Chapter III

PROCEDURE

In this chapter, the procedure adopted for selection of subjects, selection of variables, reliability of data, collection of data and statistical techniques for analysing the data have been described.

Selection of Subjects

Eighty-two male fast bowlers were selected as subjects for the specific purpose of this study in terms of a purposive sample. All the eighty two fast bowlers were of fairly well-developed physique as all of them had been participating in cricket regularly for a number of years.

The selection of subjects was placed on the specific purpose of the study in that their performance and achievement levels were taken into consideration i.e. those fast bowlers were taken as subjects who have represented their university at the All India Inter University or represented their State in the Ranji Trophy Tournament. The subjects belonged to Gujarat and Maharashtra State.

All the subjects voluntarily agreed to cooperate in the testing procedures explained to them in the interest of promotion of knowledge. Prior to the administration of tests, the research scholar met all the subjects and their coaches. The requirements of the testing procedures were explained to them in detail so
that there was no ambiguity in their minds regarding the efforts required on their part.

No special techniques were used to motivate the subjects to put in their best efforts, but the subjects were quite mature and participated whole heartedly in testing.

**Selection of Variables**

The anthropometric, physical and physiological variables that influence the performance in fast bowling as gleaned from a review of professional literature besides consultation with experts resulted in the selection of the following variables, which were classified under dependent and independent variables.

**Dependent Variables**

Velocity of the ball was considered as the dependent variable.

**Independent Variables**

The independent variables were of three categories i.e. anthropometric variables, physical variables and physiological variables.

The variables under each category were as follows:

a) **Anthropometric Variables.**

1. Height
2. Weight
3. Foreleg length
4. Thigh length
5. Leg Length
6. Upper arm length
7. Forearm length
8. Ponderal Index
9. Crural Ratio
10. Arm length
11. Hand length
12. Upper arm girth
13. Forearm girth
14. Wrist Circumference
15. Shoulder Width
16. Chest girth
17. Thigh girth
18. Calf girth

b) Physical Variables

1. Arm and shoulder strength
2. Back strength
3. Leg strength
4. Speed
5. Arm power
6. Agility
7. Balance
8. Wrist flexibility
9. Shoulder flexibility
10. Hip flexibility
11. Ankle flexibility
12. Spine flexibility

c) Physiological Variables

1. Vital capacity
2. Resting heart rate
3. Body composition
4. Anaerobic Power/Weight
5. Anaerobic Power/Mass
6. 12 min. Run/Walk Test

**Reliability of the Data**

The reliability of data was ensured by establishing the instrument reliability, tester competency and reliability of tests and subject reliability.

**Instrument Reliability**

Goniometer, Dynamometer, Sphygmomanometer, Spirometer, Skinfold Calipers, Weighing Machine, Stop Watch, and Steel Tape used in this study were obtained from standard firms which cater to the needs of various research laboratories in India and abroad, their calibrations were accepted as accurate enough for the purpose of this study.
Tester Competency and Reliability of Data

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. All the measurements were taken by the scholar with the assistance of his colleagues, who were all acquainted with the tests and their testing procedures. The tester competency was evaluated together with the reliability of the tests. To determine the reliability of tests, data on fast bowling was recorded twice with a gap of one day in between under identical conditions on thirty subjects selected at random from the entire group. The scores thus obtained on two occasions were correlated using Pearson's Product Moment Correlation method. The coefficients of correlation obtained are presented in the Tables 1, 2, 3 and 4 respectively.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
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<tbody>
<tr>
<td>RELIABILITY COEFFICIENT FOR TEST-RETEST SCORES</td>
</tr>
<tr>
<td>OF FAST BOWLING PERFORMANCE</td>
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<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Coefficient of Correlation 'r'</th>
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<tbody>
<tr>
<td>Velocity of the Ball</td>
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N = 30.
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<thead>
<tr>
<th>Tests</th>
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<tbody>
<tr>
<td>Height</td>
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<tr>
<td>Weight</td>
<td>.84</td>
</tr>
<tr>
<td>Foreleg Length</td>
<td>.85</td>
</tr>
<tr>
<td>Thigh Length</td>
<td>.85</td>
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<tr>
<td>Leg Length</td>
<td>.87</td>
</tr>
<tr>
<td>Upper Arm Length</td>
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<td>Forearm Length</td>
<td>.85</td>
</tr>
<tr>
<td>Ponderal Index</td>
<td>.85</td>
</tr>
<tr>
<td>Crural Ratio</td>
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</tr>
<tr>
<td>Arm Length</td>
<td>.87</td>
</tr>
<tr>
<td>Hand Length</td>
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<tr>
<td>Upper Arm Girth</td>
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<tr>
<td>Forearm Girth</td>
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<td>Wrist Circumference</td>
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<tr>
<td>Shoulder Width</td>
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<td>Chest Girth</td>
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<td>Thigh Girth</td>
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<td>Calf Girth</td>
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N = 30.
<table>
<thead>
<tr>
<th>Tests</th>
<th>Coefficient of Correlation 'r'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm and Shoulder Strength</td>
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<tr>
<td>Back Strength</td>
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<tr>
<td>Leg Strength</td>
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<tr>
<td>Speed</td>
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<td>Arm Power</td>
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<td>Agility</td>
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<td>Balance</td>
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<tr>
<td>Wrist Flexibility</td>
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<td>Shoulder Flexibility</td>
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<td>Hip Flexibility</td>
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N = 30
TABLE 4
RELIABILITY COEFFICIENTS FOR TEST - RETEST SCORES OF
SELECTED PHYSIOLOGICAL VARIABLES

<table>
<thead>
<tr>
<th>Tests</th>
<th>Coefficient of Correlation 'r'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital Capacity</td>
<td>.85</td>
</tr>
<tr>
<td>Resting Heart Rate</td>
<td>.84</td>
</tr>
<tr>
<td>Body Composition</td>
<td>.84</td>
</tr>
<tr>
<td>Anaerobic Power/Weight</td>
<td>.85</td>
</tr>
<tr>
<td>Anaerobic Power/Mass</td>
<td>.86</td>
</tr>
<tr>
<td>12 Min. Run/Walk Test</td>
<td>.86</td>
</tr>
</tbody>
</table>

N = 30.

Subject Reliability

The above test - retest coefficients also established that subject reliability was significant as the same subjects were used under similar conditions by the same tester and no motivational techniques were used nor any training given when the tests were repeated.

The anthropometric measurements were taken with the help of steel tape strictly following their specific procedures as given in literature and after having practice sessions with experts. So their reliability was also accepted.
Collection of Data

After establishing the reliability of the data, the data was collected by administering the standard procedure/tests for taking anthropometric measurements, physical variables and physiological variables as well as fast bowling performance.

Anthropometric Measurements

Height

Equipment: Wall scale and Hard board.

Description:

The standing height was taken with subject standing erect without shoes against a wall with a marked scale. The subject was instructed to keep the heels together, touching the wall with heels, buttock and back head erect without tilt and to take and hold a full breath and stand tall while measurement was taken. A stiff hard board was held horizontally on his head, slightly pressing his head and touching the scale marked on the wall at right angle. The subject was asked to step out by lowering the head and the reading indicated by the hard board's lower end was read on the scale. Height was recorded to nearest centimetres.¹

Weight


Description:

Weight was taken with the help of a standard and calibrated weighing machine. Subjects were asked to come on the weighing machine with short pants. They were asked to stand still keeping the body erect. The scores were recorded to the nearest kilograms.²

Foreleg Length

Equipment: Steel measuring tape.

Description:

Foreleg length of the subject was measured with a flexible steel tape vertically from the outside edge of the centre of the foot to the most protuberant part of the patella bulge, coinciding with the centre of the knee bend at the back. The measurement was recorded to the nearest one tenth of a centimetres.³

²Clarke, Application of Measurement to Health and Physical Education, pp. 94-95.

Thigh Length

Equipment: Steel measuring tape.

Description:
Thigh length was measured vertically from the patella line to a line drawn horizontally through the midgluteal bulge at the point of tangency to a vertical line contacting the buttocks. The measurements were recorded to the nearest one tenth of a centimetres.

Leg Length

Equipment: Steel measuring tape.

Description:
To determine the leg length, the research scholar faced the subjects, placed his hand approximately four to six inches below the subject's waist on each hip and asked the students to swing the right leg back and forth slowly, and to lift it to the outside by manipulation, the research scholar could locate the spot where the greater trochanter enters the pelvic girdle. The height of the greater trabecutes from the floor was measured. The measurement was recorded to the nearest one tenth of a centimetres.

Upper Arm Length

Equipment: Steel measuring tape.
Description:

The subject was asked to stand straight and relaxed. A steel tape was used. The tip of the tape was placed on the tip of the acromion process and measured to the head of radius. The measurement was recorded to the nearest one tenth of a centimetres.

Forearm Length

Equipment: Steel measuring tape.

Description:

The subjects were asked to stand erect by keeping their arms along with the body. The measurement was taken from the lateral epicondyle to the styloid process of ulna. Measurement was recorded to the nearest centimetres.

Ponderal Index

\[
\frac{\text{Standing Height}}{3^\circ} \cdot \text{Weight}
\]

This ratio for each subject was calculated by substituting in the formula, the score of the height of subject in inches and the score of weight in kilograms.\(^4\)\(^5\)

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\(^5\) Cureton Jr., *Physical Fitness of Champion Athlete*, p. 49.
Crural Ratio

Foreleg Length
Thigh Length

This ratio was computed by dividing the score of foreleg length by the corresponding score of thigh length and the obtained value was recorded correct to four decimal places. This ratio is named as crural ratio.  

Arm Length

Equipment: Steel measuring tape.

Description:

The arm length was measured with a flexible steel tape. The subject was asked to stand erect, measurement was taken from the acromion to the tip of the middle finger measurement was recorded to nearest centimetres.

Hand Length

Equipment: Steel measuring tape.

Description:

The subjects were asked to stand erect keeping their arms along with the body. The measurement was taken from the styloid process of ulna to the tip of the middle finger, measurement was recorded to the nearest centimetres.

6 Ibid. p. 49.
Upper Arm Girth

Equipment: Steel measuring tape.

Description:

Upper arm girth was measured with a flexible steel tape at a level half way between the tip of the acromial process, just on the top of the shoulder joint, and the elbow joint. The level was marked on skin first than the tape placed around the arm so that it was in tight contact with the skin all round, but not pressing the skin inward. The arm hang down loosely at the side in a relaxed manner. The measurement was taken twice and recorded in centimetres.7

Forearm Girth

Equipment: Steel measuring tape.

Description:

The subject is asked to sit on a chair. The arm is extended slightly forward and palm facing upward and relaxed. The maximum girth of the forearm is taken to the nearest of a centimetres.8

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9 Ibid., p. 114.
Wrist Circumference

Equipment: Steel measuring tape.

Description:

Subjects were asked to stand with their right arm extended forward. With the tape passing just proximal to the styloid process of right ulna, measure the minimum circumference of the wrist. The measurement was recorded in centimetres.\(^9\)

Shoulder Width

Equipment: Steel measuring tape.

Description:

Shoulder width was measured distance in between outer edges of the acromial process of the two shoulder joints. The measurement was taken and recorded in centimetres.\(^10\)

Chest Girth

Equipment: Steel measuring tape.

Description:

The measurement of the chest girth of the subject was taken in relaxed position. Steel tape was used to take the measurements. The subjects were asked to remain relaxed after

\(^9\text{Ibid., p.116.}\)

\(^10\text{Ibid., p. 124.}\)
taking a normal breath and in this stage it was measured round the nipple level. The tape was taken around the chest so that it was on the lower end of scapula at the back and infront at nipple level. The measurement was taken three times and score recorded to the nearest centimetres.

**Thigh Girth**

Equipment : Steel measuring tape.

Description :

Thigh girth was measured with a steel tape, placed around at thigh horizontally with its top edge just under the fold of the buttock. The subject stands with his weight equally distributed on both feet. Measurement was recorded to the nearest centimetres.

**Calf Girth**

Equipment : Steel measuring tape.

Description :

The calf girth measurement was taken with a steel tape, at the maximum circumference of the calf in a place at right angle to its long axis. The leg was held diagonally over a table so that the tape measure was in horizontal plane. The measurement was taken twice and recorded to the nearest centimetres.
Physical Variables

Arm and Shoulder Strength

The purpose of the test was to measure the arm and shoulder strength of the subject.

Equipment: Standard weighing machine, horizontal bar, gymnastics mat, paper and pencil.

Pull-ups:

A horizontal bar was used an instrument to measure pull-ups. The height of the bar was so adjusted that all subjects hanged freely without taking support of the floor. One chair was kept under the bar to assist in taking the initial stance on the bar and as soon as the position was taken the chair was removed. Subject was required to raise his body until his chin was over the bar and he was asked to lower his body until he attained the position with his arm fully extended. Scoring was done in number of correct pull-ups. The subject was cautioned against taking swing while pulling up.

Push-ups:

The subject was asked to take straight arm, front leaning rest position. From this initial position he was asked to lower body until the chest touched the mat and then he raised the body to the initial position. This complete process was considered
as one correct push-up. The body was kept straight and the movement was only from shoulders. This exercise was continued. Total number of correct push-ups performed was the score for this test.

After gathering scores from the above test, Roger's formula was applied to measure the arm strength of the subjects.

Description:

To measure the arm strength of the subjects, the investigator employed Roger's formula 4, which included the following items:

- Height (in inches)
- Weight (in pounds)
- Pull-ups (in numbers)
- Push-ups (in numbers).

Arm strength was computed by applying the following formula:

\[ \text{Pull-ups} + \text{Push-ups} \left( \frac{W}{10} + H - 60 \right) \]

Shoulder Flexibility

The purpose of this test was to measure shoulder flexibility of the subject.

Equipments: Flexomeasure case, yard sticks, ruler guide, paper and pencil.
Description:

The subjects were assembled in the cricket field in the afternoon session. The subjects were asked to assume a prone lying position with arm straight forward and a stick was gripped about shoulder width, then they were asked to raise the stick upwards as high as possible keeping chin on the floor and elbow straight.

Scoring:

Reading was recorded at the highest point. Arm length from the acromian process of the tip of the middle finger was recorded and was subtracted from the highest point of the lift of the shoulder. Three trials were given to the subjects and the best of the three trials was recorded as the final score.

Ankle Flexibility

The purpose of this test was to measure the total movement capability of ankle joint that is the flexibility of ankle.

Equipments: Flexomeasure case, ruler guide, paper and pencil.

Description:

The subjects were gathered in cricket ground in the afternoon session. The subjects were asked to remove their shoes and take sitting position with their right leg as straight as possible. The research scholar placed the zero end of the yard stick on
the floor and slide the case downward until the ruler guide rested across the lowest point of the shin bone. The subjects were asked to extend the ankle and repeat the measurement at the highest point of the foot (either the toe or the instep) during maximum extension. The same procedure was repeated for the left foot.\footnote{James S. Boss and William F. Gustafson, Measurement and Evaluation in Physical Education, Fitness and Sports (Englewood Cliffs, N.J.: Prentice Hall Inc., 1983), p. 109.}

Scoring:

The difference between the upper foot line (during extension) and lower bone line to the nearest one eighth of an inch for each foot was recorded as score. Three trials were given and best of the three was considered as the final score.

Wrist Flexibility

The purpose of this test was to measure wrist flexibility of the subjects.

Equipment: Simple Goniometer, paper and pencil.

Description:

The subjects were gathered in the afternoon session at the cricket ground. The subjects were asked to keep arms as straight as possible and palm in line with the forearms and the
movable arm of the Goniometer was set in line with the palm and the static arm in line with the forearm, then the subjects were asked to flex their wrist to the maximum level and the movable arm was brought down to keep it in line with the palm. The ankle shown on the dial of the Goniometer was noted carefully. The palm was brought back to the basic position and both arms of the Goniometer were readjusted. From the basic position of subjects were readjusted. From the basic position of subjects were asked to extend their wrist to the maximum level and the angle was recorded.

Scoring:

The ankle of the flexion of the wrist and the extension were added to give the total range of wrist movement. Three trials were given and the best of the three was recorded as the final score.

**Back Strength**

The purpose of the test was to measure the back strength of the subjects.

**Equipments:** Back dynamometer, paper and pencil.

**Description:**

To measure the back strength of the subjects, the calibrated back dynamometer was used. The test was administered in the afternoon. The subject was asked to stand on the
of the Dynamometer holding the handle of the chain attached to the platform just above the knees. This height was adjusted accordingly. The subjects were asked to stand with legs straight i.e. knees completely extended and elbow straight, the trunk was bend forward making an angle of 135° with legs. Subjects were asked to pull the handle up without taking external support and flexing the elbows.

Scoring:

The reading was carefully noted down to the nearest of half a kilogram. Three trials were given and best attempt was recorded as the final score.

**Leg Strength**

The purpose of the test was to measure the leg strength of the subjects.

**Equipments:** Leg Dynamometer, paper and pencil.

**Description:**

A calibrated leg dynamometer was used to measure the leg strength of the subjects. It was taken on all subjects in the evening after a warming up session. The subjects were asked to stand on the platform of the dynamometer holding the handle of a chain attached with the platform of the dynamometer, the handle of dynamometer was placed infront of the thigh and the height of the handle was adjusted with the varying height to
the subjects. The elbows were bent and were placed by the side of the body and knees flexed. Subjects were then asked to lift the handle up, by straightening the legs. The subjects were instructed not to pull with hands.

Scoring:

The reading on the dial of dynamometer was carefully recorded to the nearest half a kilogram. Three trials were given to the subjects and the best attempt was recorded as final score.

Speed (30 yard run)

Equipment: Stop watch.

Description:

The subjects were asked to stand in standing position at the starting line, they ran as rapidly as possible on command 'go' through finish tape at 30 yard mark. Two subjects were allowed to run together. Score was calculated to the nearest tenth of a second.

Agility (4 x 10 m. Shuttle Run)

The purpose of this test was to measure the ability to rapidly change body position and direction while running.

Equipments: Clapper, Stop watches, and wooden blocks (2" x 2" x 4").
Description:

To measure agility, two lines were marked parallel to each other and ten metres apart on the ground. The subject stood behind one of the lines and two blocks were kept beyond the other line. On signal "start" (sound of clapper) the subject ran to the blocks, took one block and returned to the starting line and placed the block behind the line. The subject again ran to the second block which he carried across the starting line on his way back. Two subjects were allowed to run together.

Scoring:

The score was the total time taken to complete the course and was recorded in seconds. 12

**Dynamic Balance**

Equipment: Stop watch.

Description:

The subject was asked to stand with his right foot on the starting mark and leaped to the first tape mark with his left foot and tried to hold a steady position on the ball of his left foot up to five seconds (both the stop watch and counts was used). After five seconds he leaped from tape to tape.

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The subject was asked to stand on each tape mark for five seconds in such a way that the foot completely covered the tape. No trial was allowed.

The score for each mark successfully covered was given five points and in addition one point was awarded for each second. The balance was held upto five seconds per mark. Thus, a subject could get a maximum of ten points per mark or a total of 100 points for the test.

The subject had to lose five points for improper landing such as - (a) failing to step upon the tape after a leap, (b) touching the tape on the ground with the heel, (c) failure to completely cover the mark with the ball of the foot.

The subject had to lose points at the rate of one point per second for (a) touching any part of the body with the floor other than the ball of the supporting foot, or (b) moving the foot while in balance position, or (c) if he lose his balance, he had to step back on the proper marker and then leap to the next mark.

**Arm Power**

**Equipments** : Rope, chair, marking tape.

**Description** :

To measure the power of the arms and shoulder girdle
in a vertical rope pull from sitting position on a chair (seat level
at least fifteen inches off the floor) and grasp as high up the rope
as possible without raising the buttock from the chair or bench
seat concerning the grasp, the hand of the preferred arm should
be just about the opposite hand. The tester should place a piece
of marking tape around the rope just above the upper most hand
the performer who should then pull (without letting the feet touch
the floor) and reach as high up the rope as possible and grasp
and hold the rope until the tester can again place a piece of
marking tape above the upper most hand. The tester should
allow each perform three trials. The best score of pulled distance
between the two tape marks was considered as the score of the
pull in inches.13

Hip Flexibility

Equipment: Simple Goniometer, paper and pencil.

Description:

The subject was asked to lie down in a supine position.
The fixed point of the goniometer was kept at the most lateral
point of the iliac crest. The fixed arm of the goniometer was
kept pointing in line with the femur bone. The moveable arm
of the goniometer was kept along with the trunk. The subject

13 Ibid., p. 208.
was asked to raise his legs and bring as close as possible to the chest. The angle between the initial and final position is measured in degrees.

**Spine Flexibility** (Bridge-up Test)

The purpose of this test was to measure the spine flexibility of the subjects.

Equipments: Yard stick, flexomasure case and steel tape, paper and pencil.

Description:

Bridge-up test was administered in order to assess the flexibility of spine. The subjects were gathered in cricket field in the afternoon session. The subject was asked to lie down in the supine position on the floor and tilt his back while walking the hands and feets as close as possible. Investigator placed the zero end of the yard stick on the floor and slide the flexo-measure case vertically upward until the ruler guide touched the highest points of arched spine. Standing height i.e. from floor to navel region of body was also measured with the help of steel tape.

Scoring:

It was done by recording the best score of the three traits and then subtracting from standing height. Reading was
carefully noted to the nearest quarter of an inch.  

**Physiological Variables**

**Resting Heart Rate**

The purpose of the test was to measure the number of heart beats of the subjects in a minute.

**Equipments**: Stop watch and Stethoscope.

**Description**:

Heart rate was taken in the morning. Ten minutes before taking the heart rate, the subjects were asked to take rest on the bed. The tester used stop watch for taking the heart rate. Total number of heart beats per minute for each subject was recorded with a stethoscope placed on the chest below the left nipple at a point halfway between the sternum and the left nipple.

**Scoring**;

Total number of heart beats per minute for each subject was recorded as his score.

**Vital Capacity**

**Equipment**: Spirometer.

**Description**:

The spirometer was equipped with extra length rubber

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\[^{14}\text{Ibid. P.268.}\]
hose (36 to 42 inches) filled with water to within one inch of the top, and placed at such a height that all subjects could sit erect when beginning the test.

The subject was instructed to take one or two deep breaths before the test. Then, after the fullest possible inhalation, he exhaled slowly and steadily, while bending forward over the hose until the air within his control was expelled. Care was taken to prevent air from escaping either through the nose or around the edges of the mouth piece and to see that a second breath is not taken by the subject during the test. If the test is improperly performed or if in the opinion of the tester, the subject did not do his best, it was repeated after an explanation of the mistake so as to make the test a successful one.

The tester carefully watched the indicator closely to note when it reached the highest point.

Scoring:

Each subject was given three chances, and the best was recorded.

**Anaerobic Power Per/Kg. Body Weight.**

**Equipments:** Weighing machine, marked black board, and chalk powder.

**Description:**

Each subject was weighed early in the morning on weighing
machine fully calibrated. The weight was recorded in kilograms to the nearest of 500 gms.

Sargent Jump

The subjects were assembled in batches and appraised of the objectives of the test and the test was fully described. A black board was fixed on the wall and was marked in segments measuring from the ground upward. In this jump, the individual swung his arm downward and backward taking a crouch position with knees bent approximately to a right ankle. The subject pause in this position to eliminate the possibility of a double jump and leapt upward as high as possible, swinging the arms forcefully forward and upward. As the subject reach the highest point of the jump he swing the arm forward and downward, motion being timed to coincide with height of the jump. Each subject was given three chances. The subjects were asked to stand close to the wall and touch the board with fully stretched hand and the reading was recorded. He then put chalk powder on fingers and tried a jump. As he jumped and touched the black board, the powder left a mark on the board and this reading too was recorded. The difference between the initial reading (standing) and final reading (jump) was calculated and this was considered the score of the vertical jump.
Scoring:

The performance in vertical jump was divided by total body weight and obtained value was considered the score for anaerobic power per/kg. body weight.

**Anaerobic Power Per/Kg. Lean Body Mass**

Equipment: Weighing machine and fat caliper.

Description:

The weight of each subject was taken as already explained, lean body mass was calculated by assessing total body fat and subtracted it from total body weight. Absolutely fat free weight of the body was considered as lean body mass.

Scoring:

The performance in sergeant jump was divided by lean body mass and obtained value was considered as score of each subject for anaerobic power per/kg. lean body mass.

**Body Composition**

(Skinfold Measurement)

The purpose of this test was to measure the percentage of body fat of the subject.

Equipment: Lange Skinfold Caliper.
Description:

The investigator pick-up a fold of subcutaneous tissue firmly between the thumb and the index finger of the left hand and pulled away the underlying muscle from the marks marked on the body of the subject.

The jaws of the caliper were then applied a little below the fingers of the left hand and allowed to exert their full pressure before taking the reading of the thickness of the fold. The muscular tissue was not included in the pinch was ensured by asking the subjects to use the muscle in appropriate movement. Measurements were taken on the right side of the body. The anatomical sites utilized were as follows:

1. Subscapular: The skinfold was taken at the tip of the scapula (inferior angle) with the subject in a relaxed standing position. The fold was lifted in the diagonal plane at about 45 degrees from the vertical and horizontal planes.

2. Triceps: The skinfold was taken over the triceps muscle a point halfway between the shoulder (acromial process) and the tip of the elbow (olecranon process). The point was located with forearm flexed at 90°. In taking the measurement however, the arm was hanging free. The fold was lifted parallel to the long axis of the arm.
3. Biceps: The skinfold was taken midway on front of upper arm over biceps skinfold was lifted parallel with the long axis.

4. Supra-iliac: The skinfold was lifted diagonally following the natural line of the iliac crest, just above the crest of the ilium at the mid axillary line.

Scoring:

The reading of the four sites were recorded in millimetres and added up.\textsuperscript{15}

\textbf{12 Minute Run/Walk Test}

The purpose of the test is to measure cardio-vascular fitness.

Equipments: Stop watch and Score-sheet.

Description:

The 12 min. Run/Walk Test was conducted at 400 metres track at 5.00 pm. The subjects were assembled and were instructed regarding 12 min. Run/Walk Test. They were made to run in four batches of fifteen each. They used standing start and the race started on the sound of the clapper. The subjects run/walked for 12 minutes the tester alert the subjects 30 seconds before

\textsuperscript{15}Clarke, Application of Measurement to Health, Physical Education and Recreation, pp. 82-83.
before the end of the 12 minutes and a long whistle was blown which was the indication to stop. There was one supervisor for three subjects separately and they counted the number of laps and additional distance covered by each of them. The distance was measured to the nearest meter. The same procedure was adopted for the next batch of subjects and the data was collected.\(^{16}\)

Rules:

Walking/jogging/running were permitted. The subjects were asked to cover maximum possible distance in 12 minutes. The subjects were advised to run close to the inner border of the track.

**Velocity of Ball**

The purpose of this test was to measure the velocity of ball in fast bowling performance.

**Equipment:** Six stop watches capable of measuring hundredth of a second, wooden clapper, new cricket balls, paper and pencils.

**Description:**

The subjects were assembled at the cricket ground on a bright afternoon. The temperature recorded was 33°C. All the

six time keepers were requested to take their respective places i.e. three at the bowling end where the bowl was to be released from the subjects hand, and the rest of the three time keepers took their place at the batting end. A helper with the clapper was requested to stand at the point approximately where most of the bowlers were supposed to start their approach run with the sound of the clapper the bowler started running towards the bowling end and also all the six time keepers started taking time. As the bowler released the ball the three stop watches stopped at the bowling end. The other three stop watches stopped when the ball crossed the line of the stumps at the batting end. Two white screens were placed on both ends at fifteen metres distance in front of time keepers to facilitate with the clear vision of the release of ball and its crossing over the other end.

Scoring:

The distance 22 yards was converted into metres. The time taken by the ball was recorded by substracting the recorded time between the two time keepers. Six trials were given and an average of the time taken by the ball in each case was recorded at the final time. Velocity was obtained by dividing distance covered by the time taken in metres/seconds.
Statistical Techniques for Analysis of Data

In order to find out the relationship of anthropometric, physical, physiological variables to velocity of ball, correlational statistics were applied. Multiple Correlation was computed to find out the combined contributions of anthropometric, physical and physiological variables to fast bowling performance.

Multiple regression equation was developed in order to predict the most contributory factors towards fast bowling performance for the anthropometric physical and physiological variables.

For testing the hypotheses the level of confidence was set at .05.