript{10} Ibid., p. 135.
\textsuperscript{11} Manual for Two Hand Coordination Test (Pune: Anand Agencies), pp. 2-8.
Equipment:

Two hand coordination instrument (electrical).

Procedure:

The chronoscope was attached to the instrument and switch was put on. The subject stood comfortably near to the apparatus while holding the side and centre handles with his left and right hand respectively. The side handle moves the pin of the apparatus forward and backward and the centre handle move the pin to the sides. On the command of go the subject started moving the pin from left side to right side as per the design of the apparatus.

Scoring:

The score was the time taken by subject for tracking out the pattern plus the error time recorded in the chronoscope. Three trials were given to each subject.

Statistical Techniques Applied

The relationship of each somatotype components, viz. endomorphy, mesomorphy and ectomorphy, to performance in different motor ability components was established by computing Product Moment Correlation\textsuperscript{12}. In order to find the combined effect of various somatotype

components, multiple correlation was applied. To find out significant difference between three different somatotype components. The analysis of variance (ANOVA) was applied at 0.5 level of significance.

Further a regression equation was developed to predict somatotype components i.e. endomorphy, mesmorphy and ectomorphy, separately on the bases of motor fitness components.

For testing the hypothesis, the level of significance was set at .05.