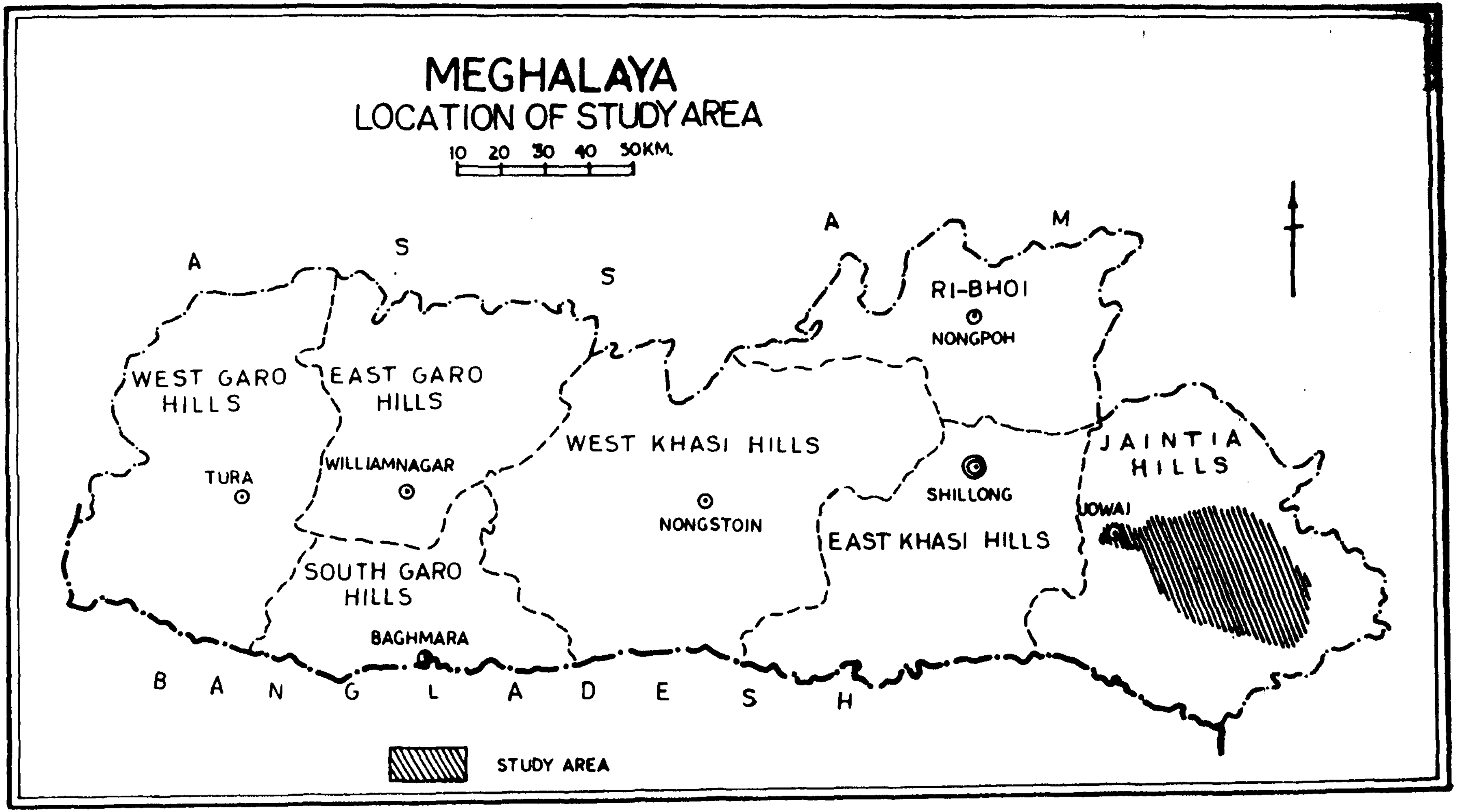
CHAPTER IV

MATERIAL AND METHODS


MEGHALAYA
LOCATION OF STUDY AREA
10 20 30 40 50 KM.
A
S
S
A
M
RI-BHOI
NONGPOH
WEST GARO HILLS
EAST GARO HILLS
WEST KHASI HILLS
JAINTIA HILLS
TURA
WILLIAMNAGAR
SHILLONG
NONGSTOIN
JOWAI
EAST KHASI HILLS
SOUTH GARO HILLS
BAGHMARA
B A N G L A D E S H
STUDY AREA

The Subjects

The Jaintia Hills District of Meghalaya is inhabited by at least four indigenous groups of people, i.e., the Pnar, the Bhoi, the War and the Hadem or Biate. Though the demographic details of the four individual groups are not recorded in the census, the Pnar happen to be the dominant group of people in the District. All four groups collectively are known as the Jaintia. For the present study, the Bhoi, the War and the Hadem have not been considered. This study takes into account only the Pnar. The subjects of the present study are 11 to 18 years old boys whose both parent are Pnar. All subjects considered here are school-going boys, and apparently normal and healthy.

The Area

The Pnar people are spread over a large geographical area in the central, and western to eastern part of the Jaintia Hills District. Relatively speaking, smaller geographical areas are being inhabited by the Bhoi in the northern, the Hadem in the north-eastern, and the War in the south-western part of the district (see Map).

The area of field work for the present study is the central part of the Jaintia Hills District which is inhabited by the Pnar people. The subjects of this study hails from rural as well as urban area. The rural subjects belong to 20 different villages namely, Sutnga, Moopala, Narwan, Jalaphet, Mookympad, Tluh, Jarain, Latyrke, Moolamylliang, Lamyrsiang, Tongseng, Sakhain, Lelad, Khliehriat, Myndihati, Lumshnong, Dkhiah, Rymbai, Bapung and Moolamynnoh. While the urban subjects are derived from the town of Jowai which also happens to be the headquarters of the Jaintia Hills District. The field work for the present study has been conducted during July through November 1993 and March 1994.

The Data

The data for the present study has been collected from 8 schools located in the rural area (i.e., Sutnga Presbyterian High School, Sutnga Government M.E. School, Khliehriat High School, Dkhiah Presbyterian High School, Rymbai Presbyterian High School, Tluh High School, Latyrke M.E. School and Lumshnong M.E. School) and 2 schools located in the urban area (i.e. Jowai Government Boys' High School and Government Senior Basic School, Jowai).

The present study comprises of cross sectional data on a total of 509 boys belonging to eight different age groups, i.e., age 11 to 18 years. The age groups are based on decimal age following the Decimal Age Calendar given by Tanner (c.f. Weiner & Lourie, 1981). Age group 11 years, for example, includes all those subjects whose decimal age falls between 10.500 to 11.499 years, and so on.

Out of a total of 509 subjects, 256 belong to rural and 253 belong to urban area. Urban subjects are those who have been born and brought up in the town only; similarly, rural subjects are born and brought up in their respective villages, and they never had prolonged stay in any urban area, or vice versa for the urban subjects. Age groupwise distribution of the sample is presented in Table 1.

Table 1. Age Groupwise Distribution of Sample.

Age group (years)	Urban	Rural	Total
11	32	32	64
12	31	32	63
13	33	32	65
14	31	34	65
15	33	32	65
16	30	31	61
17	30	31	61
18	33	32	65
Total	253	256	509

The data on basic background information on each subject includes, name, date of birth, place of birth, residence since birth, class in which studying, parents' clan, education, occupation and total family income. In addition, information on the subjects' general food habits and personal habits (like smoking, drinking, chewing) has also been gathered.

METHODS

For evaluating individual's somatotype a total of ten anthropometric measurements have been taken on each subject. The human body which is subjected to exercise may elicit bilateral differences. Considering the aims and significance of the present study, the bilateral measurements have been recorded on the right side of the body of the subjects. All measurements are taken according to techniques standardized by Weiner & Lourie (1981).

ANTHROPOMETRIC MEASUREMENTS

1. Stature - It is the straight distance between horizontal floor (on which the subject stands with his heels together) and vertex, when the head is kept in Frankfurt Horizontal plane. The Anthropometer was used to record this measurement.

2. **Weight** - It is a three-dimensional measurement, and records the total bulk of the body. The subject stands in the centre of the platform of the accurate scale, with minimal clothing. Weight was recorded (using light weight personal weighter) to the nearest 0.5 kg with an allowance deducted for the clothing.

SUBCUTANEOUS FAT

GENERAL INSTRUCTIONS

Instrument: Harpenden Skinfold Caliper.

Technique: The objective is to measure the thickness of a complete double layer of skin and subcutaneous tissue without including any underlying muscle tissue. A double layer of skin and subcutaneous tissue is grasped with the thumb and forefinger, the fold being large enough to get a complete double layer, but not so large as to get so much skin and fat as may cause excessive amounts of tension beyond the finger-tips. The fold of skin and fat is held somewhat loosely while the centres of the caliper faces are 1.0 cm from the edges of the thumb and forefinger.

The reading on the dial of the caliper is taken after applying the full spring pressure of the instrument for all measurement. Time was allowed for the full pressure of the caliper to take effect, but not so long that the fat is being 'squeezed out' of the skinfold (Firmer pressure of the fingers on the skinfold will normally arrest the movement of the indicator if the movement is excessive). The measurement is recorded to the nearest 0.1 mm.

3. Triceps

The subject stands with the arm by the side and the elbow extended but relaxed (muscle fibres are excluded, if necessary, but locking the elbow joint momentarily in full extension). The skinfold is raised with the thumb and forefinger of the left hand over the triceps muscle on the back of the right arm, halfway between the acromion and the elbow. The skinfold runs parallel to the long axis of the arm.

4. Subscapular

The subject stands with shoulders erect but relaxed and arms by the sides. The skinfold is raised with the thumb and forefinger of the left hand lateral to the inferior angle of the right scapula, the skinfold running downward and outward in the direction of the ribs.

5. Suprailiac

The subject stands in normal erect position. The subject is instructed to draw in a medium breath and hold it. The skinfold is raised with the thumb and forefinger of the left hand in a position one to two inches above the right anterior superior iliac spine so that the fold runs forward and slightly downward.

6. Calf

The subject sits on a chair with his foot on the floor and the leg vertical. The skinfold is raised with the thumb and forefinger of the left hand on the medial side of the right calf just above the level of the maximum calf girth so that the fold runs vertically.

BONE DIAMETERS

GENERAL INSTRUCTIONS

Instrument: Sliding caliper.

Definition of Measurement: Bi-epicondylar diameter of the distal extremity of the humerus and femur.

Landmarks: The points on either epicondyle of the distal extremity of the humerus or femur most lateral to the medial plans of the bone.

Technique: The discs on the branches of the caliper are applied against the epicondyles in such a manner as to bisect the angle of the joint and to lie in the same plane as the limb. Firm pressure is applied and the measurement is recorded to the nearest .05 cm.

7. **Humerus**

The arm of the subject is raised forward to approximately the level of the shoulder and the forearm is flexed upward at a right angle to the arm. The cross-arms of the caliper are applied to the epicondyles, bisecting the angle of the elbow, and lying in the same plane as the arm and forearm.

8. **Femur**

The subject sits on a chair with his foot on the floor and the leg vertical.

The observer kneels in front of the subject and applied the cross-arms of the caliper to the epicondyles, bisecting the knee angle and keeping the caliper branches in a parallel to the thigh and the leg.

MUSCLE GIRTHS

Instrument: Flexible steel tape.

Definition of measurement: The maximum girth of the muscle when measured at right angles to its long axis.

Technique: The tape is passed around the limb and the region of the muscle explored with the tape always at right angles to the long axis of the bone, until the largest reading is obtained. The tape is in light contact with the skin (so as to produce defomation of the tissue), and maximum girth is recorded to the nearest 0.1 cm.

9. Biceps

The arm of the subject is horizontal, the forearm is separated and the elbow fully flexed. The subject is instructed to clench his fist and contract his 'biceps' as strongly as possible.

The tape is passed around the arm approximately midway between the acromion and the elbow, at right angle to the long axis of the arm.

10. Calf

The subject stands on a floor with his feet six to nine inches apart, with his weight equally distributed through both lower limbs.

The tape is passed around the leg near the top of the calf muscle and lowered until the greatest girth is located a right angle to the long axis of the leg.

SOMATOTYPING

According to the method of Heath and Carter (1967), the somatotype is expressed in a 3 numeral rating system consisting of 3-sequential numerals, always recorded in the same order. The first component (Endomorphy) refers to the relative fatness and leanness in individual physique. The second component (Mesomorphy) refers to the musculo-skeletal development per unit of height and can be treated as the relative lean body mass. The third component (Ectomorphy) refers to the relative linearity of individuals and is based on ponderal index. Before obtaining the somatotype rating, appropriate data were entered in the appropriate place at the left side of the rating form given by Heath & Carter (1967).

First Component Rating

1. Calculate the sum of three skinfolds (Triceps, Subscapular and Suprailiac) and record it at right side of total skinfolds.
2. Go to the numeral section (right side block) and choose the appropriate value which is very close to the value of total skinfolds. Then encircle that value.
3. Look to the row of 'First Component' and observe carefully which value is directly under (vertically) the column which have already encircled. Again encircle that value and now we get the first component.

<u>Second Component Rating</u>

1. Go directly to the numerical section and consider only the horizontal row of height, mark the point of the subject's height by a downward arrow (↓) to the nearest value of height (regard the height row as a continuous scale).

2. For each of the measurement of left side (Bone: humerus and femur) go directly to the right side block, consider each horizontal row and encircle the value which is nearest to the value of the left side.

3. Subtract the triceps skinfold thickness value from muscle: Biceps (note that triceps skinfold thickness has been measured in mm unit and muscle: Biceps in cm unit, so it would be best to divide skinfold thickness measurement by 10, then subtract the value from muscle: Biceps). In case of calf, again subtract the calf skinfold thickness (keeping in mind for the transformation of the unit).

4. For each corrected value obtained from 3 (muscle: Biceps/Calf go along the row on the right side block and encircle the value which is nearest to the value on the left side.

5. Now, do not look at the numerical values. Consider only columns, ignore height row and take the other

four rows (Humerus, Femur, Biceps and Calf) of the right side block.

6. There will be four encircled figures in the four rows out of these four, take the left most encircled column as '0' (Zero) or as the 'base point', then count the column deviations of the three encircled figures along the row. Add the total deviation of the three encircled figures along the row and divide the total by 4.

7. Take the number obtained by division described in point 6. Still consider the left-most encircled column as the base point and count the number (obtained by division) horizontally towards the right side column (count each column as 1). Mark a point (.) to the column position reached after counting; it may be fraction between two consecutive columns. Then go vertically up along the column marked with a point to the height row and mark a point with a asterisk (*) on the row.

8. Consider the column only, count horizontally the column deviation from asterisk (*) to mark of height (↓) or vice versa.

9. Remember the column (done in 8), look to the row of 'second component' and '4' as the base point. Then more towards left or right horizontally (depending

upon the direction of the asterisk from the height marker). Now, count the number of column deviation from 4 and encircle the second component figure. Note: If the asterisk is to the right of height then count 4+ figures and if the asterisk is to the left then count 4- figures. Caution: In this row, the unit in consecutive columns has a half unit increment.

Third Component Rating

1. Calculate the ratio height/ $\sqrt[3]{weight}$ (Ponderal index, except that here multiplication by 100 is not done.
2. Look to the right side block and encircle the value very close to the ratio.
3. Look to the row of 'third component' and locate the value directly under (vertically) the column already encircled. Encircled the value. Now, the third component is obtained.

Limitations of the Rating Form

Although the rating form provides a simple method of calculating the anthropometric somatotype, it has some limitations. First, the mesomorphy scales do not include some of the values found at the low and high ends with unusually small and large subjects. Second, some rounding error may occur in calculating the mesomorphy rating, because the subject's height often is not the same as the column height. The following procedures described by Carter (1980a) can correct these problems, and has been used in the present study.

1. Endomorphy = $- 0.7182 + 0.1451(x) - 0.00068(x^2) + 0.0000014(x^3)$

   x = sum of triceps, subscapular and suprailiac skinfolds.

2. Mesomorphy = [(0.858 x humerus breadth) + (0.601 x femur breadth) + (0.188 x corrected arm girth) + (0.161 x corrected calf girth)] - (height x 0.131) + 4.50.

3. Ectomorphy = Height-Weight Ratio x 0.732 - 28.58.

Somatotyping Children

With minor modifications, the Heath-Carter somatotype method can be applied to children. The extended scales are required for calculating mesomorphy in children. These scales may be added to those on the rating form or the rating is calculated using the equation for mesomorphy (as above). Hebbelinck *et al*. (1973) recommended an adjustment of 170.18 cm, a combined universal mean for adult men and women. Before determining the rating for endomorphy the sum of the three skinfolds is multiplied by the reference

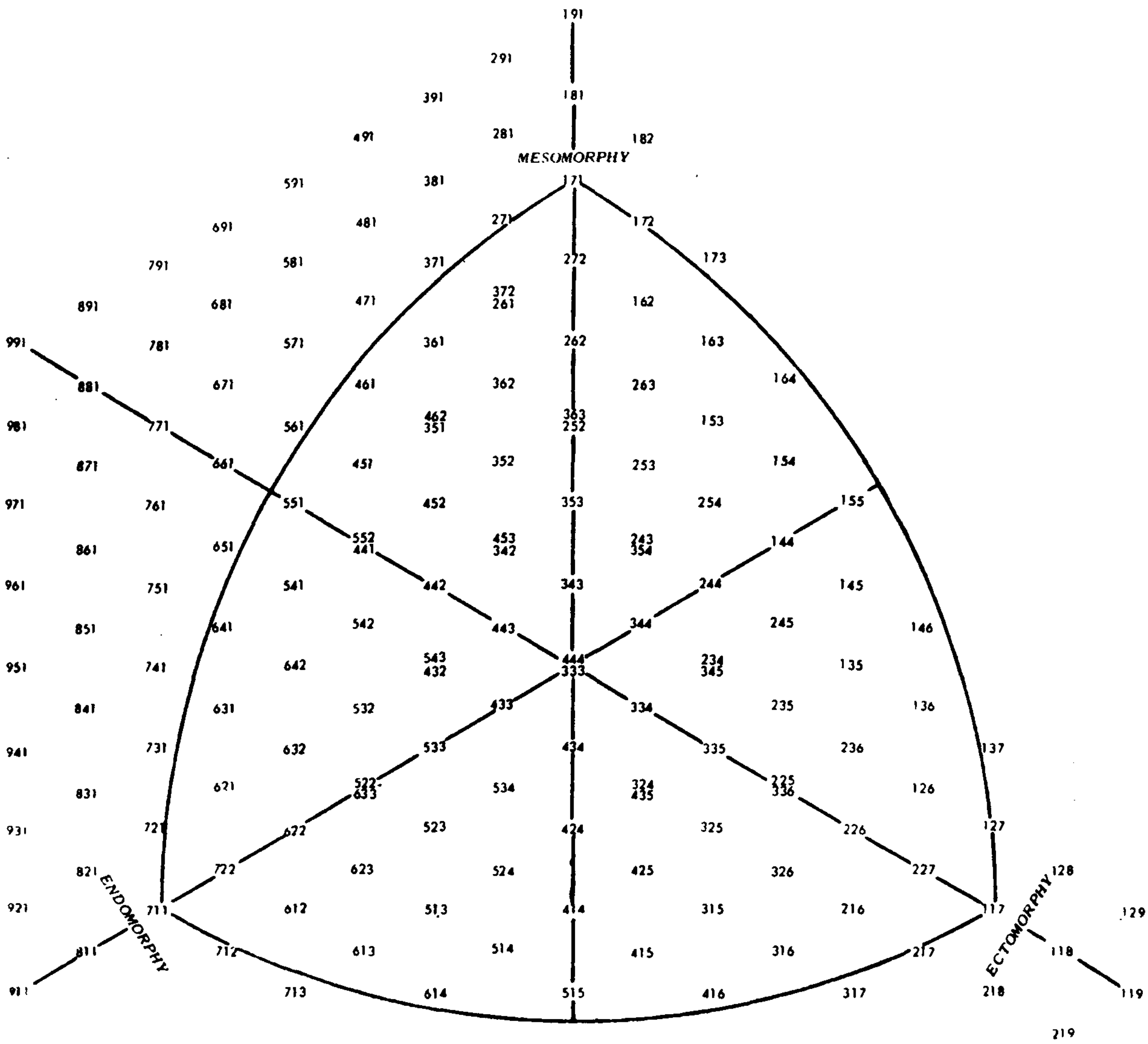


FIG.1 SOMATOCHART

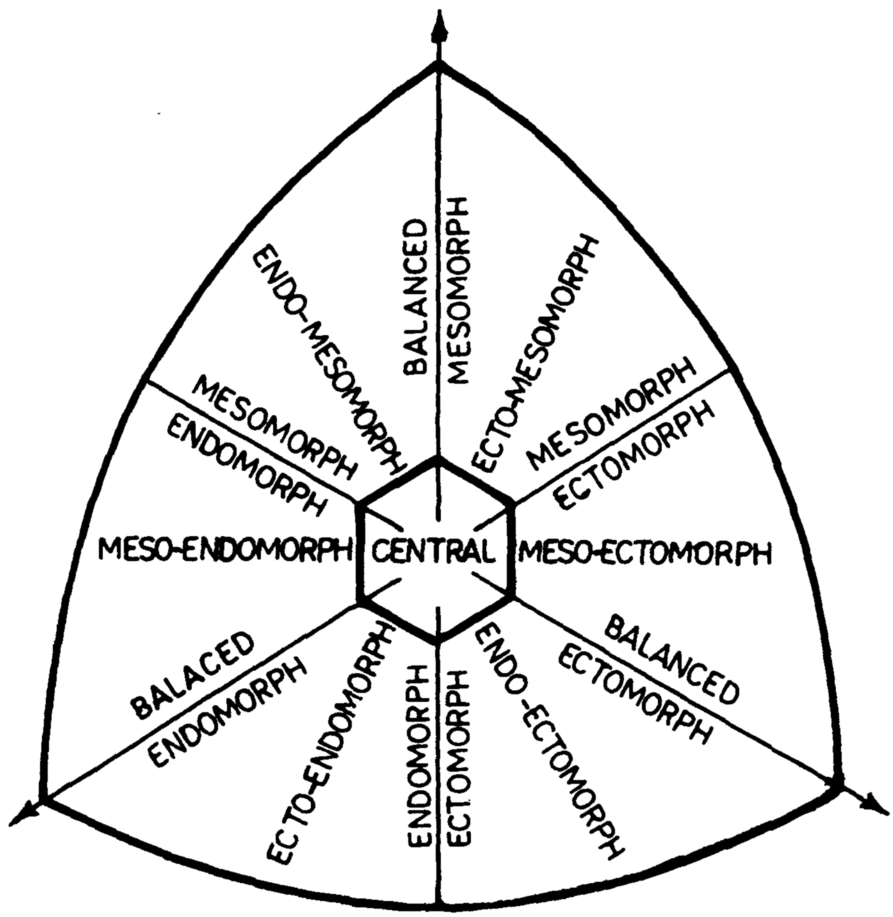


FIG.2 SOMATOTYPE CATEGORIES

height (170.18/height in cm) to adjust for body size.

The above adjustments recommended by Carter (1980a) and Hebbelinck et al. (1973) have been applied to the present data, before determining each individual's somatotype.

SOMATOCHART

Sheldon used a somatotype triangle to represent individual somatotype in it. The somatotype triangle has all the three sides of equal length and are arc-shaped. The corners of the triangle represent the extremes in each component. The left corner at the base of the triangle represents extreme in endomorphy, the right corner at the base represents extreme in ectomorphy and the top corner represents extreme in mesomorphy. The somatotypes can be plotted on the somatotype triangle as 'dots' whose visual inspection can be very useful in interpreting the somatotypes. Heath-Carter (1967) and Carter (1975) utilized the same concept of triangle to design the somatochart (Fig. 1). A typical somatochart has been displayed where the individual somatotypes can be plotted which are called somatoplots. The somatotypes can be divided into following categories depending upon the position of the somatotypes on the somatochart (Fig. 2).

(i) Balanced endomorph: The first component dominates over second and third which are either equal or differ no more than 0.5 units (5-3-3, 5-3-2.5, 5-2.5-3).

(ii) Balanced mesomorph: Second component dominates, the first and third components are either equal or differ no more than 0.5 units (3-5-3, 2.5-5-3, 3-5-2.5).

(iii) Balanced ectomorph: Third component dominates, first and second components are either equal or differ no more than 0.5 units (3-3-5, 3-2.5-5, 2.5-3-5).

(iv) Mesomorph-endomorph: First or second components either equal or differ no more than 0.5 units and dominates over third component (5-5-3, 4.5-5-3, 5-4.5-3).

(v) Mesomorph-endomorph: Second and third components either equal or differ no more than 0.5 units and dominates over the first component (3-5-5-, 3-5-4.5, 3-4.5-5).

(vi) Endomorph-ectomorph: First and third components either equal or differ no more than 0.5 units and dominate over second component (5-3-5, 4.5-3-5, 5-3-4.5).

(vii) Mesomorphic endomorph: First component greater than second and the third is the smallest (5-3-2, 5-4-2)

(viii) Ectomorphic endomorph: First component greater than the third and the second is the smallest (5-2-3).

(ix) Endomorphic mesomorph: Second component greater than first whereas the third is the smallest (3-5-2).

(x) Ectomorphic mesomorph: Second component greater than third and the first is the smallest (2-5-3).

(xi) Endomorphic ectomorph: Third component dominates over first and the second is the smallest (3-2-5).

(xii) Mesomorphic ectomorph: Third component greater than second and the first is the smallest (2-3-5).

(xiii) Central: All components are either equal or differ no more than one unit from other two, the rating of all components should be within and consist of rating of 2, 3 or 4 (3-3-3, 4-4-4, 3.5-4-4, 4-3.5-4, 4-4-3.5, 3.5-4-3.5).

SOMATOTYPE ANALYSIS

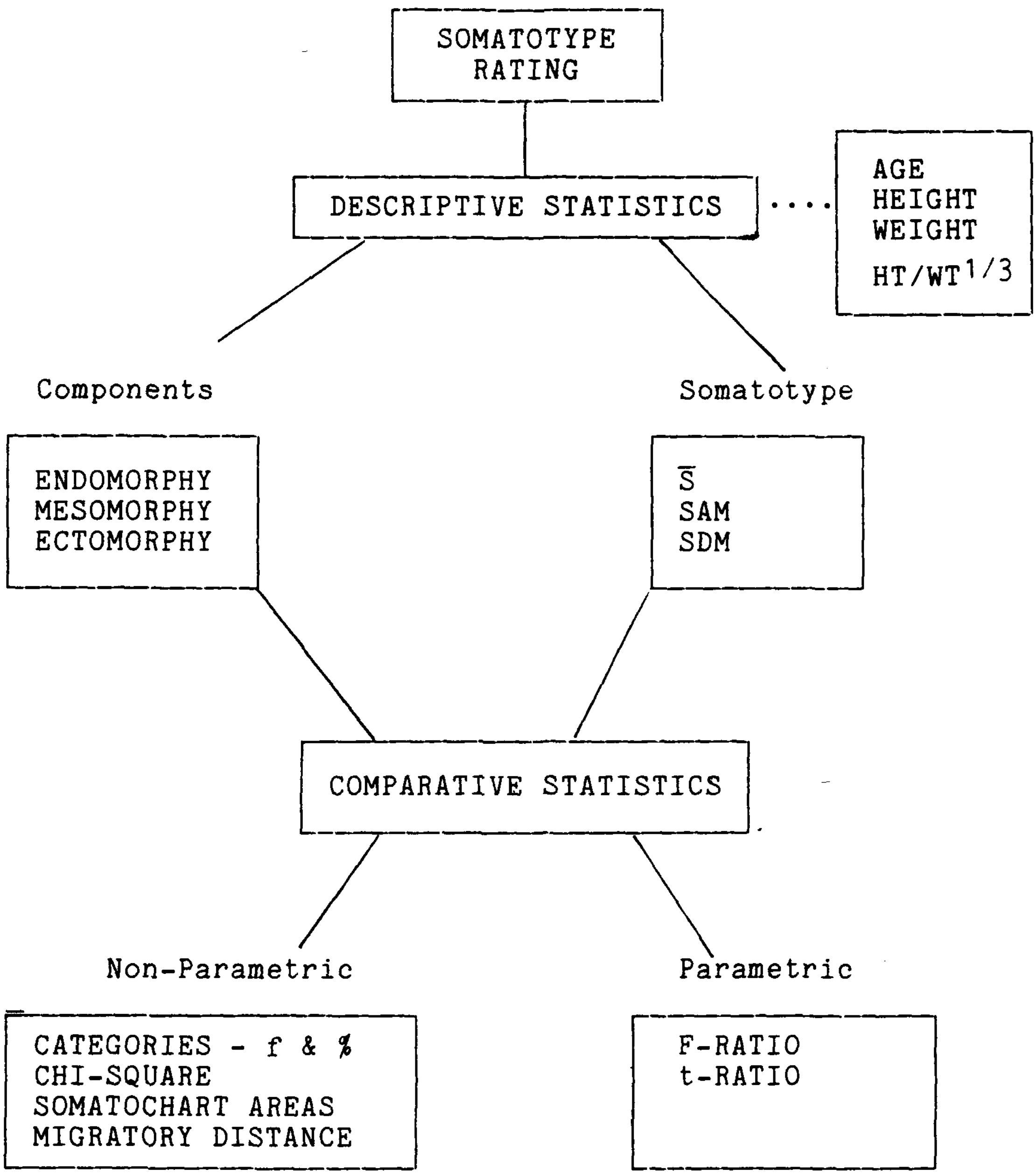


Fig. 3. A Summary of Descriptive and Comparative Statistic.

Statistical Analysis

The nature of the data, the numbers of subjects and the kinds of groups to be compared determine exact procedures of an analysis. A summary of descriptive and comparative statistics which may be used in somatotype analysis is given in Fig. 3. The data for the present study has been subjected to the following statistical treatment.

Descriptive Statistics

For analysis of somatotype ratings for one or more samples, the mean, standard deviation, etc., for each component are calculated. To provide further information on each sample, the same statistics is calculated for age, height, weight, and height-weight ratio (HWR). Somatocharts (two dimensional) for each sample are also plotted.

Mean Somatotypes ($\bar{S}$)

The somatotype ratings are also analysed one at a time, for which simple descriptive statistics is also used.

Somatoplot Coordinates

Calculation of X-Coordinate

$$X = \text{Ectomorphy} - \text{Endomorphy}$$

Calculation of Y-Coordinate

$$Y = 2(\text{Mesomorphy})-(\text{Endomorphy} + \text{Ectomorphy})$$

Somatotype Dispersion Distances (SDD)

Somatotype dispersion distances (SDD) is the distance between the somaplots which have the coordinates (X_1, Y_1) and (X_2, Y_2) and is calculated as follows:

$$SDD = \sqrt{3(X_1 - X_2)^2 + (Y_1 - Y_2)^2}$$

The 3 under the square root sign is a constant which converts X distances into Y distances units. The location of the somatotype in terms of (X, Y) coordinates on the somatocharts is referred to as its somatoplot.

Somatotype Dispersion Mean (SDM)

A somatotype dispersion means (SDM) is the mean SDD of the somatoplots in a distribution from the $\overline{S}$ (mean) somatoplot. This may be obtained by the following formula:

$$SDM = \sum_{i=1}^{n} \frac{SDD_1}{n}$$

Where SDM is the somatotype dispersion mean and the SDD_1 are the somatotype dispersion distances from the plot of the calculated mean somatotype $\overline{S}$ of the distribution to each somaplot for any given number of subjects (n) in the distribution.

Somatotype Attitudinal Distance (SAD)

The SDD is used for distances on the two dimensional somatochart. However, somatotypes are best represented by a point in three dimensional spaces called Somatopoint. This distance between any two somatopoints is the Somatotype Attitudinal Distance (SAD) and is calculated in component units.

$$SAD_{A,B} = \sqrt{(I_A - I_B)^2 + (II_A - II_B)^2 + (III_A - III_B)^2}$$

Where I, II and III represent endomorphy, mesomorphy and ectomorphy components of a somatotype, and A and B are the two somatotypes.

Somatotype Attitudinal Mean (SAM)

The somatotype attitudinal mean is the average of the somatotype attitudinal distances (SADs) of each somatotype.

$$SAM = \sum_{i=1}^{n} \frac{SAD_i}{n}$$

Comparative Statistics

Somatotype Categories

The relative frequencies of somatotypes by category is the most commonly used non-parametric statistics. The distribution of the somatotypes on the somatocharts may be described by simple counting the number of somatotypes in the area of the somatochart.

Chi-Square

A Chi-square test can be applied to test for significance of the differences between the distribution of somatotypes by category or area.

F- and t-Ratios

F- and t-ratios are used for comparisons between two or more mean somatotypes. In these comparisons the distances between the means in terms of SADs or SDDs are tested for significance. These tests determine whether there is a difference between the somatoplots or somatopoints seen on the somatochart.

Compogram

Compogram is a simple method for presenting the results of comparisons between the mean somatotypes of two samples. The means from the three components from two samples are plotted, and then the means for each are connected.

Per-cent Overlap

The urban and rural samples are compared graphically by circumscribing the limit of each pair of somatotype distribution on a somatochart and counting the number and percentage of somatoplots that overlap in each distribution (Hebbelinck *et al*. 1980; Carter *et al*., 1983).