Chapter – III

PROCEDURE

In this chapter subjects, criterion measures, reliability of data, collection of data, and statistical technique employed for the analysis of the data have been presented.

Subjects

For the purpose of this study 90 male cricket players to different universities and states who have participated in cricket championship of various levels were selected as subjects. The subjects were ranging from 17-25 years of age. Depending upon their level of participation, they were divided into three groups such as beginners who have participated at college level competitions, the intermediate were those who have participated in intercollegiate and university championship and advanced were those who have participated in All India Inter-university cricket championship.

Criterion Measures

The performance of the subjects in pace bowling was the criterion measure of the study.

Reliability of Data

The reliability of the data was ensured by establishing the instrument reliability and the tester's reliability.
Instrument Reliability

The instruments used for the study were available at the human performance laboratory of Lakshmibai National Institute of Physical Education, Gwalior. Instruments were calibrated and tested prior the collection of data. Thus, these were considered accurate enough for the purpose of this study.

Tester’s Reliability

The tester’s reliability was established with the help of test retest method, the performance of 30 subjects selected at random on the select variables were recorded several times under identical conditions by the research scholar. A Pearson’s Product Moment Correlation was computed between the two measures of each variable, the reliability coefficient have shown higher values. The values of coefficients are given in Table 1.
### TABLE 1
RELIABILITY COEFFICIENTS OF TESTS, RETEST SCORES
(N = 30)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Tests</th>
<th>Coefficient of Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Standing Height</td>
<td>.99</td>
</tr>
<tr>
<td>2.</td>
<td>Arm Length</td>
<td>.96</td>
</tr>
<tr>
<td>3.</td>
<td>Leg Length</td>
<td>.97</td>
</tr>
<tr>
<td>4.</td>
<td>Grip Strength</td>
<td>.98</td>
</tr>
<tr>
<td>5.</td>
<td>Arm Strength</td>
<td>.98</td>
</tr>
<tr>
<td>6.</td>
<td>Explosive Strength</td>
<td>.97</td>
</tr>
</tbody>
</table>

**Collection of Data**

The data pertaining to physical and biomechanical variables were obtained by administering standard tests and measurement procedure.
Physical Variables

Standing Height

Subjects were made to stand erect without shoes against the marked scale on the wall. The heels, buttocks and back were touching the wall. The subjects were instructed to keep the heels together, head without tilt and to take and hold full breath while measurement was taken. A stiff hard board was help horizontally on the head touching the scale marked on the wall. The subject asked to step out and the reading indicated by the hard board was recorded. Stature was recorded to the nearest half of a centimeter¹.

Arm Length

The subject stood erect by keeping his arms along with his body. Arm length was measured with the flexible steel tape. The tip of the tape was placed at the upper edge of the head of acromiale to the tip of the top of the point of radiale. The arm length was recorded correct to the nearest half of a centimeter².


² Ibid. p. 48.
Leg Length

Subjects were instructed to stand erect and leg length was taken with the flexible steel tape from the greater trochanter to the floor. The leg length was recorded correct to the nearest half centimeter\(^3\).

Grip Strength

Grip strength of the subject was measured with the help of grip dynamometer. The concave edge of the dynamometer was placed between the first and second joint of the fingers of the strong hand with the dial towards the palm of the hand and both the needles were kept on zero. The were allowed any type of movement while squeezing the handle of the instrument, provided they did not hit any object with their fist and the grip strength of the hand was tested. The score of the grip strength was recorded to the nearest kilogram from the indicating needle of the dynamometer dial\(^4\).

Selected Strength Variables

Arm Strength

Arm strength of the subject was also measured by dynamometer which was on the wall and subject was asked to stand near the facing his back to wall keeping feet parallel about six inches apart. Bar of the

\(^3\) Ibid. p. 49.

dynamometer was held with shooting hand by keeping the elbow flexed. The position was almost similar to the throwing stance before the subject was asked to extend his elbow, the tester ensured that the leg and back were straight and head was erect with chest up. Than the subject asked to extend his elbow in the throwing action. The score of the arm strength was recorded to the nearest kilogram from the dynamometer dial.

**Explosive Strength of Leg**

Explosive strength of the subject’s leg was measured with the help of vertical jump test, which was administered at the basketball court. In this test basketball pillar was used as well and smooth surface of the pillar of about two feet wide and 3.5 meter height was marked in centimeters. The test was explained and demonstrated to the subjects. The subject was made to stand with the side towards the wall, heels together, using hands in the coloured chalk power keeping the heels on the floor, the stretched upward as high as possible and made a mark on the wall and then flexed his knees and jumped vertically as high as possible and marked another point on the wall at the height of his jump. The total distance between the standing reached and the jump marked was measured and recorded to the nearest half of a centimeter. There trials were given to each subject and best of three trials were recorded as the final score⁵.

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Speed Variables

To measure the running speed of the subjects 50 meter dash test was organized. In this test the subjects were asked to stand behind the starting line and they had to run after the call of 'go' by bringing both the arms of clapper together. Time was noted at the finishing point. Total time (in seconds) was recorded as the running speed of the subjects.

Flexibility Variables

Hip Flexibility

Modified sit and reach test was employed to measure the hip flexibility of all the subjects. First of all the 15 inch mark of the yardstick was lined up and ends of the stick were taped to the floor, so that the flexometer case faces down. The subjects were asked to sit down and line up their heads with the near edge of the 15 inch mark and sliding their seats back beyond the zero end of the yardsticks, knees were kept locked. Now the subjects were asked to part their heels, not more than 5 inches and slowly stretch forward pushing the flexometer case as far as possible with the finger tips of the hands. Reading was recorded at the highest edge of the flexometer case. The best of three trials measured to the nearest of an inch was the test score.
Shoulder Flexibility

To measure the shoulder flexibility of the subjects, 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. 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 and the best of the there trials was recorded as the final score.

Kinematic Variables

In order to obtain the selected kinematic variables the subjects were filmed by using the standard procedure of photographic techniques. The subjects were asked to perform the pace bowling for analysis purposes only one moment was taken into consideration which was the moment release (figure 1 and 2). A video camera was used to film the subjects while performing the pace bowling. The movement was filmed in sagittal plane only. Before the actual recording of the pace bowling, the known height of the object (hurdle), was filmed from the point where the pace bowling at moment release be taken. The camera was fixed on a tripod at a height of 1.60 meter and 6.40 meters away from the performing plane. The subject was asked to perform pace bowling performance of all trials were recorded separately.
Figure – 1: PHOTOGRAPH OF MOMENT RELEASE

Figure – 2: STICK FIGURE OF MOMENT RELEASE
Angular Kinematic Variables

The film was analyzed to measure the angles of various joint using computers. The angles of the various joints of the body were recorded by segmentation method\(^6\) in release of the pace bowling. The details of the selected angular kinematic measures are as under:

**Angle of Wrist Joint**

To measure the angle of wrist joint different land marks dactylion, stylion and radiale were marked in static position of moment release only. All the points were joined with the help of a computer and measured with the help of computer programme and recorded in degrees.

**Angle of Shoulder Joint**

To measure the angle of shoulder joint three different land marks i.e. iliac crest, acromiale and point of radiale were marked on the screen which were then joined with the help of scale and measured in degrees\(^7\).


Angle of Hip Joint

To measure the angle of hip joint three different landmarks, acromiale, point of greater trochanter and point of tibiale were marked on the graph sheet. All the three points were joined with the help of scale and measured by protractor and recorded in degrees.

Angle of Knee Joint

To measure the angle of knee joint three different points, point of greater trochanter, point tibiale and point of sphyrion were marked at the maximum knee flexion which were then joined with the help of a scale and measured by the protractor. The angle of knee joint was recorded in degrees.

Angle of Ankle Joint

To measure the angle of ankle joint different landmarks tibiale, sphyrion and acropodion were marked on the graph sheet. All the points were joined together with the help of a scale and angle of ankle joint was measured by the protractor and recorded in degrees.

Selected Kinematic Variables

Height of Center of Gravity

For the purpose of the study only one moment was selected i.e. moment stance. The center of gravity was calculated with the help of segmentation method. Following are the steps.
1. The reference points associated with each segment were marked on the photograph.

2. A stick figure was constructed representing of the subject by ruling straight lines between appropriate reference points.

3. Length of each segment line was measured and divided these various lengths in the appropriate ratio as indicated in Table – 2, division points were marked (that were the center of gravity of the segments) on their respective lines.

4. Two arbitrary axes (OY and OX) were rules, one to the left and one below the stick figure.

5. A table was prepared in column 1. The weight of the segment was entered.

6. For each segment, the perpendicular distance from the center of gravity of the line OY was measured and this distance was entered in the appropriate place on the form (table – 3, Column – 2).

7. To find the moments about OY, the weight of each segment was multiplied by the distance of its center of gravity from the line, and these values were entered on the form (Table – 3, Column – 3).

8. The sum of the moments about OY by adding the contents of column on the form was calculated (this was equal to X).
9. I line OY was ruled parallel to OY and a distance of X. The center of gravity of the subject lies on this line.

10. Steps 5 to 9 were repeated, taking moments about OX instead of OY. The center of gravity of the subject lies on the line O'X' drawn parallel to OX and at the computed distance from it. And, finally, because of center of gravity lies on both O'Y' and O'X' and in these two lines one point was common (the point where they intersect), it was the center of gravity of the subject.

**TABLE – 2**

**LOCATION OF CENTER OF GRAVITY OF BODY SEGMENTS**

<table>
<thead>
<tr>
<th>Segments</th>
<th>Center of Gravity Location Expressed as Percentage of Table Distance Between Reference Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>46.4% to vertex; 53.6% to chin-neck intersect</td>
</tr>
<tr>
<td>Trunk</td>
<td>38.0% to suprasternal match; 62.0% to hip axis</td>
</tr>
<tr>
<td>Upper Arm</td>
<td>51.3% to shoulder axis; 48.7% to elbow axis</td>
</tr>
<tr>
<td>Fore Arm</td>
<td>39.0% to elbow axis; 61.0% to wrist axis</td>
</tr>
<tr>
<td>Hand</td>
<td>80.0% to wrist axis; 18.0% to knuckle II</td>
</tr>
<tr>
<td>Thigh</td>
<td>37.2% to hip axis; 62.8% to knee axis</td>
</tr>
<tr>
<td>Calf</td>
<td>37.1% to knee axis; 62.9% to ankle axis</td>
</tr>
<tr>
<td>Foot</td>
<td>44.9% to heel; 55.1% to tip of longest toe</td>
</tr>
<tr>
<td>Segment</td>
<td>Column 1</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Segment</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Segment</th>
<th></th>
<th>0.073</th>
<th>0.507</th>
<th>0.026</th>
<th>0.026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Upper</td>
<td></td>
<td>Right Arm</td>
<td>0.026</td>
<td>Right Forearm</td>
<td>0.016</td>
</tr>
<tr>
<td>Trunk</td>
<td>0.016</td>
<td>Right Hand</td>
<td>0.007</td>
<td>Left Upper Arm</td>
<td>0.026</td>
</tr>
<tr>
<td>Left Upper Arm</td>
<td>0.026</td>
<td>Right Forearm</td>
<td>0.016</td>
<td>Right Hand</td>
<td>0.007</td>
</tr>
<tr>
<td>Left Forearm</td>
<td>0.103</td>
<td>Left Hand</td>
<td>0.015</td>
<td>Right Thigh</td>
<td>0.103</td>
</tr>
<tr>
<td>Right Thigh</td>
<td>0.043</td>
<td>Left Thigh</td>
<td>0.043</td>
<td>Right Calf</td>
<td>0.043</td>
</tr>
<tr>
<td>Left Thigh</td>
<td>0.015</td>
<td>Left Calf</td>
<td>0.015</td>
<td>Right Foot</td>
<td>0.015</td>
</tr>
<tr>
<td>Left Calf</td>
<td></td>
<td>Left Foot</td>
<td>0.015</td>
<td>Total</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Total = 1.000
Height of Ball at Release

Height of ball at release was measured with the scale from the ground level of the point of last contact of the ball with finger and recorded in centimeters which were then converted into actual height by multiplying.

Duration of Flight

The difference of timing from the moment ball was released and touched the wicket or pass through the level of wicket was recorded to the 1/10th of a second.

Velocity of the Ball

Velocity of the ball in pace bowling was measured by dividing distance i.e. the distance between releasing point of the ball and the time taken by the ball to travel the distance to the wickets. Total three trials were given to each subject. Best of three trials in meter/seconds was recorded as velocity of the ball. A steel tape was used to measure the distance between the point of release position to the point where the ball touched the wicket or level of wicket. Time taken by the ball to travel this distance was recorded by stop watches, which had a capacity to measure up to hundredth of a second.
Scoring

To assess the performance of pace bowling in cricket, five point for run-up, five point for placement of foot, ten point for execution, ten point for speed of the ball and twenty point for line and length of the ball. Three trials were given to each subject and performance of each trial was recorded separately.

Analysis of Data

The data obtained for physical and biomechanical variables in pace bowling were analyzed by using following statistical techniques.

1. Mean
2. Pearson’s Product Moment Correlation.
3. Analysis of Variance.

In order to test the hypothesis, level of significance was set at .05.