Chapter III

PROCEDURE

In this chapter the selection of subjects, selection of variables, criterion measures, reliability of data, collection of data, detailed methodology and statistical techniques for analysing the data have been presented.

Selection of Subjects

Eighty eight male tennis players in the age group 17 to 25 years, studying at various Indian Universities, who had reported at Trivandrum for participation in All India Inter- varsity Tennis Competition, South Zone, in January 1986, were selected as subjects for the study. About one hundred tennis players had reported for the competition. From among these players only eighty eight were considered as subjects because they completed all test items. Those who could not complete all the tests were thus eliminated.

The subjects came from different parts of the country and belonged to different socio-economic strata. All subjects had fairly well developed physique because all of had been playing tennis regularly for a number of years.

Prior to the administration of tests the research scholar held a series of meetings with the subjects, coaches
and managers of various teams. The requirement of testing procedures were explained to them in details, so that there was no ambiguity in their minds regarding the efforts required from them and the strains they might endure in addition to those involved in their participation in the competition. All the subjects readily agreed to participate in the study. The coaches and managers also exhorted the subjects to put in their best efforts in the interest of scientific investigation and in order to enhance their own performance and achievement standards. Though no special techniques were used to motivate and encourage the subjects to put in their best, the subjects appeared very enthusiastic and cooperative throughout the research project.

A feasibility analysis as to which of the important variables could be taken up for investigation in keeping with the availability of equipment, acceptability to the subjects and the legitimate time that could be devoted for tests as well as to keep the entire study unitary and integrated, was made in consultation with experts.

With the above criteria in mind the following physiological, psychological, anthropometric variables and functional assessment tests were selected because they are directly or indirectly related to the performance of tennis players in competitive conditions/situation.
Physiological Variables

Resting Heart Rate
Blood Pressure (Systolic and Diastolic)
Pulse Pressure
Vital Capacity
Anaerobic Power per kg/Body Weight
Anaerobic Power per kg/Lean Body Mass
Body Composition

Psychological Variables

16 P.F. Test

Anthropometric Variables

Ponderal Index
Pryor's Width Length Index
Crural Ratio
Arm Ratio (Fore Arm and Upper Arm)
Arm Length

Functional Assessment

Hewitt's Tennis Test items which includes four items namely Service placement, Speed of service, Forehand drive, and Backhand drive.
Criterion Measures

The criterion measures chosen for testing the hypothesis were:

Playing Ability

The judgement of tennis playing ability of each subject was based on the five point scale, which was made use of by three expert judges in a game situation.

Physiological Variables

1. Number of heart beats per minute during resting condition.
2. Blood pressure was measured by sphygmomanometer in mm/Hg.
3. Pulse pressure was calculated after deducting diastolic blood pressure from systolic blood pressure.
4. Vital capacity was measured in liters, best of three trials.
5. Anaerobic power per/kg body weight was calculated by dividing the subjects performance in sargent jump by total body weight of each subject.
6. Anaerobic power per/kg lean body mass too was calculated by dividing subjects performance in sargent jump by lean body mass of each subject.
7. Skinfold measurement taken and expressed in millimeter using skinfold calipers at subscapular, triceps, biceps, and supra-iliac sites.

Psychological Variables

16 P.F. test by Cattell was used to assess 16 factors of human personality.

Anthropometric Variables

1. Ponderal Index was used to assess relationship between height and weight.

2. Pryor's width length index was administered to find out relationship of Bi-iliac diameter to standing height.

3. Crural ratio was calculated after dividing foreleg length by thigh length.

4. Total arm length was measured in centimeters. All measurements were taken with standard steel tape in centimeters.

Functional Assessment Test

Hewitt's Tennis Test items were used to assess functional ability.

Reliability of Data

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

Doctor's Sphygmomanometer, dry spirometer, skinfold calipers, weighing machines 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. All the instrument used were available in the research laboratory of Lakshmibai National College of Physical Education, Gwalior and their calibrations were accepted as accurate enough for the purpose of this study.

16 P.F. test which measures 16 various factors of human personality was considered to be the best and is accepted by majority and it is used extensively world wide. 1,2,3,4,5,6


Tester's 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 evaluation of tester competency was made together with reliability of tests. Reliability of tests was established by test-retest process whereby consistency of results was obtained by product moment correlation. The data collected from a random selection of ten subjects in test-retest, were computed for each variable and correlations obtained have been presented in Table 1.

Since very high correlations (.829 to .925) were obtained, so investigator's competency to administer the tests as well as reliability of tests were established.


### TABLE 1

**RELIABILITY COEFFICIENT OF TEST-RETEST SCORES**

<table>
<thead>
<tr>
<th>Tests</th>
<th>Coefficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting Heart Rate</td>
<td>.917*</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>.849*</td>
</tr>
<tr>
<td>Vital Capacity</td>
<td>.829*</td>
</tr>
<tr>
<td>Anaerobic Power per/kg Body Weight</td>
<td>.870*</td>
</tr>
<tr>
<td>Body Composition</td>
<td>.842*</td>
</tr>
<tr>
<td>Ponderal Index</td>
<td>.876*</td>
</tr>
<tr>
<td>Pryor's Width Length Index</td>
<td>.912*</td>
</tr>
<tr>
<td>Crural Ratio</td>
<td>.925*</td>
</tr>
<tr>
<td>Ratio of Upper and Forearm</td>
<td>.825</td>
</tr>
<tr>
<td>Arm Length</td>
<td>.912*</td>
</tr>
</tbody>
</table>

N = 10

*Significant at .01 level of confidence.

\[ r_{.01} (8) = .765 \]

From the Table 1 it is evident that tester reliability was significantly high thus establishing the competency of the scholar to administer the tests.
The correlation coefficients also indicated the reliability of the tests selected as very high correlations were obtained when the tests were repeated.

**Subject Reliability**

The above test-retest coefficients of correlation method also established that subject reliability 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 given.

**Collection of Data**

The necessary data was collected by administering various tests for the chosen variables. The test to assess functional ability was administered on the ground of Tennis Club, Trivandrum and other tests were administered at the residence of the subjects. Almost all subjects were put in a big youth hostel which facilitated the investigator in collecting the data without much inconvenience.

Before the administration of tests the subjects were given a chance to practice the tests, so as to become familiar with various test items. The use of equipments was explained and clearly demonstrated prior to administration of tests. To ensure uniform testing conditions the subjects were tested only in the morning from 7 to 8 before breakfast for physiological variables and in the evenings for anthropometric
variables. Sixteen Personality Factor Test was also administered in the evening, however the test of functional assessment was administered in the afternoon sessions.

**Test Administration**

**Physiological Variables**

**Resting Heart Rate**

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

**Description:** Heart rate was obtained in early morning. The scholar approached the hostel where the subjects stayed early in the morning and used a calibrated stop watch and a stethoscope for counting heart rate. The subjects were requested not to leave their bed and in case somebody moved out he was requested to lie down quietly for ten minutes before taking his heart rate.

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

**Blood Pressure**

The purpose of the test was to measure the blood pressure (systolic and diastolic) of the subjects.
**Equipments:** Doctor's Sphygmomanometer, Stethoscope.

**Description:** A sphygmomanometer (dial type) and a stethoscope were used to measure the blood pressure (systolic and diastolic) of the subjects. Each subject was asked to sit relaxed in a chair. It was taken on all subjects early in the morning. The cuff of the sphygmomanometer was wrapped around the left upper arm of the subject just above the elbow. The cuff was then connected to the pump and the manometer. After closing the outlet valve of the pressure pump, the pressure in the inflatable rubber bag was rapidly raised to 180 mm Hg by pumping air which was sufficient to obliterate completely the brachial artery so that flow of blood through the artery was arrested and radial pulse disappeared. The sound of the pulsation was monitored by keeping the "chest piece" of the stethoscope over the brachial artery and listening to the sound through the ear piece of the stethoscope as the pressure over the artery was being manipulated. The pressure was then gradually lowered by opening the valve. As soon as the pressure in the cuff fell just below the systolic pressure, it allowed the passage of small amount of blood through the compressed artery into the distal segment. This produced a clear tapping sound and the pressure shown on the dial was noted as soon as this sound was heard. This denoted the measure of systolic blood pressure. As the cuff pressure was lowered still further,
more blood flowed through due to rebound relaxation of the arterial vessel and this was indicated by a louder sound. The pressure at which this sound could be muffled by manipulating the pressure pump was read on the menometer scale. This denoted the measure of systolic blood pressure. The difference between systolic and diastolic blood pressure was recorded as pulse pressure. These measurements were repeated twice for each subject and the latter was recorded as his scores in these variables.

Vital Capacity

**Equipments:** Dry Spirometer, Alcohol, Clean piece of cloth, Nose Clip.

**Description:** Vital capacity was measured with a dry spirometer supplied by Hindustan Scientific Instrument Co., New Delhi, made in Germany, in liters and the spirometer was placed on such an height that all subjects could be tested in standing position. The inner dial of the spirometer was set on zero mark at the beginning of the test. The subjects took two deep breaths before starting the test and then after fullest inhalation the subjects placed the mouth piece of the spirometer in his mouth, taking care to see that no air escaped through the edges of the mouth piece. The subjects exhaled slowly and steadily while bending forward
slightly until the maximum volume of air could be expelled without taking in a second breath. The subjects were instructed to take care that they blew out only through the mouth and not through the nose even partially, however the nose of each subject was clipped by a nose clip to prevent the air flow from escaping through the nose. The score of vital capacity for each subject was recorded in litres. Each subject was provided a trial before the final test.

**Scoring:** Best effort of each subject was recorded as score in litres.

**Anaerobic Power per/kg. Body weight**

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

**Description:** Each subject was weighed early in the morning on a weighing machine fully calibrated, supplied by Messrs Quality Surgical and Medical, Gwalior. The weight was recorded in kg to the nearest 500 gm.

**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 swings his arm downward and backward taking a crouch position with knees bent approximately to a right angle. The subject pauses in this position to eliminate the possibility of a double jump and leaps upward as high as possible, swinging the arms forcefully forward and upward. As the subject reaches the highest point of the jump he swings the arm forward and downward, motion being timed to coincide with height of the jump. The specified movements in executing the jump are extremely important, 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 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**

**Equipments:** Weighing Machine, Fat Caliper.
Description: The weight of each subject was taken as already explained. Lean body mass was calculated by assessing total body fat (described under body composition in details) and subtracted it from total body weight. Absolutely fat free weight of the body was considered as lean body mass.

Scoring: The performance in sargent jump was divided by lean body mass and obtained values were 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 subjects.

Equipment: Lange Skinfold Calipers.

Description: The investigator picked up a fold of subcutaneous tissue firmly between the thumb and the index finger of the left hand and pulled away the under lying 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 as shown in figures A_1, A_2, A_3, A_4. 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 elbow (olecranon process). The point was located with forearm flexed to 90 degrees. 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.
Fig. A1. Skinfold Measurement: Inferior Angle of Scapula.
Fig. A_2: Skinfold Measurement: Back of Upper Arm.
Fig. A3. Skinfold Measurement: Front of Upper Arm.
Scoring: The readings of the four sites were recorded in millimetres and added up.

A basic test to measure human personality factors is the personality test. After discussing with experts in personality, it was agreed that there are many tests believed to all by other tests because they are not considered to be valid. In a pilot study, a sample of 500 questionnaires were sent to all the subjects in the world over.

In Fig. A4, a skinfold measurement of the supra iliac site is shown.

It was observed that expressions and other situations in the presence of the 15 P.I. was within the competence of the subjects in the experimental group to respond adequately without feeling any linguistic or conceptual difficulties.

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Clarke, Application of Measurement to Health, Physical Education and Recreation, p. 82-83.
Scoring: The reading of the four sites were recorded in millimetres and added up.  

Psychological Variables

Sixteen Personality Factors

A broad survey was made of various standard tests to measure human personality, particularly of university students. After discussing with faculty members guiding research and experts in psychology, it was decided to use sixteen personality factors by Cattel Form A. Though there are many tests to measure human personality, 16 P.F. was preferred to all other tests because it has been used extensively world over and considered to be appropriate for this study. In a pilot study the scholar administered a few of the questionnaires to a sample of students comparable to experimental group. It was observed that the linguistic vocabulary expressions and other situations in the questions of the 16 P.F. was within the competence of the subjects in the experimental group to respond adequately without feeling any linguistic or conceptual difficulties.

7 Clarke, Application of Measurement to Health, Physical Education and Recreation, pp.82-83.
The subjects were assembled in a large room and were acquainted with the purpose of the study. The investigator persuaded the subjects to participate in the study and created a very congenial and friendly atmosphere before the questionnaires were distributed along with the answer sheets. They were asked to write their names and the name of the university they represented, on the top of the answer sheet in the space provided for this purpose. All necessary instructions were given regarding the questionnaire and the research scholar requested the subjects to carefully read the instructions before attempting the questions. The investigator and his associates went around and instructed the subjects whenever they did not understand anything pertaining to questions. A great care was taken that there should be only one answer for one question. After making sure that the subjects had understood the procedure clearly they were asked to proceed with actual answering the questions.

**Scoring:** The card board stencil, key for answer sheet, the 16 P.F. test form A, was directly applied to the form. Great care was taken while placing the key over the form, all instructions mentioned on "key for answer sheet" were strictly followed. The raw scores for all the 16 factors were counted and entered in the space provided for it in the answer sheet. The same way the second key was applied and raw scores counted and recorded on the answer sheet. The raw
scores, then, were converted into sten scores by using Tabular Supplement No.1 to the 16 P.F. Hand Book Norms for the 16 P.F. form A and B.\textsuperscript{8} The sten scores thus were recorded.

**Anthropometric Variables**

**Ponderal Index**

\[
\text{Standing Height} \div \sqrt{\text{Weight}}
\]

This ratio for each subject was calculated by substituting in the formula, the score of the height of a subject in inches correct to 1/4 of an inch and the score of weight in pounds correct to nearest pound. The value for this ratio was obtained by using nomograph (Figure A\textsubscript{5}). This ratio is named as Ponderal Index in literature.\textsuperscript{9,10}

**Height**

The subjects were asked to stand without any footwear on the height measuring stand in straight and relaxed state.

\textsuperscript{8}Norms for the 16 P.F. forms A and B. 1967-68 ed. (The Psycho-Center, New Delhi 1977),p.12.

\textsuperscript{9}Clarke, Application of Measurement to Health and Physical Education, pp.94-95.

\textsuperscript{10}Cureton, Physical Fitness of Champion Athlete,p.49.
and the scale was put straight over their heads and the readings recorded.

Weight was taken with the help of a standard and calibrated weighing machine in kilograms and then converted into pounds (1 kg = 2.2 lbs).

Body Ratios:

Forearm Length

Ht. / \sqrt{W}

15.0
16.0
16.5
17.0
17.5
18.0
18.5
19.0
19.5
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0

95
100
95
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200

9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5
19.0
19.5
20.0

Ponderal Index: \frac{Ht}{\sqrt{W}}

Ibid.

Ibid., p. 48.
and the scale was put straight over their heads and the readings recorded.

Weight

Weight was taken with the help of a standard and calibrated weighing machine in kilograms and then converted into pounds (1 kg = 2.2 pounds).

Crural Ratio

\[
\text{Fore Leg Length} \div \text{Thigh Length}
\]

This ratio was computed by dividing the score of fore leg 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 in literature.\(^{11}\)

Fore Leg Length\(^{12}\) The subjects were asked to remove clothes except short underwear. Fore leg length was measured vertically from the bottom outside edge of the foot in the center in the instep to a line drawn horizontally through the most protuberant part of the petella bulge (coinciding with the centre of the knee bend at the back).

\(^{11}\text{Ibid.}\)

\(^{12}\text{Ibid., p. 48.}\)
Thigh Length: Thigh length was measured vertically from the patella line to a line drawn horizontally through the mid-gluteal bulge at the point of tangency to a vertical line contacting the buttocks. The tape was placed at the center of knee bend and measured to tip of iliac crest.

Pryor's Width-Length Index

\[
\frac{\text{Bi-iliac diameter}}{\text{Standing Height}} \times 1000
\]

This ratio for each subject was calculated by substituting in the formula, the scores of bi-iliac diameter of a subject in centimeters and the score of standing height also in centimetres. The obtained value of this index was recorded correct to three decimal places. This ratio is named as Pryor's Width-Length index in literature.\textsuperscript{14}

Bi-iliac Diameter

The subject stood with his heels together and the wooden anthropometric arms were brought into contact with the top of the hip bone (iliac crest) at the place it sticks out

\textsuperscript{13} Ibid.

\textsuperscript{14} Ibid.
most, that is the place which gives the greatest hip diameter. The object was to measure the bony width only so, strong pressure was put on anthropometric arms to push aside any fat covering the bone.

Standing Height

A wooden stand with all standard marking was used. The subject was asked to stand straight and relaxed and the reading recorded in centimetres.

Arm Ratio

Arm ratio was obtained by dividing the scores of upper arm by the corresponding scores of lower arm and the obtained value was recorded correct to four decimal places.

Upper Arm

The subject was asked to stand straight and relaxed. A steel tape supplied by Mollimex Company was used. The tip of tape was placed on the tip of acromion process and measured to the head of radius.

Arm Length

Arm length was taken from the acromion process above the shoulder joint to the tip of the middle finger.

\[15 \text{Ibid.}\]
Functional Assessment Test Items

Hewitt's Tennis Achievement Test Items

Forehand and Backhand Drives.

A. Preparation of the Court (Marking the Court)

1. For the forehand and backhand drive tests one half of an official tennis court was marked off (Figure B1). Four areas or zones 4'6" each were marked off starting at the base line. Chalk lines were drawn across the court at these distances and for the first zone from the base line 4'6" from the base line. For the next zone, which is 4 feet 6 inches or 9 feet from the base line, a chalk line was drawn across the court and a large number 4 was inserted on the line. Same procedure was followed for the line three which was again 4'6", and a large number 3 was inserted on the line, and the already established service line was labelled with large 2. Whole forecourt became zone 1.

2. Restraining line...... A wooden Pole (7"x2"x2") was installed at each net post. A rope (one fourth inch in diameter) was tied between two poles at 7' height above the net.

Fig. B1 Forehand and backhand drives.
B. Equipment for Test

1. One basket
2. Two dozen new Tennis balls
3. Two tennis rackets
4. Clip board and lines score sheet
5. Pencil with eraser.

C. Subjects

Eighty eight students representing various university who had participated in inter varsity competition (South Zone) acted as subjects.

D. The test for Forehand and Backhand

Description: All subjects were given a demonstration of the test to be taken. A ten minutes period of warm up was provided to each subject on another court, prior to testing.

Subjects were asked to stand at the inter section of base line at X (as shown in Fig. B.) while the instructor with basket of tennis balls placed himself across the net at the intersection of the centre service line and service line.

The instructor hit five practice balls to each subject just beyond the service court. The subject moved into proper position for the forehand drive and drove the ball over the net into the zoned area to score points. The
subjects were advised to drive the ball as near to the base line as possible to obtain higher points. Ten trials each were provided to each subject and the subjects were free to choose any ten balls to return on the forehand and the backhand. The research scholar himself hit all the balls to all subjects in order to standardize the procedure.

E. Scoring the Backhand and Forehand Drives

1. A subject recorded all scores in proper places on the score sheet for each of the 10 forehand and ten backhand drives going over the net and under the restraining rope. These scores were for the number zones marked on the lines for their respective spaces 5, 4, 3, 2 and 1.

2. Balls hit over the 7 feet restraining rope and into the scoring zones scored one half the regular value.

3. Balls hitting into the net labelled N (net)=0 score.

4. Balls going over the base line labelled O (out)= 0 score.

5. Balls going wide of side lines labelled W (wide) = 0 score.

6. All net ball repeated.
Service Test

A. Placement of Service in right service court.

1. Preparation of the court.

   Marking of right service court.

   a) Three feet were measured off down the center service line and 1'6" over the service line. The box was closed in with chalk and inserted number six in the center of the three foot line (Figure B₂).

   b) Below zone six another three feet were measured off down the center service line and 1'6" over into the service court. The box was closed in with chalk line and number five was put on the line (Figure B₂).

   c) A line was measured 1'6" on the service line from zone six and three feet down in service court. The box was closed with chalk lines. A large number four was inserted on line.

   d) The remaining top of the right service court 10'6" x 6' was named zone 2.

   e) Zone 1 was the remainder of the right service court.

Note: The highest value of six points was given for the score closest to the center service line, since for a right
handed opponent this area would be his backhand. Lesser values were given for hits in the area further away from the center of service target. Numbers were inserted on the lines rather than in the spaces to provide better target. Numbers on the lines represented both the lines and spaces to right of the number.

B. Restraining line

A wooden pole (7'X2"X2") was installed at each net post. One quarter inch rope was fixed between poles at the 7 feet height above the net.

C. Equipments

a) A basket
b) Three dozen tennis balls
c) Tennis rackets
d) Clip board and score sheet
e) Pencil and eraser.

D. The service Test

a) The investigator demonstrated the test.
b) Ten minutes warm-up was allowed before test on other court.
c) Subject started test at right of center line and behind base line at X (Figure B_2).
d) Subject served ten balls into the right service court target area for placement.

**Speed of Service**

After considerable experimentation with a stop watch attempting to measure the speed of the serve it was found out that the distance the ball bounces after it hits the service court is a good indicator of the speed of the serve.

Type of serve such as slice, straight, overhead, American twist etc., had little effect on the distance the served ball bounces. The bounce of the service is more related to the experience and ability of the player, for example a varsity player could hit the fence on the second bounce when serving a slice serve.

1. Scoring the serve.
   a) Placement of serve:

   For every ball hit over the net and under the 7 feet restraining line, the serve scored on the basis of target area hit. Since the numbers were on lines scored all hit for their appropriate lines and their adjacent spaces to the right of each number (Figure B3).

   i) Score as 6,5,4,3,2,1 placement for each of the ten balls served.
Fig.B3 Speed of service—distance serve bounces.
ii) Ball hitting out of the service court labelled as L (Long) = 0 Score.

iii) Ball served out of the service court wide labelled as W (wide) = 0 Score.

iv) Net balls were repeated.

v) Served ball going over the restraining line labelled as H (high) = 0 Score.

b) Speed of the service or distance the served ball bounced to the second bounce.

For each of the ten good serve placements score the distance the served ball bounces into the respective zones:

i) Zone 1. Backcourt area to base line = 1 point.

iii) Zone 2. Area ten feet beyond the base line = 2 points.

iii) Zone 3. Area ten to twenty feet beyond the base line score = 3 points.

iv) Zone 4. The area 20 feet beyond the base line on the fence in most instances score = 4 points.

Reliability of the above mentioned test was ascertained by the "test-retest" method. The following correlations were achieved by repeating the test on two successive class periods.
Forehand drive placement .75
Backhand drive placement .78
Service placement .94
Speed of service or distance
the ball bounces .84

Analysis of Data

The relationship between dependent variable (playing ability) and independent variables (physiological, psychological, anthropometric variables and functional test items) was established by computing Pearson Product Moment Correlation (zero order) and the combined effect or contribution of physiological, psychological, and functional assessment test items to tennis performance was obtained through Wherry Doolittle Method of multiple correlation. Tennis playing ability was predicted from physiological, psychological, and functional assessment test by utilizing regression equation. The relative contribution of a single independent variable to dependent variable (playing ability) by eliminating or partialing out the effect of one or the others was found through partial correlation.

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