3.1 Introduction

In this chapter, the selection of the subjects, selection of the variables, instruments reliability, tester competency, reliability and validity of the tests, procedure for administering the tests and statistical techniques for analysing the data have been described.

3.2 Selection of Subjects

The subject for this study were 1800 boys of three states of Eastern Region of India viz., Bihar, West Bengal and Orissa and five states of North East Region of India viz., Assam, Arunachal Pradesh, Meghalaya, Manipur and Tripura. Only those boys who had been participating in physical education programme of school curriculum or who had been actively participating in sports and games were considered for the present study. The subjects for the present study were between 8-14 years of age. The Age-wise selection of the subjects of the Eastern Region (ER) and North East Region (NER) have been presented in Table I. A brief description of geographical location, environmental condition and life style of ER & NER from where subjects of the study were collected are presented below.

**Eastern Region** : The Eastern Region (ER) of India comprises of three States - Bihar, West Bengal and Orissa. The climatic and environmental condition of these three States are generally hot and humid as compared to North East Region (NER) States, because geographically it is located closer to sea level. These three States are located in
the plain area of the eastern part of Indian Subcontinent. These three States are inhabited by
dozen of tribes of mixed races but there is no noticeable striking difference in terms of
ethnic element, geographical features, climatic condition, pattern of living or life style,
culture, food habits etc. among the people between these three States of ER and hence
forth, these three States are clubed together as a part of Eastern Region of Indian Sub-
continent in the present study.

**North East Region**: The North East Region (NER) of India comprises of
seven States - Assam, Arunachal Pradesh, Meghalya, Manipur, Mizoram, Tripura, and
Nagaland. The climatical and environmental condition of these States are generally cool
and temperate as compared to ER States because geographically it is located slightly
above the sea level and in the mountain range of north eastern part of Indian Subconti-
nent. These States are of special significance as its vallies, hills and forests are largely
inhabited by dozen of tribes who are basically Mongoloid in their origin with short to
medium stature with muscular body. There is no noticeable striking difference in terms of
ethnic elements, geographical features, climatic condition, pattern of living or life style,
culture, food habits etc., among the people living in these seven States of North Eastern
Region (NER) are henceforth are clubed together as NER States of Indian Subcontinent.
The geographical location of Eastern Region and North East Region States are presented
in fig. 1.

**TABLE 1. Age-Wise Selection of the Subjects of Eastern Region (ER)
and North East Region (NER)**

<table>
<thead>
<tr>
<th>AGE GROUP</th>
<th>BOYS(ER)</th>
<th>BOYS(NER)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 YEARS</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>9 YEARS</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>10 YEARS</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>11 YEARS</td>
<td>200</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>12 YEARS</td>
<td>250</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>13 YEARS</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>14 YEARS</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>TOTAL</td>
<td>900</td>
<td>900</td>
<td>1800</td>
</tr>
</tbody>
</table>
Fig. 1. Geographical Location of ER & NER of India
3.3 Selection of Variables

Keeping in view the feasibility, criteria and the relevancy of the variables to the present study, the anthropometric measurements with their units are presented in Table 2 and the motor ability variables selected for the study along with the tests items chosen to measure these variables are given in Table 3.

TABLE 2. Selected Anthropometrical Measurements with their Units

<table>
<thead>
<tr>
<th>S.NO</th>
<th>ANTHROPOMETRICAL VARIABLES</th>
<th>MEASUREMENT UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BODY HEIGHT</td>
<td>CENTIMETER (c.m)</td>
</tr>
<tr>
<td>2.</td>
<td>BODY WEIGHT</td>
<td>KILOGRAM (kg.)</td>
</tr>
<tr>
<td>3.</td>
<td>BODY FAT</td>
<td>PERCENTAGE (%)</td>
</tr>
<tr>
<td>4.</td>
<td>SOMATOTYPE COMPONENTS</td>
<td>NUMERICAL VALUES</td>
</tr>
</tbody>
</table>

It was assumed that the above selected parameters, individually as well as collectively would indicate the Anthropometric and Motor Quality profiles of boys of Eastern and North East Region of India. The choice of the tests were made in the light of the objectivity and reliability of the tests. The anthropometric measurements and motor tests for the present study were selected keeping in view the administrative feasibility, which provides maximum accuracy for the valid and reliable results and which ensures minimum of time consumption.

The instruments involved in the measurements of these parameters were simple and were readily available at Human Performance Laboratory of SAI Eastern Centre, Calcutta. Due to lack of facilities and instruments, the Researcher had to restrict his finding only to above tests and measurements.
<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>MOTOR ABILITY</th>
<th>TEST ITEMS</th>
<th>NUMBER OF ATTEMPTS</th>
<th>MEASUREMENT UNIT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Speed</td>
<td>30 mt. (Flying Start)</td>
<td>1</td>
<td>1/100 sec</td>
</tr>
<tr>
<td>2.</td>
<td>Agility</td>
<td>6x10 mt Shuttle Run</td>
<td>1</td>
<td>1/100 sec</td>
</tr>
<tr>
<td>3.</td>
<td>Explosive strength</td>
<td>(a) Standing Broad Jump (SBJ)</td>
<td>3</td>
<td>cm.</td>
</tr>
<tr>
<td></td>
<td>(lower extremities)</td>
<td>(b) Standing Vertical Jump (SVJ)</td>
<td></td>
<td>cm.</td>
</tr>
<tr>
<td>4.</td>
<td>Explosive strength</td>
<td>Ball Throw (400 gm)</td>
<td>3</td>
<td>cm.</td>
</tr>
<tr>
<td></td>
<td>(Arms and Shoulder)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Strength</td>
<td>Grip Strength tests</td>
<td>2</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>(Hand grip)</td>
<td>(Grip Dynamometer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Strength</td>
<td>Back Strength tests</td>
<td>2</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>(Back)</td>
<td>(Back Dynamometer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Endurance</td>
<td>800 meter Run</td>
<td>1</td>
<td>Min &amp; sec</td>
</tr>
</tbody>
</table>

### 3.4 Tester Competency

To ensure that the investigator was well versed with the technique of conducting the field tests as well as for taking various anthropometric measurements, the investigator had a number of practice sessions in the testing procedure (particularly of anthropometric measurements), under the guidance of an expert. Tester reliability was established by the test-retest method, whereby, consistency of the results were obtained by product moment correlation by using the formula of Clark & Clark (1970).

The data collected twice, from a random selection of 10 subjects through pilot study, were correlated to obtain the reliability of the data for the selected Anthropometric and Motor Quality variables. The obtained co-efficient of correlation...
between the two sets of data by test and retest method in various Anthropometric measurements and Motor quality variables have been presented in Table 4.

### TABLE 4. Coefficient of Reliability

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>COEFFICIENT OF CORRELATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anthropometric Measurements</strong></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>98</td>
</tr>
<tr>
<td>Weight</td>
<td>97</td>
</tr>
<tr>
<td>Skinfold Measurements</td>
<td>.89</td>
</tr>
<tr>
<td>Bone diameter</td>
<td>.92</td>
</tr>
<tr>
<td>Muscle girth</td>
<td>.90</td>
</tr>
<tr>
<td><strong>Motor Ability Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>.89</td>
</tr>
<tr>
<td>Agility</td>
<td>.86</td>
</tr>
<tr>
<td>Explosive Strength (Lower Extremities)</td>
<td>.92</td>
</tr>
<tr>
<td>Explosive Strength (Arms &amp; Shoulder)</td>
<td>.93</td>
</tr>
<tr>
<td>Strength (Grip)</td>
<td>.93</td>
</tr>
<tr>
<td>Strength (Back)</td>
<td>.94</td>
</tr>
<tr>
<td>Endurance</td>
<td>.90</td>
</tr>
</tbody>
</table>

Since a very high correlation value of .87 to .98 were obtained for the variables, the competency of the tester to administer the tests were established.

### 3.5 Reliability of the Instruments

The Stop watches, Weighing machine, Grip dynamometer (Synoh, Japan), Back dynamometer (Synoh, Japan), Skin fold caliper, Anthropometric Rod, Sliding caliper and Steel tapes used in the study were procurred from the reliable companies. All the instruments were calibrated before the use at different venues of testing. All the
instruments used were available in the Human Performance Laboratory of Sports
Authority of India, Netaji Subhas Eastern Centre, Calcutta and their calibration were
accepted as accurate enough for the purpose of this study.

3.6 Reliability and Validity of Tests

The test and measurements for the present study were conducted according
to the standard procedures adopted by various Researchers and referred by various
Authors in the published literature. Thus the tests and measurements used were valid
and references for these tests have been mentioned during the detailed discussions in the
conductance of the tests.

3.7 Procedure for Administering the Tests

The administration and conductance of the tests and measurements for the
present study were made at different venues of different selected States of Eastern
and North East Region. The data for the present study were collected during the Final
State level selection of the boys between 8-14 years for different scheme of SAI during
the year 1992, 1993 and 1994. Those boys who were screened through district level
selection trial were eligible for the State level selection.

Before the actual administration of the tests the subjects for the present
study were subjected for General Medical Examination and Age Verification by Medical
officers/Sports Medicine experts. Only those children who were medically fit and whose
age were verified by Medical officers were considered for the present study. Before
the actual administration of the field tests for motor abilities, all the Coaches who were
assisting the Scholar were briefed about the procedure of conductance and measure­
ment technique for different tests through demonstration and explanation. The test
were also demonstrated to the subjects before the actual administration of the field tests.
The subjects were subjected to the brief session of warming up before the actual adminis­
tration of the field tests for motor abilities. It was ensured that no physical exercises or
training was done before the field tests sessions. All the Anthropometric measure­
ments and Motor quality tests were administered within one or two days in two or
three sessions depending upon the strength of the subjects at the venues of testing. A
minimum of two hours rest period was given between two sessions of testing programme on the same day. This was done to ensure similar and identical condition for testing and for obtaining reliable data. The Anthropometric measurements and Motor quality tests were conducted in a definite sequence in different session which are presented in table 5.

**TABLE 5. Testing Programme for Medical Examination, Age Verification, Anthropometric Measurements and Motor Quality Tests**

<table>
<thead>
<tr>
<th>SESSION</th>
<th>NAME OF TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Session</td>
<td>1. Medical Examination &amp; Age Verification</td>
</tr>
<tr>
<td></td>
<td>2. Height</td>
</tr>
<tr>
<td></td>
<td>3. Weight</td>
</tr>
<tr>
<td></td>
<td>4. Skinfold Measurements</td>
</tr>
<tr>
<td></td>
<td>5. Muscle Girth Measurements</td>
</tr>
<tr>
<td></td>
<td>6. Bone Diameter Measurement</td>
</tr>
<tr>
<td></td>
<td>7. Grip Strength</td>
</tr>
<tr>
<td></td>
<td>8. Back Strength</td>
</tr>
<tr>
<td>II - Session</td>
<td>1. 30 Meter (Flying Start)</td>
</tr>
<tr>
<td></td>
<td>2. Standing Broad Jump</td>
</tr>
<tr>
<td></td>
<td>3. 6 x 10 Mt. Shuttle Run</td>
</tr>
<tr>
<td>III - Session</td>
<td>1. Standing Vertical Jump</td>
</tr>
<tr>
<td></td>
<td>2. Ball Throw</td>
</tr>
<tr>
<td></td>
<td>3. 800 Meter Run</td>
</tr>
</tbody>
</table>

The participants were divided into groups for Motor quality tests where the numbers of participants were large, in order to conduct the tests simultaneously but in the same sequence. 800 mt. run for endurance were conducted at the last after completing all the other Motor quality tests.
The Anthropometric measurements were taken by the Researcher with the help of expert in a confined room at all venues of testing. The tests for Motor qualities were administered in the field with the marking of 400 meter track at different venues of testing. The data were collected under the direct supervision of the scholar with the help of J.S.O. (Exercise Physiology) of SAI Eastern Centre, Calcutta and Coaches of different games/sports, who were competent enough and experienced in conducting tests, recording items and taking measurements. The details of the procedure of the conductance of the test items are mentioned in the following pages.

3.7.1 The Conductance of Anthropometric Measurements

The anthropometric measurements were taken by adopting the standard procedure as mentioned in the literature.

**Height**

The body height was measured by the calibrated anthropometric rod procured from the reliable Firm. The subject stands erect barefooted with heels, posterior thoracic region and back of the head touching the wall. The distance from the floor to the highest portion of the head were measured with the help of anthropometric rod, which indicated his height. The height was recorded to the nearest centimeter.

**Weight**

The weight of the subject was taken by the weighing machine. The subject wearing short and vest stands at the centre of weighing machine. The weight was recorded correct to the nearest Kilogram.

**Measurement of Girth (Circumference)**

**Bicep**: Measuring steel tape was placed on the upper two-third of the bicep uniformly, the portion which gave the highest measure of the biceps along with the tricep was recorded correct to the nearest centimeter. The right hand of the subject was used to determine the girth.
Fig. 2 Research Scholar Measuring Biceps Girth (Circumference)
Calf: Measuring steel tape was placed on the calf region uniformly and the portion which gave the highest measure of the calf was recorded correct to the nearest centimeter. The right leg was used to determine the calf girth.

Measurement of Bone Diameter

Biacromial Diameter: The most lateral margin of the acromial processes of the subject was measured by sliding caliper with elbow flexed position. The Humerus diameter was recorded to the nearest centimeter.

Knee Diameter: The widest margin between the lateral and medial epicondyles of the femur was measured with the help of sliding caliper, with the subject sitting on stool and knee flexed to 90°. The knee diameter was recorded to the nearest centimeter.

Body Fat

A Harpenden skinfold caliper was used to assess the body fat percentage. The instrument consists of accurately calibrated dial which indicates in millimeter the thickness of the skinfold when the jaws are open, holding the skinfold.

The right side of the body was used to determine the percentage of fat. The thickness of the skin and subcutaneous fat was grasped between the thumb and index finger and measurement was taken to the nearest millimeter from four different sites of the body using the skinfold caliper.

To eliminate errors the reading was made between three to four seconds when essentially all compression has taken place and the measurement were stabilized. If this precaution was not taken, the skinfold would have gradually decreased because of the tissues being squeezed out from the jaws of caliper.

The skinfold measurements were taken at the following prescribed site of the body:

Bicep: The skinfold was lifted over the bieep muscle at a point halfway between the forearm and the tip of the elbow.
Fig. 3 Exercise Physiology Expert Measuring Elbow Diameter

Fig. 4 Exercise Physiology Expert taking Skinfold Measurement
Tricep: The skinfold measure was obtained over the triceps of the acromial process and olecranon process. When the arm was hanging freely, the skinfold was lifted parallel to the long axis of the right arm one centimeter above the site and measurement was taken about one centimeter below this.

Sub-scapula: The skinfold was lifted at the tip of the right scapula on a diagonal plane of about 45° from the horizontal when the subject remained in a relaxed standing position. The measurement was taken about one centimeter laterally below this site.

Supra-illiac: The measurement was taken just above the crest of the ilium at the mid axillary line. The fold was lifted diagonally, following the natural line of the iliac crest.

Calf: The measurement was taken at the level of the maximum circumference of the calf on the medial border of the leg.

The skinfold thickness at the site of biceps, triceps, sub-scapular and supra-illiac were used to calculate the fat percentage. The Body fat percentage was calculated by using the formula of Siri (1961)

Somatotype

Somatotype H-C method was used for the description of morphological confirmation. Somatotype were expressed in three numerical ratings, consisting of three sequential numerals always recorded in the same order which represented endomorphy, mesomorphy and ectomorphy component.

Height, weight, bi-epicondylar diameter of humerus and femur, bicep and calf girths and skinfold measurements at the site of calf were used for evaluation of the somatotype. Somatotype (H.C) was calculated by using the equation of modified Heath and Carter (1967).
3.7.2 Conductance of Motor Quality tests

30 Meter Run (Flying Start)
(SAI. Manual, 1992)

Aim : To measure the maximum running speed.

Equipment : Stop watch (1/100 of a second) 5 flag posts, 45 meter running strip, Measuring tape, Rope.

Marking : A 45 meter distance of standard width was divided into two zones of 15 meters and 30 meters respectively. (As shown in Fig.5) AB was of 15 meters and BC was of 30 meters. A radius of 30 meters was taken and arcs were marked from point B and C intersecting at point D. Then DB was joined and extend up to E and DC was joined and extend up to F. Flags were fixed at point D, G, E, H, & F.

Procedure : The subject started from behind the line A on the command “Read go” and accelerated, ran and crossed the line C with maximum possible speed through the running lane.

Scoring : The time-keeper was standing on point D and when the runner came in line with the flag GE, he started the watch and when the torso of the runner came in line with HF he stopped the watch. The time was recorded to the nearest 1/100 of the seconds.
Fig. 5: 30 Meter (Flying Start)
6 x 10 Meter Shuttle Run
(SAI Manual, 1992)

Aim : To test the agility of the subject in running and changing direction.

Equipment : Stopwatch, Wooden clapper, Lime powder.

Marking : 10 meters of distance were marked by two parallel lines of 5 meters each. A straight line was marked from the centre of parallel line to enable to run two subjects at a time.

Procedure : The subjects started form behind the starting line. On the signal of "ready and sound of clapper", the subject ran faster, went nearest to other line and touched with hand (Fig.6) turned and ran back to starting line, touched it with hand, turned and repeated it for a total of six times. Two subjects ran at a time.

Scoring : The time to the nearest of 1/100 of a scored were recorded as score of the test.

Standing Broad Jump
(AAHPER, 1976)

Aim : To measure the explosive strength of the legs in jumping forward.

Equipment : Steel measuring tape, long jump pit or sand pit, take off board or lime marking.

Marking : A line were marked near the edge of the jumping pit in case take off board was not available.
Fig. 6. 6 x 10 Mt Shuttle Run

Fig. 7. Standing Broad Jump (SBJ)
Procedure: The subjects were asked to stand behind the take off line with feet parallel, approximately hip width apart. Then the subjects were asked to bend the knees and swing the arms and then to jump as far forward as possible to cover the maximum horizontal distance. Three trials were given to the subject. (Fig. 7)

Scoring: The distance covered in centimeters between the inner edge of the take off line and the nearest landing mark (heels) was measured and recorded as the score of the subject.

Standing Vertical Jump
(Verduci, 1980)

Aim: To measure the explosive strength of the legs in jumping vertically upward.

Equipment: Chalk powder, Measuring tape, Duster, Bench & Box.

Marking: A smooth wall with smooth surface of one meter width were marked in centimeters upto 3.25 meter.

Procedure: The subject was asked to stand against the wall with one side toward the wall with heels together and arms extended fully without raising his heels. The subjects marked point on the wall with his fingers dipped in chalk powder. Then the subject was asked to jump as high as he could and make a point further up on the wall at the peak of the jump. The reading was noted by keeping eyes in level with the chalk mark on the graduated marking.
Scoring : The standing reach was subtracted from the jump and reach. Three chances were given. The best out of the three was recorded to nearest cms. as the score of the subject.

Ball Throw
(SASI. Manual, 1992)

Aim : To measure the explosive strength of arms and shoulder and coordination of the upper body.

Equipment : 400 grams Mini Basketball, Steel measuring tape.

Marking : A shot put circle probably with toe board.

Procedure : The subject was asked to sit in the centre of the circle assuming stable sitting position (legs extended and apart). The subject holds the mini basketball by both the hands and takes it behind and overhead by flexing elbow joint. With simultaneous extension of elbows and forward swing of upper body the ball was thrown in forward direction as far as possible. Three chances were given to each subject (Fig. 8).

Scoring : The distance measured in centimeters from the centre of the circle to the point where the ball lands first was recorded as the score of the subject.
Fig. 8: Ball Throw Test
Grip Strength Test  
(Jensen & Hirst, 1980)

Aim : To assess the hand grip strength.

Equipment : Grip Dynamometer.

Procedure : The grip dynamometer was used to secure strength score of the grip of each hand. The dynamometer had an adjustable handle to fit the size of the hand and a maximum needle indicator for case of scoring. The scoring dial were marked off in kilogram. The concern edge of the dynamometer was placed between the first and second joint of the fingers with the dial toward the outside of the palm. The subjects were asked to stand straight and take the testing hand to the side. Then they were asked to squeeze the instrument provided they did not hit any object with their fist. The right grip was tested first (Fig. 9).

Scoring : Grip strength of a subject was taken by Grip Dynamometer to the nearest kilogram.

Back Strength Test  
(Jensen and Hirst, 1980)

Aim : To assess the back strength

Equipment : Back Dynamometer.

Procedure : The back dynamometer was used to secure the strength scores of the back muscles. The dynamometer had an adjustable handle with iron chain, which can be adjusted according to the height of the subjects. The scoring dial were marked off in kilogram. The subject was asked to
Fig. 9  Grip Dynamometer Test

Fig. 10  Back Dynamometer Test
stand on the base of dynamometer. The bar of the handle was adjusted according to the height of the subject. The subject hold the handle bar with alternate grip and was asked to pull it up keeping the knee straight and using only the back muscles (Fig. 10).

Scoring : Back strength of the subject was taken by Back Dynamometer to the nearest kilogram.

800 Meter Run
(Disch, et al. (1975))

Aim : To measure the cardio-vascular endurance.

Equipment : Stop watches, wooden clapper.

Marking : 400 meters distance were marked with 2 straight and 2 curves on the field as on a 400 meters track.

Procedure : The 800 Meter Run test was conducted in the standard 400 meter track. 10 to 15 subjects ran for the test at a time. The subjects were assembled at the starting line before taking the test. They were instructed to run two round of the track i.e. 800 meters in the minimum possible time. On the signal “Ready, sound of clapper” all the subjects started running and completed the distance. The tester had assistants in conducting the tests to record the timing and the order of finishing of 10-15 subjects. After the subjects had ran for a given distance, the timing of each subject was recorded by the time keeper. The subjects were not allowed to run with the spikes.

Score : The time in minutes and seconds were recorded as the score of the subjects.
3.8 Environmental Condition

During testing in the confined room at different places of ER & NER States, the temperature and humidity were varying from 25°C to 30°C and 65% to 75% respectively. The temperature and humidity during the field tests also were varying from 20°C to 25°C and 50% to 60% in the North East Region (in most of the places). The temperature and humidity were varying from 27°C to 32°C and 70% to 80% respectively in most of the places of Eastern Region.

3.9 Statistical Analysis

Statistical analysis used were the mean, standard deviation, Analysis of variance (ANOVA) to find out significance of difference among and between different age groups, coefficient of correlation “r” was used to establish relationship between Anthropometric and Motor quality variables and Percentile Ranking was used to set the norms for different selected tests. All the statistical analysis of the data were made through Computer.