MATERIAL AND METHODS
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1100 children belonging to upper socio-economic status were studied.

(A) Selection of Cases

Proper consideration to the socio-economic status was the key to this study and, therefore, strict selection criteria was applied by employing an "Extended Kuppuswamy Scale". Kuppuswamy (1962) devised a technique by which numerical scores are assigned according to education, income and occupation of the individuals to know the socio-economic class. However, it was felt that although these three variables are very important determinants of the socio-economic class, there are at least two more factors which affect the health status of any subject. These are:

(a) General standard of living, and
(b) Health awareness

General standard of living is a factor which can be, to a great extent, independent of the factors described by Kuppuswamy, e.g. there are families with good income and prestigious occupation like high business class, yet their way of life is not necessarily conducive to good health.
Health awareness, similarly, is another factor which may not relate well with income in certain cases. Attitude towards health may be unwholesome because of lack of knowledge, traditional beliefs and religious taboos rather than any problem of affording.

In view of these observations we had extended the Kuppuswamy Scale by inclusion of these two factors.

The detailed scoring system of this "Extended Kuppuswamy Scale" is deputed in the attached Annexure.

(B) Collection of Sample

Only absolutely healthy children with no history of any illness within the last four weeks were selected for the study. Children were drawn from high-class schools who cater only to the affluent strata.

(C) Criteria for Exclusion

Any subject who had any of the following problems was excluded from the study:

1. Infectious diseases like measles, polio, etc. within the last 4 weeks.
2. Any other systemic illness likely to affect growth and development like hepatic, renal or metabolic problems.
3. Any congenital malformations.
(D) Age Grouping and Size of the Sample

A total of 1100 children were studied. All the measurements and observations were made at a fixed age point. Every effort was made to establish the exact age of the subject by verification from birth certificates, immunization cards, school records, etc. At the time of recording the age, care was taken that variation there was no of more than ± 30 days from the given age point. Study was done at the following age points:

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Minimum No. of cases</th>
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<tbody>
<tr>
<td>6</td>
<td>100</td>
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<td>15</td>
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<td>16</td>
<td>100</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>1100</strong></td>
</tr>
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</table>

(E) Recording of Data

In the selected subjects, required information
regarding the parents and child was recorded, after detailed interview on a specially prepared pretested proforma.

(F) Recording of Anthropometric Measurements

The following anthropometric measurements were recorded in each case.

(i) Weight
(ii) Height
   Crown heel (CH)
   Crown rump (CR)
(iii) Head circumference
(iv) Chest circumference
(v) Mid arm circumference
(vi) Skin fold thickness
   Triceps skinfold
   Subscapular skinfold
   Suprailiac skinfold
(vii) Upper limb measurements
   Total length
   Upper arm segment
   Fore arm segment
   Hand segment
1. Showing weight of a child

2. Showing height of a child.
(viii) Lower limb measurements

Total length
Thigh segment
Leg segment
Foot segment

All the measurements were taken in children with minimal clothing using standard equipment and standard techniques which are described in the following paragraphs.

(i) Weight Recording:

Weight was recorded by using the Detecto Lever Balance in all cases. The child was weighed with minimum garments and weight recorded was in kilograms. Efforts were made to weigh the child one hour after meals. The weighing machine was corrected for zero error after every 5th reading and was periodically actuated with known weights. The reading was taken to nearest 50 gm.

(ii) Height Recording:

Standing height was taken with the help of vertical Detecto Lever Balance measuring rod in all cases. After removing shoes the child was asked to stand on the horizontal platform with heels together stretching
upwards to the fullest extent with arms hanging on the sides and heel and buttocks touching against the rod. The head was held comfortably erect with the lower border of the orbit in the same horizontal plane (Frankfurt plane) as the external auditory meatus. Mild upwards pressure was exerted on the mastoid region bilaterally. The head piece was gently lowered, crushing the hair and making contact with the top of the head. The reading was taken to the nearest 0.1 cm.

(a) Sitting height (CH) :

This was measured by making the child sit as far back as possible on a bench with the legs hanging freely buttocks firmly in contact with the top of the bench. The spine was straightened and the head was kept in Frankfurt plane with gentle upward pressure applied over the mastoid process. The sliding end of the measuring rod was brought in firm contact with the head. The distance between the bench top and the vertex gave the sitting height. The height was measured to nearest 0.1 cm.

(iii) Head Circumference :

Measurement was made with a fibre glass tape. The child's head was steadied and greatest circumference by placing the tape firmly around the frontal bone just
superior to the supra or ital ridges passing it round the head at the same level on each side and laying it over the maximum prominence at the back. Measurement was made to the nearest 0.1 cm.

(iv) Chest Circumference (cm):
A fibre glass tape was used and the measurement made at the nipple preferably in between inspiration and expiration. This line of measurement usually corresponds to the Xiphisternum anteriorly and lower angle of Scapula posteriorly. The reading was made up to 0.1 cm.

(v) Mid-arm Circumference (cm):
The mid arm circumference was measured to nearest 0.1 cm with an insertion tape. The left arm was measured, while hanging freely at its mid point. The tape was placed gently but firmly at the point midway between the tip of the acromion process of the scapula and the olecranon process of ulna.

(vi) Skin fold thickness:
Three skinfold measurements were taken with the help of Holtain Skin Fold Calliper. The instrument had been designed to give a constant pressure of 10 g/
1. Showing Triceps Skinfold Thickness

2. Showing Subscapular Skinfold Thickness

3. Showing Suprailiac Skinfold Thickness
sq mm over its entire operating range. The reading was taken upto 0.1 mm.

(a) Triceps skinfold:

Triceps skinfold was measured half way down left arm between tip of acromian and olecranon process of ulna with left arm hanging freely. At that point the thumb and the forefinger of left hand picked up fold of skin and subcutaneous tissue and pinched it away from the underlying muscle. The calliper was applied to the fold a little below the pinch point and the right hand was allowed to relax its grip on the trigger so that jaws could exert their full pressure. The reading was taken to 0.1 mm.

(b) Sub-scapular skinfold:

Subscapular skinfold was measured in the same way just below the angle of left scapula. The skinfold was pinched and picked up in a vertical line and reading was taken to nearest 0.1 mm.

(c) Supra-iliac skinfold:

This was measured just above the left iliac crest. The skinfold was picked in a vertical line and reading was taken upto 0.1 mm.
(vii) Upper limb measurements (cm):

(a) Total length:

This was measured with a fibre glass tape with the left arm fully extended in anatomic position. It was measured from the most distal point, palpable from above on the acromion process of scapula (acromial) to the tip of middle finger (dactylon).

(b) Upper arm segment:

This was measured while the arm hangs loose and palms applied to thigh. It was measured from acromiale to the uppermost point of the border of radius (radial).

(c) Fore arm segment:

This was measured from the uppermost point of the border of the radial cup to distal most point of the styloid process of the radius (styilon).

(d) Hand segment:

This was measured with a fibre glass tape. This was measured from the distal most point of the styloid process of the radius (styilon) to the tip of the middle finger (dactylon).
(viii) Lower limb measurements (cm):

(a) Total length:
This was measured from the most laterally projecting point of the crest of the ilium (ilio-cristale) to the floor (anthropometer) while standing.

(b) Thigh length:
This was measured from the most laterally projecting point of the crest of the ilium (ilio-cristale) to the upper border and edge of the inner tuberosity of the head of the tibia (Tibiale).

(c) Leg segment:
This was measured from the upper border and edge of the inner tuberosity of the head of the tibia (Tibiale) to the tip of the internal malleolus (sphyrion or malleolare).

(d) Foot segment:
This was measured by a foot length meter. This instrument consists of a platform against which the heel of the child is placed and a sliding bar which makes contact with the tip of the biggest toe. The scale fixed longitudinally ranges from 0-25 cm and reads to the nearest 1 mm.
(G) Recording of Onset and Development of Secondary Sex Characters

The methodology of study differs in males and females and is described separately.

In Females:

The following are studied as detailed below:

1. Axillary hair - absent or present
2. Apocrine sweat glands function - absent or present
3. Menarche - Attained or not attained
4. Tanner staging - as below

In Males:

The following are studied as detailed below:

1. Axillary and facial hair - absent or present
2. Apocrine glands function - absent or present
3. Development of breast - Preadolescent and adolescent
4. Voice change - absent or present
5. Tanner staging - as below

Tanner Staging:

The details of Tanner Staging are described in the following paragraphs and to make a uniform comparison, standard photographs were employed.
In Females:

Terminology of staging, breast changes and pubic hair are studied and divided into five stages each.

(a) The breast stages in females are as follows:

Stage I \( (B_1) \) Preadolescent; elevation of papilla only.

Stage II \( (B_2) \) Breast bud stage; elevation of breast and papilla as a small mould, enlargement of areola diameter.

Stage III \( (B_3) \) Further enlargement of breast and areola with no separation of their contours.

Stage IV \( (B_4) \) Projection of areola and papilla to form a secondary mould above the level of the breast.

Stage V \( (B_5) \) Projection of papilla only, due to recession of areola to the general contour of the breast. Mature stage.

(b) Pubic hair stages in females:

Stage I \( (PH_1) \) Preadolescent; no pubic hair.

Stage II \( (PH_2) \) Sparse growth of long slightly pigmented downy hair straight or only slightly curled appearing chiefly along labia.

Stage III \( (PH_3) \) Considerably darker, coarser and more curled. The hair spreads sparsely over the junction of pubes.
Stage IV (PH₄) The hair are now adult type, but the area covered by it is still considerably smaller than in most adult. There is no spread to the medial surface of the thighs.

Stage V (PH₅) Adult type in quantity and type, distributed as an inverse triangle of the classically feminine pattern. Spread to the medial surface of the thighs but not up the linea alba or elsewhere above base of inverse triangle.

**In males:**

The terminology of staging, pubic hair and genital growth are studied and divided into five stages each.

(a) **Genital growth in males:**

**Stage I** (G₁) Pre-adolescent; tests, scrotum and penis are of about the same size and proportion as in early childhood.

**Stage II** (G₂) The scrotum and testes have enlarged and there is a change in texture of scrotal skin.

**Stage III** (G₃) Growth of penis has occurred first mainly in length but with some increase in breadth. There is further growth of testes and scrotum.

**Stage IV** (G₄) Penis further enlarged in length and breadth and development of glands. Testes and scrotum are further enlarged. There is further darkening of the scrotal skin.

**Stage V** (G₅) Genitalia adult size and shape. No further enlargement takes place after this stage.
(b) Pubic hair staging in males:

Stage I \((PH^1)\) Preadolescent; No pubic hair.

Stage II \((PH^2)\) Sparse growth of long slightly pigmented downy hair, straight or only slightly curled appear chiefly at base of penis.

Stage III \((PH^3)\) Considerably darker coarser and curled. The hair spreads sparsely over the junction of the pubes.

Stage IV \((PH^4)\) Hairs are now adult type, but area covered by it is still considerably smaller than most adults. There is no spread to the thighs.

Stage V \((PH^5)\) Adult in quantity and type, distributed in inverse triangle spread on medial surface of thighs but not upto linea alba.

(H) Analysis of Data

Each anthropometric parameter obtained in the study was treated as follows:

(a) The mean values and the standard deviation was calculated for each age group and presented in the form of table.

(b) The data for male and female children were statistically compared by calculating the difference between the two means using 't-test'.

t-test \( t \) = \frac{\bar{X}_1 - \bar{X}_2}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}

where, \( s^2 = \frac{n_1 \sigma_1^2 + n_2 \sigma_2^2}{n_1 + n_2 - 2} \)

Where,

\( \bar{X}_1 \) = Mean of boys sample

\( \bar{X}_2 \) = Mean of girls sample

\( n_1 \) = Total number of boys in boys sample

\( n_2 \) = Total number of girls in girls sample

\( \sigma_1 \) = Standard deviation of boys sample

\( \sigma_2 \) = Standard deviation of girls sample

(c) Line diagrams were prepared for the mean observed value. The line diagrams so obtained were compared with similar line diagrams of NCHS, British and ICMR wherever available.

(d) Indices of various body proportions have been computed to express one segment of the body in percentage of the other. They are as follows:

Upper extremity : Stature index = \( \frac{\text{Upper extremity length}}{\text{Stature}} \times 100 \)

Lower extremity : Stature index = \( \frac{\text{Lower extremity length}}{\text{Stature}} \times 100 \)
Upper extremity : Lower extremity index
(Intermembral index) = \( \frac{\text{Upper extremity length}}{\text{Lower extremity length}} \times 100 \)

Brachial index = \( \frac{\text{Fore arm length}}{\text{Upper arm length}} \times 100 \)

Crural index = \( \frac{\text{Leg length}}{\text{Thigh length}} \times 100 \)

Hand fore arm index = \( \frac{\text{Hand length}}{\text{Fore arm length}} \times 100 \)

Foot leg index = \( \frac{\text{Foot length}}{\text{leg length}} \times 100 \)

(e) Correlation coefficients of various parameters was worked out by using the following formula:
Where, \( r_{xy} \) is the correlation coefficient between \( X \) and \( Y \), \( n \) is the size of the sample

(f) Regression equation was derived to estimate different parameters from single known parameter.
Regression equation was derived by using the undermentioned formulae:

\[ Y = a + b X \]
Where,

\[ Y \text{ is dependent variable} \]
\[ X \text{ is independent variable} \]
\[ a \text{ and } b \text{ value of constraints from given data.} \]

(g) Mean ages for appearance of various stages of pubertal development were calculated by probit method.