CHAPTER III
SUBJECTS AND METHODS

- Research Design
- Area
- Variables
- Technique
- Sample
- Age Assessment
- Analytical Procedure
Location of JNV & KV in Chhattisgarh
Research design:

A cross sectional study on the growth pattern, nutritional and health status, motor quality and body composition has been made on 900 boys, aged 10-18 yrs in Jawahar Navodaya Vidyalaya (JNV) and Kendriya Vidyalaya (KV) of Chhattisgarh. The study aimed to find out the growth pattern, nutritional and health status, body composition and fitness status of JNV boys, which is a residential school of children, predominantly from the rural areas and was compared with the boys of KV, a non-residential school of children of central government employees. The target schools were intentionally selected. The JNV boys under study residing in the hostel of schools belonged to various geographically scattered locations / villages of Chhattisgarh, which can be taken as fairly representatives of rural areas of Chhattisgarh. They mostly belong to the most vulnerable segment of the under privileged communities i.e. ST, SC, and OBC. The KV boys under study residing at home belonged to urban area and were predominantly representatives of general caste. These comparative study offer insight in to issues of geographic variations (Rural and Urban), socio-economic variations, ethnic variations and life style variation on growth, nutritional, physiological and physical fitness status of JNV and KV boys.

Area:

The study was conducted in Jawahar Navodaya Vidyalaya (residential higher secondary school for rural children) and Kendriya Vidyalaya (non-residential higher secondary school, mostly for urban children) situated in 08 districts of Chhattisgarh state, which are mentioned below :-

Jawahar Navodaya Vidyalaya:

1. Jawahar Navodaya Vidyalaya, Mana Camp, District Raipur.
5. Jawahar Navodaya Vidyalaya, Malahar, District Bilaspur.

Kendriya Vidyalaya:
5. Kendriya Vidyalaya, Bilaspur, District Bilaspur.

Variables:
The variables selected were classified into four categories namely:

I. Anthropometric
II. Physiological
III. Physical fitness
IV. Nutritional

Anthropometric variables:

Composite measurements
1. Body weight (kg)
2. Stature (cm)

**Vertical or linear measurements (cm)**
3. Sitting height
4. Length of upper extremity
5. Length of lower extremity

**Transverse measurements (cm)**
6. Humerus bi-epicondylar diameter
7. Femur bi-epicondylar diameter
8. Biacromial diameter
9. Biiliocristal diameter
10. Wrist breadth
11. Ankle breadth

**Girth measurements (cm)**
12. Mid-upper arm circumference
13. Calf circumference
14. Thigh circumference
15. Chest circumference (normal)
16. Chest circumference (expanded)

**Skinfold thickness (mm)**
17. Biceps skinfold
18. Triceps skinfold
19. Subscapular skinfold
20. Supraspinale skinfold
21. Supraliliac skinfold
22. Abdominal skinfold
23. Calf skinfold
24. Thigh skinfold
25. Forearm skinfold

**Physiological variables:**

1. Heart rate
2. Respiratory rate
3. Peak flow rate
4. Blood pressure - systolic
5. Blood pressure – diastolic

**Physical fitness variables:**

1. Vertical jump
2. Standing broad jump
3. Bend knee sit-ups
4. Sit & reach test
5. Pull-up test

**Nutritional variables:**

1. Dietary pattern
2. Nutritional anthropometry
3. Clinical signs of malnutrition survey

**Technique:**

In the present study cross-sectional method was applied for the assessment of growth pattern. The techniques of taking measurements were those of Martin & Saller, (1957) and Weiner & Lourie, (1981), Singh and Bhasin, (1968) and Singh & Malhotra, (1989) for anthropometric measurements. To measure various anthropometric variables standard instruments, Weighing machine, GMP Skin fold caliper, GMP Anthropometer, sliding calliper, measuring tape were used. These instruments were reliably calibrated and accurated and are utilized by scientist in the field of anthropology and sports anthropology.
Physical growth:

Tanner, (1962) states "selection of technique and measurements depend upon the purpose of the study". In the present study various anthropometric measurements were taken to assess growth pattern, body proportion, somatotype, body composition and for the evaluation of physiological variables, physical fitness components and nutritional & health status.

Following anthropometric measurements were taken according to standard methods following IBP recommendation (Weiner & Lourie, 1981) and Singh and Bhasin, (1968) and Singh and Malhotra, (1989).

Composite measurements:

Body weight:

Weighing machine was used for recording body weight. Weighing machine was placed on plain surface and the boy was made to stand on the centre of platform bare foot without support. Extra clothing and shoes were removed. Body weight recorded in Kilogram (kg).

Stature:

Anthropometer was used to measure the height. The boy was made to stand upright barefoot and without raising the heels from the ground. Then the horizontal bar of the Anthropometer was lowered until it touches the head. The measurement was taken carefully and the bar was not allowed to press the head. The reading to the nearest half cm was recorded.

Sitting height:

This measurement was also taken by Anthropometer. The boy was allowed to sit on a horizontal surface with stretching his vertebral column to the maximum. Then Anthropometer was held at the back of the subject and measurement was recorded.
Length of upper extremity:

With the subject's arm and hand fully extended by his side, the tip of one arm of the Anthropometer was placed at the inferior border of the acromion process. The distance from acromion to the tip of longest finger was measured.

Length of lower extremity:

This parameter is obtained indirectly for each subject by subtracting the sitting height measurement from his stature measurement.

Transverse measurements:

All the Transverse measurements viz. humerus bi-epicondylar diameter, femur bi-epicondylar diameter, biacromial diameter, biiliocristal diameter, wrist breadth and ankle breadth was measured in cm with sliding caliper.

Biarcromial diameter:

First segment of anthropometer or rod compass was used for taking this measurement. The subject was told to keep his shoulders straight and then the measurement was recorded.

Biiliocristal diameter:

The subject was told to keep his feet close to each other. Then the measurement was taken by keeping the first segment of anthropometer between two iliac bones with the help of cross bars.

Girth measurements:

All the girth measurements viz. mid-upper arm circumference, calf circumference, thigh circumference, chest circumference (normal), chest circumference (expanded) was measured in cm with non-stretchable glass tape.

Skinfold measurements:

Skinfold measurements viz., biceps skinfold, triceps skinfold, subscapular
Skinfold, supraspinale skinfold, suprailiac skinfold, abdominal skinfold, calf skinfold, thigh skinfold and forearm skinfold, were measured by GPM skinfold calliper having a pressure of 10 g/mm² of contact surface area. A fold of skin was picked up at respective site and the caliper was applied a little below from fold and then reading was taken in mm following the method of Weiner & Lourie, (1981). Each skinfold measurement was recorded to the nearest 0.5 mm. Triceps skinfold was measured over the triceps muscle at the same level as relaxed arm circumference, i.e. between the and acromial processes. The skinfold was held parallel for the longitudinal axis of the upper arm. The subscapular skinfold was taken below the inferior angle of the left scapula with the skinfold following the natural cleavage line of the skin. The suprailiac skinfold was measured just above the right iliac in the mid-axillary with the fold perpendicular to it. The calf skinfold was measured at the level of maximal circumference on the aspect of the right calf, with the fold parallel to the longitudinal axis of the leg. The biceps skinfold was measured at the level of mid-point of the distance between the inferior border of the acromion process and the external superior border of the head of radius, in line with the cubital fossa. The suprailiac skinfold is taken about one cm above and two cm medial to the anterior superior iliac spine. The skinfold was picked up at the above mentioned site and measured with a skinfold calliper. The abdominal skinfold is taken at the level of the umbilicus about five cm lateral to it.

Log transformation of skinfold measurements were done as per the following formula (Edwards, D.A.W. et al, 1955).

\[ 100 \times \log_{10} (\text{mm} \times 10^{-18}) \]

Physical fitness variables:

To study fitness status following tests was administered on each subject (Baumgartner & Jackson, 1995), (AAHPER, 1976; AAHPERD, 1980); (AAHPERD Physical best Tests (1989)) and (Texas, 1973).
Vertical jump:

It tests the explosive strength of the leg and extensibility of hip. The subject reaches upward with a chalk in hand from the standing position and puts at maximum in the wall, then he squats and jumps as high as possible and marks the wall. The height of the jump is the measured distance between standing and jumping height.

Standing broad jump:

This test assesses the explosive strength of leg. Students stand behind a line feet apart about shoulder width. The subject squats and jumps horizontally as far as possible the distance is recorded, best of three trials is taken.

Bend knee sit-Ups:

This test evaluates abdominal muscular strength and endurance. The subject lies on back with knee flexed and feet on floor, heels 12 to 18" from the buttocks. Arms are crossed on chest with hands on opposite shoulder. The subject tightens his abdominal muscles curls to sitting position touching elbow to thigh then he return down, number of sit-ups in 60 second are recorded.

Sit and reach test:

This test is used to measure the flexibility of the lower back and posterior thigh. The subject without shoes, sits at the test apparatus with knee fully extended and keeps feet shoulder width apart. The subject extends the arms forward with hands placed on top of each other, holds the position of maximum reach, on the fourth trial, and holds this position for one second the point reached is recorded.

Pull-up test (modified):

For this test, the boy lies down on his back with the shoulders directly under a bar that has been set 1 to 2 inches above the boy’s reach. The boy grasps the bar with an overhand grip (palms away from the body). From this “down” position with the arms and legs straight, buttocks off the floor, and only the heels touching the floor, the
boy pulls until the chin reaches an elastic band placed on the pull-up equipment. The band is set 7 inches below the pull-up bar. No. of pull ups in 60 sec. are counted.

**Physiological variables:**

Following physiological variables were measured (Goyal and Patel, 2005):

**Heart rate:**

Heart rate was conveniently measured as pulse rate by palpation of the radial artery at the wrist (with the help of three fingers), the number of beats occurring in half minute being counted and doubled to give the rate per minute by using stop watch.

**Respiratory rate:**

Respiratory rate is the breathing frequency per minute which was observed by keeping hand on chest of the subject for one minute and number of times air inhaled / exhaled was recorded.

**Peak flow rate:**

Peak flow rate was measured with the help of peak flow meter, the subject stands in erect position, inserts the mouthpiece in to mouth he then takes a deep breath seals lips around the mouth piece and then blows out as hard as possible. The reading of the pointer is recorded.

**Blood pressure:**

Blood pressure was measured with the help of sphygmomanometer, the arm and body of the subject should be as relaxed as possible and his mind at rest. The cuff is wrapped snugly around the left arm in level with the heart. The examiner firmly places the stethoscope bell on the brachial artery just above the elbow and slightly toward the inside. When the first pulse sound is audible, the examiner notes the reading on the mercury column or gauge in millimetres Hg. This is the systolic pressure.
The cuff pressure is released continually until a dull, forceless beat is heard this is the diastolic pressure. When both pressures are recorded they appear as a fraction, with systolic pressure over diastolic pressure.

**Body Proportion:**

Following indices were calculated to know the body proportion:

**Relative upper extremity index:**

\[
\frac{\text{Total arm length (cm)}}{\text{Stature(cm)}} \times 100
\]

According to Brugsch et.al. (c.f. Singh and Bhasin, 1968).

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>up to 44</td>
</tr>
<tr>
<td>2</td>
<td>From 44.1 to 44.5</td>
</tr>
<tr>
<td>3</td>
<td>From 44.6 to above</td>
</tr>
</tbody>
</table>

**Relative lower extremity index:**

\[
\frac{\text{Total leg length (cm)}}{\text{Stature}} \times 100
\]

According to Brugsch et.al. (c.f. Singh and Bhasin, 1968).

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>up to 53.5</td>
</tr>
<tr>
<td>2</td>
<td>From 53.6 to 54.0</td>
</tr>
<tr>
<td>3</td>
<td>From 54.1 to above</td>
</tr>
</tbody>
</table>

**Relative Biacromial breadth index:**

\[
\frac{\text{Biacromial diameter (cm)}}{\text{Stature(cm)}} \times 100
\]
According to Brugsch (c.f. Singh and Bhasin, 1968).

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 up to 22 &amp; below</td>
<td>Narrow shoulders</td>
</tr>
<tr>
<td>2 From 22.1 to 23</td>
<td>Medium shoulders</td>
</tr>
<tr>
<td>3 From 23.1 to above</td>
<td>Broad shoulders</td>
</tr>
</tbody>
</table>

Relative bicristal breadth index:

\[
\text{Bicristal diameter (cm)} \times \frac{100}{\text{Stature (cm)}}
\]

According to Brugsch (c.f. Singh and Bhasin, 1968).

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 up to 16.4 &amp; below</td>
<td>Narrow pelvic</td>
</tr>
<tr>
<td>2 From 16.5 to 17.4</td>
<td>Medium pelvic</td>
</tr>
<tr>
<td>3 From 17.5 to above</td>
<td>Broad pelvic</td>
</tr>
</tbody>
</table>

Relative chest girth index:

\[
\text{Chest Circumference (cm)} \times \frac{100}{\text{Stature (cm)}}
\]

According to Martin and Saller (c.f. Singh and Bhasin, 1968).

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 up to 50.9</td>
<td>Narrow chest</td>
</tr>
<tr>
<td>2 From 51 to 55.9</td>
<td>Medium chest</td>
</tr>
<tr>
<td>3 From 56 &amp; above</td>
<td>Broad chest</td>
</tr>
</tbody>
</table>

Relative sitting height index:

\[
\text{Sitting Height (cm)} \times \frac{100}{\text{Stature (cm)}}
\]

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 up to 50.9</td>
<td>Brachycormic</td>
</tr>
<tr>
<td>2 From 51 to 52.9</td>
<td>Metriocormic</td>
</tr>
<tr>
<td>3 From 53 to above</td>
<td>Macrocoramic</td>
</tr>
</tbody>
</table>
Body composition:

Body fat percentage:
It is body fat mass in terms of percentage and was estimated from the equation of Katch and McArdle (1973)

\[
\text{Body fat (\%)} = 0.43 \times A + 0.58 \times B + 1.47
\]

\( A = \) Triceps fat fold (mm)

\( B = \) Subscapular fat fold (mm)

Absolute (total) body fat mass (kg):
It includes 3% essential fat plus storage (non-essential) fat

\[
\text{Percent fat}
\]

\[
\text{Absolute Body Fat Mass (kg)} = \frac{\text{Percent fat}}{100} \times \text{Body mass}
\]

Essential fat mass (kg):
It is lipid rich store (as much as 3% of body mass in males) in bone marrow, brain, spinal cord and internal organs.

\[
\text{Essential Fat Mass (kg)} = \frac{3}{100} \times \text{Body mass}
\]

Storage (Non-essential) fat mass (kg):
It is the storage fat that accumulates in adipose tissues, subcutaneous regions and serves as nutritional reserve to protect the various internal organs trauma.

\[
\text{Storage fat Mass (kg)} = \text{Total body fat mass (kg)} - \text{Essential fat mass (kg)}
\]

Lean body mass (kg):
It is composed of essential fat (+ sex specific reserve fat in females); muscles and bones. It is considered as fat free mass.

\[
\text{LBM} = \text{Body mass (kg)} - \text{Storage fat mass (kg)}
\]
Body surface area:

Body Surface Area (A) (in Sq.m.) = \( w^{0.425} \times H^{0.725} \times 71.84 \)

Nutritional anthropometry:

In the present study the nutritional indices suggested by Jelliffe, (1966); Gomez et al, (1955); Waterlow, (1972) and Body mass index (WHO, 1995; Ferro-Luzzi et al, 1992), Pelidisi's (Mason, 1931) and Ponderal (Comas, 1960) indices were used for evaluation and grading of nutritional and health status. The NCHS Growth standards (Frisancho, 1990), and ICMR standards, (1989) were used as reference.

Body mass index (BMI):

It is the ratio of weight (kg) to stature(m)^2

It is an age independent nutritional index. Following categories of nutritional status can be derived as per Ferro-Luzzi et al (1992):

\[
\text{BMI} = \frac{\text{Weight (kg)}}{\text{Stature (m)}^2}
\]

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Nutritional Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>I &gt; 18.5</td>
<td>Normal nutritional status</td>
</tr>
<tr>
<td>II 17.0 - 18.49</td>
<td>Mild or Grade I malnutrition</td>
</tr>
<tr>
<td>III 16.0 - 16.99</td>
<td>Moderate or Grade II malnutrition</td>
</tr>
<tr>
<td>IV &lt; 16.0</td>
<td>Severe or Grade III malnutrition</td>
</tr>
</tbody>
</table>

Weight for age (%):

According to Gomez et al. (1955):

\[
\text{Weight for age (%) = } \frac{\text{Observed weight (kg) at particular age}}{\text{Standard weight (kg) at that age}} \times 100
\]
<table>
<thead>
<tr>
<th>Range Variation</th>
<th>Category / Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>2</td>
<td>75-90</td>
</tr>
<tr>
<td>3</td>
<td>60-75</td>
</tr>
<tr>
<td>4</td>
<td>&lt; 60</td>
</tr>
</tbody>
</table>

**Height for age (%):**

According to Waterlow classification (1972):

\[
\text{Height for age (\%)} = \frac{\text{Observed height (cm) at particular age}}{\text{Standard height (cm) at that age}} \times 100
\]

<table>
<thead>
<tr>
<th>Range Variation</th>
<th>Category / Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>2</td>
<td>80-90</td>
</tr>
<tr>
<td>3</td>
<td>70-80</td>
</tr>
<tr>
<td>4</td>
<td>&lt; 70</td>
</tr>
</tbody>
</table>

**Ponderal index:**

\[
\text{Ponderal index} = \frac{\text{Height (cm)}}{\sqrt[3]{\text{Weight (kg)}}}
\]

According to (c.f. Comas, 1960)

<table>
<thead>
<tr>
<th>Range Variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>up to 38.3 below</td>
</tr>
<tr>
<td>2</td>
<td>From 38.4 to 40</td>
</tr>
<tr>
<td>3</td>
<td>From 40 to 41.7</td>
</tr>
<tr>
<td>4</td>
<td>From 41.8 to 43.4</td>
</tr>
<tr>
<td>5</td>
<td>From 43.5 to 45.1</td>
</tr>
<tr>
<td>6</td>
<td>From 45.2 to 46.8</td>
</tr>
<tr>
<td>7</td>
<td>From 46.9 and above</td>
</tr>
</tbody>
</table>
Pelidisi's index:

\[ \frac{\sqrt[3]{10 \times \text{Weight (gm)}}}{\text{Sitting height (cm)}} \times 100 \]

According to Mason, 1931

<table>
<thead>
<tr>
<th>Range variation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 up to 92.0</td>
<td>Distinctly low state of nutrition</td>
</tr>
<tr>
<td>2 From 92.1-95.0</td>
<td>State of mild under nutrition</td>
</tr>
<tr>
<td>3 From 95.1-100.0</td>
<td>Normal state of nutrition</td>
</tr>
<tr>
<td>4 From 100.1-105.0</td>
<td>Middle overweight</td>
</tr>
<tr>
<td>5 From 105.1 to above</td>
<td>Obese</td>
</tr>
</tbody>
</table>

**Somatotype rating:**

Somatotype rating was done on each subject according to Carter, (1980).

**Endomorphy:**

The endomorphy or the first component indicates the relative fatness. The measurements required for endomorphy rating are skinfold at triceps, subscapular and supraspinal. With the following equation of Carter (1980) exact decimal rating of endomorphy was obtained:

Correct sum of skinfolds = (Sum of skinfolds/ Stature) X 170.18

Endomorphy = -0.7182 + 0.1451(X) - 0.00068 (X)^2 + 0.0000014 (X)^3

where X is the corrected sum of triceps, subscapular and supraspinal skinfold.

**Mesomorphy:**

With the following equation of Carter (1980) exact decimal ratings of Mesomorphy was obtained:

Mesomorphy = 0.858 \times HB + 0.601 \times FB + 0.188 \times CAC + 0.161 \times CCC - (Height \times 0.131) + 4.50
Where HB denotes Humerus biepicondylar diameter.

FB denotes Femur biepicondylar diameter

CAC denotes Corrected Arm Circumference;

CCC denotes Corrected Calf circumference

**Ectomorphy :**

\[ \text{Ectomorph} = \text{HWR} \times 0.732 - 28.58 \]

Where HWR denotes Height Weight Ratio.

**Health status:**

In the present study Nutritional & Health status was evaluated with the help of dietary survey and nutritional anthropometry.

**Diet survey:**

Diet survey was conducted by step method as suggested by Rao et al, (1986). Quantitative dietary assessment was made by weightment of raw food items and simultaneously cooked food in order to estimate the individual daily intake of food. Food intake for three consecutive days from each subject was recorded.

Prior to the survey, the cook of the hostels of JNV and housewives of households of KV boys were acquainted with the method of survey and requested to start the cooking after weighing of raw food items by the investigator early in the morning and again in the evening. All the raw food items used for the day were weighed using a standard balance. The volume of cooked food was recorded by two standardised measuring unit spoon and bowl. Investigator requested to serve the cooked food by means of standardised spoon and bowl. Later on, actual quantity was calculated by converting the volume of each food item in terms of raw food and individual intake of raw food was calculated.

Individual intake of raw food was calculated as follows.
Finally the food and nutrient intake was calculated. The mean nutrient intake of the surveyed children was taken out. The nutrient intake was calculated from the food consumption tables given in the "Nutritive value of Indian Food" (Gopalan et al, 2002). The mean nutrient intake per person per day was also taken out.

**Clinical signs of malnutrition survey:**

Clinical signs of nutritional deficiency survey were conducted on each boy as recommended by Jelliffe, (1966) and W.H.O., (1995).

The investigator took a special training in the laboratory of school of Studies in Anthropology, Pt. Ravishankar Shukla University, Raipur (C.G.) and also by the Doctor of school in order to maintain accuracy and uniformity in clinical sign investigation. In addition, detailed information about socio, cultural and ecological factors were collected from children as well as teachers and parents of children and recorded in questionnaire cum schedule.

**Socio-economic factors:**

**Occupation of family members**

A Business  
B Farmer  
C Govt. Service  
D Labour  
E Private Service

**Family size**

A Small family (1 to 4 member)  
B Medium family (5 to 8 member)  
C Large family (9 and above)
Family income
A Below 1200 per capita
B 1200-2400 per capita
C 2400-3600 per capita
D Above – 3600 per capita

Education level
Father's Education
A Illiterate
B Literate
C Primary school
D Middle school
E Metric
F Graduate
G Post graduate

Education level
Mother's Education
A Illiterate
B Literate
C Primary school
D Middle school
E Metric
F Graduate
G Post graduate

Sample:
The sample of the present study was collected from various JNV and KV schools of Chhattisgarh. The sample size consists of 900 boys aged 10+ to 18+ years (450 from JNV and 450 from KV). Four category of ethnic identification were established into which every child was classified. Based upon surname and certificate issued by the Government, 36.22% ST, 19.33% SC, 31.55% OBC and 12.22% General boys were identified in JNV and 10.88% ST, 22.44% SC, 22.44% OBC
and 44.22% General boys were identified in KV. The caste category percentage breakdown for JNV and KV is summarised in Table 3.1, which indicates a higher percentage of ST and SC boys in JNV and higher percentage of boys belonging to general caste in KV.

### Distribution of Sample

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
<td>OBC</td>
</tr>
<tr>
<td>10+ NV</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>11+ NV</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>12+ NV</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>13+ NV</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>14+ NV</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>15+ NV</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>16+ NV</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>17+ NV</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>18+ NV</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>Sub Total</td>
<td>58(12.22%)</td>
<td>142(31.55%)</td>
</tr>
<tr>
<td>10+ KV</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>11+ KV</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>12+KV</td>
<td>26</td>
<td>13</td>
</tr>
<tr>
<td>13+ KV</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>14+KV</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>15+ KV</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>16+ KV</td>
<td>28</td>
<td>7</td>
</tr>
<tr>
<td>17+ KV</td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>18+ KV</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>Sub Total</td>
<td>199(44.22%)</td>
<td>101(22.44%)</td>
</tr>
</tbody>
</table>
Age assessment:

In a growth study recording of the correct age is an important factor. In view of this every effort was made to get the same. Age of each subject was recorded from school admission register. Later on it was verified from the respective parent of each subject. In many cases the subject themselves could give the exact date of birth. The age grouping was done according to an International convention of expressing the age at the last birthday (Mitra et al, 2002). All the children who had completed 10 years but less than 11 years were considered in the age group of 10+ years. The whole data was arranged into age groups from 10 to 18 years with one-year class interval.

Analytical procedure:

All statistical analysis was performed on a computer programs known as the statistical package for the social science (SPSS) (Nie et al, 1975). Analysis of data was done by using descriptive method where mean, standard deviation (SD) and co-efficient of variation (CV) for each age group were calculated. Comparative analysis was done to observe difference between the two groups by applying ‘t’-test. Correlation statistics was used to find out relationship between various variables and regression was done to see the direction of relationship between variables.

Absolute growth, rate of growth, growth gradient and percentiles were also calculated with the following method:

Absolute growth:

Absolute growth of a character (difference of mean) is calculated by subtracting the mean value of the lower age group from that of the next higher age group

Absolute growth = $X_2 - X_1$
Where:
\[ X_1 \] - Mean of lower age
\[ X_2 \] - Mean of higher age

Rate of growth:
\[
\text{Rate of growth} = \frac{(X_2 - X_1)}{X_1} \times 100
\]
Where:
\[ X_1 \] - Mean of lower age
\[ X_2 \] - Mean of higher age

Growth gradients:
It was calculated to indicate the level of maturity of a variable at any given age, as compared to its mature size. For the present study the last age group (18+ years) stands as the level of maturity for calculating gradients of various body dimensions. The formula used is:
\[
\text{Growth gradient} = \frac{X_{10} \text{ or } X_{11} \text{ or } \ldots \ldots \text{ or } X_{18}}{X_{18}} \times 100
\]
Where \( X_{10} \) stands of mean of first age group
\( X_{18} \) stands of mean of last age

Graphical presentation of data was done wherever it was necessary.

Distance Curve:
Distance curve for each anthropometric variable is obtained by plotting in graph the mean values of the character in different age group taking age groups as abscissa and mean values as ordinate.

Velocity Curve:
Velocity curve for each anthropometric variable is obtained by plotting in graph the relative growth per annum taking age groups as abscissa and relative growth per annum as ordinate.