In this chapter, the selection of subjects, selection of variables, criterion measure and reliability of data, procedure for collection of the data and statistical technique used to analyze the data have been described.

Selection of subjects

Eight male (National / Inter university level) sprinters were selected from Sub Centre Sports Authority of India, Lucknow and Banaras Hindu University Varanasi who’s age ranged between 17 to 30 years. The purpose of the study was explained to the subjects and requested to crouch start at varied angles of block in athletics in their best effort during each attempt.

Selection of Variables

The following Anthropometrical and kinematic (Linear and Angular) variables were selected for the purpose of this study:-

**Anthropometrical Variables**

1. Age  
2. Height  
3. Weight  
4. Hand Length  
5. Fore Arm Length  
6. Upper Arm Length  
7. Upper Leg Length  
8. Lower Leg Length  
9. Foot Length

**Linear Kinematical Variables**

1. Height of center of gravity of the body at set position.  
2. Length of first step.  
3. Length of first stride length.  
4. Speed of the subject.
Angular Kinematical Variables

Angular Kinematical Variables on set position (touching the ground by both hand, and both foot) at varied angles of block in athletics

1. Angle of left ankle joint and Angle of right ankle joint
2. Angle of left knee joint and Angle of right knee joint
3. Angle of left hip joint and Angle of right hip joint
4. Angle of left shoulder joint and Angle of right shoulder joint
5. Angle of left elbow joint and Angle of right elbow joint
6. Angle of left wrist joint. Angle of right wrist joint
7. Angle of Trunk inclination
8. Angle of Head Inclinations

Criterion Measures

The following criterion measures were adopted for the present study:

Table-1: criterion measures

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tests</th>
<th>Units of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of subject</td>
<td>Chronological Age</td>
<td>Year</td>
</tr>
<tr>
<td>Height of the subject</td>
<td>Anthropometric Rod</td>
<td>Meter</td>
</tr>
<tr>
<td>Weight of the subject</td>
<td>Weighing Machine</td>
<td>Kilogram</td>
</tr>
<tr>
<td>Height of centre of gravity on set position at varied angle of block in athletics</td>
<td>Kinovea-forums experimental version-0.8.25</td>
<td>Centimeter</td>
</tr>
<tr>
<td>Speed of subject during 30 meter performance at varied angles of Block in athletics</td>
<td>Manually</td>
<td>meter/second</td>
</tr>
<tr>
<td>Angle of angular kinematical variables at varied angles of Block in athletics</td>
<td>Silicon Coach Pro-7 Motion Analysis Software</td>
<td>Degree</td>
</tr>
<tr>
<td>First step length and first stride length</td>
<td>Silicon Coach Pro-7 Motion Analysis Software</td>
<td>Meter</td>
</tr>
</tbody>
</table>
Reliability of Data

The reliability of data was established by instrument reliability and tester’s reliability.

Instrument Reliability

To obtain reliable measurement the instruments which were used for the purpose of the present study, namely camera, software, tripod, starting block, stop watch, steel tape and geometrical instruments etc. were all standard equipment available at the research laboratory and there reliability was insured by the manufactures.

Tester’s Reliability

All measurement pertaining to the anthropometrical, angular and linear variables were taken by the research scholar under the guidance of the expert.

Reliability of Tests

To determine the reliability of measurements involved in the present study, the data was collected from 8 male sprinters at varied angles of block in athletics. The sprinters were tested on selected variables.

Reliability of Subjects

The above test coefficient of correlation method also established that subject’s reliability was significant at 0.05 level of confidence, as the same subjects were used under similar conditions by the same tester and no motivational techniques were used.

Collection of Data

The performance of the subject’s, filming protocol and analysis of data is described below:-

Performance of the Subject

The performance of the subject’s at varied angles of block in athletics was measured by using the standard procedures.
Filming Protocol

The video graphic technique was used for collecting raw data. The video graphs were taken by a professional photographer under the supervision of an expert. According to availability of two Casio EX-F1 high speed cameras were used, which have frequency from 60 to 300 frames per second (f/s). The data were recorded from sagittal plane and frontal plane. Camera-1 was placed perpendicular from the subject at a distance of eight meters and above from ground one meter height. Camera-2 placed perpendicular to camera-1 and in front of subject performing at varied angles of block in athletics at the distance of ten meters and 1 meter above from grounds. For the purpose of the analysis of this study set position were selected at varied angles of block in athletics. The subjects had performed 30 meter sprints four times at varied angles of block in athletics.

Figure-1: Diagram of Set-Up for Collection of Data

Procedure for Collecting Data

The data pertaining to selected anthropometrical, linear and kinematical variables, performance of the subjects, filming protocol and analysis of the film were obtained are described as below.
Procedure for Collecting Anthropometrical data

Age:

Age was recorded in chronological age; chronological age means the age of a person recorded in years, months and days but finally scholar recorded age of subject in years only for my research purpose.

Height:

Height was measured by anthropometric rod. The subject stood erect bare footed on a plane horizontal surface against a wall with his heels, back of shoulder and Head touching the wall and stretched the body upward as much as possible without his heel leaving the ground. Then stadiometer was adjusted so that the lower edge touched the highest point of subject’s Head. Height was recorded in meter.

Weight:

The weight of each subject was taken by weighting machine. The subject was wearing minimum of clothing stood on weight machine and weight was recorded to the nearest half of the kilogram.

Hand Length:

The subject was asked to stand (in skeletal position) at ease with equal weight on both the feet and with hand hanging freely. Locating the point stylion and knuckle III, through the non stretchable tape measured the length from stylion to knuckle III point in metre.

Fore Arm Length:

The subject was asked to stand at ease with equal weight on both the feet and with hand hanging freely. Locating the point stylion and radial, through the non stretchable tape measured the length from stylion to radial point in metre.

Upper Arm Length:

The subject was asked to stand at ease with equal weight on both the feet and with hand hanging freely. Locating the point acromial and radial through the non
stretchable tape which measures the upper arm length from acromial to radial point in meter.

**Lower Leg Length:**

The subject was asked to stand at ease with equal weight on both feet and with hand hanging freely. Locating the points of tibial and point of sphysision, through the non-stretchable tape measured the length from tibial to point of sphysision in meter.

**Upper Leg Length:**

The subject is asked to stand at ease with equal weight on both the feet and with hand hanging freely. Locating the point condyle of femur and trochanter-ion, through the non-stretchable tape measured the length from condyle of femur to radial point in meter.

**Foot Length:**

The subject was asked to stand at ease with equal weight on both feet and with hand hanging freely. Locating the point heal and tip of longest toe, through the non-stretchable tape measured the length from heal to tip of longest toe point in meter.

**Procedure for Collecting Linear Kinematic Data**

**Length of First Step and First Stride:**

Marked the actual length of reference object in the video and time with the help of measuring tools of Silicon coach pro-7 motion analysis software and Casio EX-F1 high speed camera

**Speed of the Subject:**

The speed of subject at varied angles of block is the rate at which the distance is covered by the subject. This was measured by dividing the total distance covered by the total time taken. Speed of the subject was recorded in meter per second.

**Height of Centre of Gravity of the Body at Set Position**

Marked the actual length of reference object in the video and time with the help of Kinovea-forums experimental version-0.8.25 motion analysis software and Casio EX-F1 high speed camera was used for calculating centre of gravity at set position.
Procedure for Collecting Angular Kinematic Data

On the basis of the video recording, the scholar marked various angular kinematic variables with the help Silicon coach pro-7 motion analysis software i.e. Angle at Ankle Joints (Left and Right), Knee Joint (Left and Right), Hip Joint (Left and Right), Shoulder Joint (Left and Right), Elbow Joint (Left and Right), Wrist Joint (Left and Right), Trunk Inclination and Head Inclination the Angle at selected Joints was measured as shown in figures 2 to 9 as follow.

**Figure-2:** Side View of Set Position at 45/45 Angle of Block in Athletics
Figure-3: Side View of Set Position at 45/60 Angle of Block in Athletics
Figure-4: Side View of Set Position at 60/75 Angle of Block in Athletics
Figure-5: Side View of Set Position at 75/90 Angle of Block in Athletics
Figure-6: Front View of Set Position at 45/45 Angle of Block In Athletics
Figure-7: Front View of Set Position at 45/60 Angle of Block in Athletics
Figure-8: Front View of Set Position at 60/75 Angle of Block in Athletics
Figure-9: Front View of Set Position at 75/90 Angle of Block in Athletics

Angle of Ankle Joint:

To measure the Angle of Ankle Joint different land marks i.e. tibiale, sphysion and acropodian were marked and with the help of measuring tool of Silicon coach pro-7 motion analysis software, Angle at Ankle Joint was recorded in nearest degree.
**PROCEDURE AND METHODOLOGY**

**Angle of knee Joint:**

To measure the Angle of Inclination Joint three different points, points of greater trochanter, point of tibiale and points of sphysion were marked and with the help of measuring tool of Silicon coach pro-7 motion analysis software, Angle at Inclination Joint was recorded in nearest degree.

**Angle of Hip Joint:**

To measure the Angle of Hip Joint three different points, points of greater trochanter, point of tibiale and point of acromial were marked and with the help of measuring tool of Silicon coach pro-7 motion analysis software, Angle at Hip Joint was recorded in nearest degree.

**Angle of Elbow Joint:**

To measure the Angle of Elbow Joint three different points, points of radiale, points of stylion and points of acromial were marked and with the help of measuring tools of Silicon coach pro-7 motion analysis software, Angle at Elbow Joint was recorded in nearest degree.

**Angle of Wrist Joint:**

To measure the Angle of Wrist Joint three different points, points of back (dorsum) of hand, points of fore arm and points of Wrist Joint were marked and with the help of measuring tools of Silicon coach pro-7 motion analysis software, Angle at Wrist Joint was recorded in nearest degree.

**Trunk Inclination Angle:**

The Angle formed in between vertical plane and due to Inclination to fore Head at the centre of two Hip Joint with the help of measuring tools of Silicon coach pro-7 motion analysis software, Angle at Trunk Inclination was recorded in nearest degree as shown in figures.

**Head Inclination Angle:**

The Angle formed in between vertical plane and due to Inclination to fore Head at the centre of two suprasterrnal notch with the help of measuring tools of Silicon coach
pro-7 motion analysis software, Angle at Trunk Inclination was recorded in nearest degree as shown in figures.

**Analysis of Data**

Silicon coach pro-7 motion analysis software was use for kinematical analysis of sprinting performance at varied angles of block in athletics. The centre of gravity of the subject at the time of set position on block by segmentation method as suggested by Games G. Hay was recorded.

**Procedure of Location of Centre of Gravity**

Centre of gravity at set position was finding out by Kinovea-forums experimental version-0.8.25

The following steps were also followed for locating the center of gravity of each subject at the time of set position at varied angles of block in athletics.

1. On the photograph the reference pointed associate with each segment were marked.
2. A stick, figure representation of the subject by ruling straight link between appropriate reference points was prepared.
3. The length of each segment line would be measured and divided into appropriate ratio as indicated in table-2
Table-2: Location of Centre of Gravity of the Body Segments

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Segments</th>
<th>C.G. Location expressed as percentage of total distance between reference points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Head</td>
<td>46.4% to vertex; 53.6% of chin-neck intersect.</td>
</tr>
<tr>
<td>2.</td>
<td>Trunk</td>
<td>43.8% to suprasternal notch; 56.2% to Hip axis.</td>
</tr>
<tr>
<td>3.</td>
<td>Upper Arm</td>
<td>49.1% to shoulder axis; 50.9 to Elbow axis.</td>
</tr>
<tr>
<td>4.</td>
<td>Fore Arm</td>
<td>41.8% to Elbow axis; 58.2% to Wrist axis.</td>
</tr>
<tr>
<td>5.</td>
<td>Hand</td>
<td>82% to Wrist axis; 18% to knuckle III.</td>
</tr>
<tr>
<td>6.</td>
<td>Thigh</td>
<td>40% to Hip axis; 60% to Inclination axis.</td>
</tr>
<tr>
<td>7.</td>
<td>Calf</td>
<td>41.8% to Inclination axis; 58.2% to Ankle axis.</td>
</tr>
<tr>
<td>8.</td>
<td>Foot</td>
<td>44.9% to heel; 55.1% to tip of longest toe.</td>
</tr>
</tbody>
</table>

4. Two arbitrary axes (oy and ox) one to Left and one below the stick figure were ruled out.

5. Form was prepared, and in column 1, the weights of the segments were entered. The weights of body segments are given in table-2

6. For each segment, the perpendicular distance from the C.G. to the line oy was measured and entered in the appropriate place in column-1.
Table-3: Weight of body segments related to total body weight

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Segment</th>
<th>Relative Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Head</td>
<td>0.073</td>
</tr>
<tr>
<td>2.</td>
<td>Trunk</td>
<td>0.507</td>
</tr>
<tr>
<td>3.</td>
<td>Upper Arm</td>
<td>0.026</td>
</tr>
<tr>
<td>4.</td>
<td>Fore Arm</td>
<td>0.016</td>
</tr>
<tr>
<td>5.</td>
<td>Hand</td>
<td>0.007</td>
</tr>
<tr>
<td>6.</td>
<td>Thigh</td>
<td>0.103</td>
</tr>
<tr>
<td>7.</td>
<td>Calf</td>
<td>0.043</td>
</tr>
<tr>
<td>8.</td>
<td>Foot</td>
<td>0.015</td>
</tr>
</tbody>
</table>

7. To find out moment about oy the weight of each segment would be multiplied by distance of its C.G. from the line oy and these values were entered in column-2.

8. The sum of the moment about oy would be found out by adding the contents on the form.

9. Imaginary line oy parallel to o'y' was ruled at a distance x from it (x=the sum got from step8).

10. Steps from 5 to 9 would be repeated, taking moment’s ox instead of oy and ruled a line o’x’ at appropriate distance.

Since the C.G. lines on both o’y’ and o’x’ and these two lines have only one point in common (the point where they intersect) it is here that the C.G. is situated. Its height would be measured at ox axis in order to obtain height of the C.G.
Statistical Technique

1. To kinematically analyse set position at varied angles of block in athletics to, descriptive statistic was used.

2. To compare the different set position at varied angles of block in athletics, analysis of variance (ANOVA) was used.

3. To find out correlation between dependent variable (30 M performance) and independent variables (selected linear & angular kinematical variables) at varied angles of block in athletics, Pearson correlation was used.

4. To find out regression equation between Dependent variable (30 Meter performance) and independent variables (selected linear & angular kinematical variables) at varied angle of block in athletics, Step Wise Method was used.

5. The level of significance was set at 0.05.

6. The data was analysed by applying SPSS20-Version.