Sampling Procedure and Sample Selection

A multi-stage stratified random sampling procedure from district to village levels was adopted to obtain different types of data retrieved for the purpose of the thesis.

First Stage Selection

Districts being the largest units in the state, they were included in the first stage of sampling procedure. Firstly the districts with more than 60% of tribal population were selected. For the sake of convenience, these districts, based on the predominant contribution of a particular type of resource to the economy of the people, have been classified into three categories: Agriculture produce-based districts, forest produce-based districts and both agriculture and forest-produce based districts. One district from each of these categories was selected randomly. Finally three districts were selected for the study accordingly: Jhabua, Bastar and Sarguja (also known as Ambikapur) which represent the above categories in order.

Second Stage Selection

During the second stage, all the community development blocks of the three districts were stratified into either forest-based or agriculture-based categories on the basis of percentage of area under agriculture and forest respectively. One block was selected at random from each of the above categories from each of the three districts. Thus two blocks from each district were selected. They are Kathiawar and Jhabua from Jhabua district, Pharagason and Geedam from Bastar and Pratapur and Khadgeon from Sarguja (Table 2 and Fig. 1).
<table>
<thead>
<tr>
<th>Region of the State</th>
<th>District</th>
<th>Block</th>
<th>Main Source of Economy</th>
<th>Tribal Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western</td>
<td>Jhabua</td>
<td>Jhabua Kathiawara</td>
<td>Agriculture</td>
<td>Bhils</td>
</tr>
<tr>
<td>Southern</td>
<td>Bastar</td>
<td>Pharasgaon Geedam</td>
<td>Forest</td>
<td>Gonds</td>
</tr>
<tr>
<td>Eastern</td>
<td>Sarguja</td>
<td>Pratapur Khadgaon</td>
<td>Agriculture and Forest</td>
<td>Gonds</td>
</tr>
</tbody>
</table>
Third Stage Selection

This is the final stage in which the villages formed the sampling unit. Three categories of villages namely (i) Villages located within 5 km. of Primary Health Centre (PHC) Headquarters (ii) Village within 5 km. of sub-centre and (iii) Villages beyond 5 km. from either PHC Headquarters or sub-centres were selected from each block. The villages selected from the block represented the same type of economy.

The Data

The sample consisted of 600 households from each Block for demographic and family economic data and 200 households for socio-cultural and dietary intake studies. A sample for nutrition assessment consisted about 3000 individuals from each block.

The various aspects on which data were collected are as follows (1) demographic aspects (2) family economic status (3) socio-cultural aspects (4) Health and nutritional status and (5) Dietary intake. The data collection was accomplished by a set of schedules designed and pretested for their feasibility (Appendices 1 - 6). Information was collected using standard techniques and equipment (Weiner and Lourie, 1969; Jelliffe, 1966).

1. Demographic aspects

All the households in the selected village were canvassed by schedule No.1. The head of the family, who could provide full information regarding all the individuals staying under the same roof, was interviewed. Details about their age, sex, level of education, marital status, occupation, and migratory status etc., were obtained.

2. Family economic status

All those households covered under demographic survey were also
covered for collection of information on the economic status by schedule No.2. The data on land possession, crops grown, income from different sources, expenditure on food, other consumer and non-consumer durables during the previous year were obtained. Also the level of indebtedness of the household was estimated and noted.

3. Socio-cultural aspects

The socio-cultural information relevant to health and nutrition was obtained on every third household covered under demographic and economic survey. The information included breast-feeding, weaning practices, concepts of food preferences and avoidance during health and disease by different age and physiological groups, utilization of health facilities and adoption of family planning methods. The respondent for this schedule was woman, i.e., mother or mother-in-law or an elderly female in the house wherever possible (schedule No.3). The anthropological methods of observation and interviewing the elderly were employed.

4. Health and Nutritional Status

This was assessed by clinical (schedule No.4) and anthropometric (schedule No.5) examination. A thorough and systematic physical examination of all the available subjects was carried out. Information was recorded on the history of past illness, present complaints and specific nutritional deficiency signs. In addition, the following anthropometric data (bodymeasurements) were collected on all the clinically examined subjects.

1. Body weight

2. Height/length in the case of infants and small children.

3. Mid Upper Arm Circumference
4. Fat Fold at Triceps  
5. Head Circumference  
6. Chest Circumference on children below 5 years and adult males.  
7. Calf Circumference  
8. Fat Fold at Calf  
9. Fat Fold at Supra-iliac  
10. Fat Fold at Sub-Scapular  
11. Bi-iliac Diameter  
12. Bi-acromial Diameter  
13. Transverse Diameter of Chest  
14. Antero-Posterior Diameter of Chest  
15. Arm Length  

The measurements from 7 to 15 were taken only on adult males.  

All the measurements are described below with respect to procedure/technique, instruments used and precautions taken.

1. Body Weight  
The body weight of the subject was taken with minimum clothing and without shoes. The weight of the children weighing below 20 kg, was taken on 'TANSI' beam balance and for others on the lever balance. The weight was recorded to the nearest 100 g.  

2. Height/Length  
2(a) Height  

Anthropometer rod was used for taking height. The subject was made to stand erect with heels together and toes apart on an even surface
without any footwear. By standing on the left side of the subject, the anthropometer rod was held in my right hand and placed in the centre of the two heels of the subject. The subject's head was held firmly in the Frankfurt Horizontal Plane (with the Infra-orbitale margin and tragus of the ear in the same plane) with my left hand holding his chin over the mastoid process and my right hand little finger lifting the subject's occipital protuberance.

The horizontal blade in movable head-piece of the rod was put in the sagittal plane over the head of the subject. Pressure was exerted on the horizontal blade over the hair to minimise the thickness. The measurement was read while the horizontal blade of the rod was still in position. The average of three measurements was recorded. The measurement was recorded to the nearest millimeter.

2(b) Length

The height of infants and children who could not stand and of those who could stand but were non-cooperative was taken with the help of the infantometer.

The infant/child was made to lie down on the infantometer with the head towards the fixed end and legs towards the sliding end. The infant/child was made to look up with the head touching the fixed end. An assistant held the infant's head a little firmly in that position. The infant's/child's leg was held with my left hand over knee-joint and the sliding piece with my right hand. The sliding piece was brought close to the soles of the infant. The complete soles were brought in contact with the sliding piece. With minimum pressure on the soles, the reading was noted to the nearest millimeter while the sliding piece was still in position.
3. Mid Upper Arm Circumference

The measurement is always taken on the left arm by international convention. The mid-point between the tip of the acromion of the scapula and the tip of the olecranon of the ulna was marked with the arm flexed so that the tip of the olecranon was visible and the measurement was read with tape touching the tip. Then the mid-point was marked by halving the length measured between acromion and olecranon and a line was drawn at the mid-point. The arm circumference was measured at this point with the fibre glass tape. Care was taken to see that neither extra pressure was exerted over arm nor the tape kept too loose.

4. Fat Fold at Triceps

This was measured at the same mid-point where arm circumference was measured on the left arm. A fold of skin was lifted gently between the thumb and forefinger of the left hand at about 1 cm above the mid point marked. The caliper was applied at the marked site and the measurement was taken while still holding the fold. The measurement was recorded to the nearest 0.5 mm with Una Caliper. The zero error of the caliper was checked before using the same.

5. Head Circumference

The tape was passed round the head over eye brows and the maximum projection of occiput. The tape was held firmly around and the measurement was taken.

6. Chest Circumference

The tape was passed around the chest just below the inferior angles of the scapulae on the back and over the nipples in front. The measurement comprised of the mean of the readings at inspiration and expiration.
7. Calf Circumference

The subject was made to sit on a raised platform with his left leg hanging freely. The tape was passed round the calf at the maximum circumference.

8. Fat Fold at Calf

The fold was picked at the place of maximum circumference with the subject's left leg hanging freely and the measurement was taken at that point.

9. Fat Fold at Supra-iliac

The clothing over the waist was lowered and the skin fold picked up at a place above 1 cm and 2 cm medial to the antero-superior iliac spine. The skin fold was recorded to the nearest 0.5 mm.

10. Fat Fold at Sub-Scapular

The subject was unclothed. The fold was picked up with my thumb and forefinger under the angle of the scapula on the left hand, so that the fold was either vertical or points slightly downwards and outwards. The measurement was read quickly and recorded to the nearest 0.5 mm.

11. Bi-iliocristal Diameter

The subject stood steady with his heels together. I stood behind the subject with two blades of the first segment of the anthropometer rod in my hands. I brought the blades into contact with the iliac crest with the help of the fore-fingers at the place which gave the maximum width. Strong pressure was applied on the blades to press aside the fat over the iliac crests.
12. Bi-acromial Diameter

The measurement was taken with the first segment of the anthropometer rod. I stood behind the standing subject with the fore-fingers of my hands resting on the two blades of the anthropometer rod. The acromion points were located with the help of the fore-fingers while the subject stood with his shoulder relaxed to the point of slumping forward. The measurement was read with a little pressure on the blades.

13. Transverse Diameter of Chest

The measurement was taken with the first segment of the anthropometer rod with two arms/blades of the rod resting on the external surface of the sternum (or nipple level) on each side in a horizontal plane. The measurement was taken at the end of a normal expiration with light pressure on the blades.

14. Antero-Posterior Diameter of Chest

The measurement was taken with the first segment of anthropometer rod. The subject was kept standing and I stood on one side of the subject and passed the two blades, one on the anterior side and the other on the posterior side at the 3/4 level of sternabrae (nipple level) in a plane perpendicular to the body axis. The measurement was taken by exerting little pressure on the blades.

15. Arm Length

The distance between the inferior border of the acromion process and the tip of longest finger with the arm hanging down and the palm facing inward was measured with the help of a flexible fibre glass tape.
Nutritional Status

The body weight indicates the body mass and gives a rough estimate of body volume. It has been observed to be a sensitive indicator of growth failure and current nutritional status of the individuals. Moderate underfeeding of children results in partial depletion of nutritional resources and those children present a moderate clinical picture. The body weights of such children range between 76-90 per cent of the theoretical or ideal average for their respective ages. Such children are considered to suffer from first degree malnutrition. As the underfeeding increases by duration and quantity, the clinical condition of these children becomes more marked. Such children are considered to suffer from second degree malnutrition. The body weights of such children are usually between 61-75 per cent of the theoretical average for their ages. When body's nutritional stores are further depleted, the children's clinical conditions become more serious. The body weights of such children fall below 60 per cent of the theoretical average for their respective ages. These children are considered to suffer from third degree malnutrition. The above cut-off levels are validated by the statistically significant mortality rates (Gomez et al., 1956) between children from second (22.6%) and third (33.53%) degrees of malnutrition. Those of the children who are not subjected to any underfeeding usually look clinically normal and their body weights are more than 90 per cent of the theoretical averages of their respective ages. The details of cut-off levels are as below and classification is known as "Gomez's Classification" (Gomez et al., 1956).
<table>
<thead>
<tr>
<th>Nutritional grade</th>
<th>Body weight as per cent of standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>790</td>
</tr>
<tr>
<td>First degree malnutrition or Mild</td>
<td>75 - 90</td>
</tr>
<tr>
<td>Second degree malnutrition or Moderate</td>
<td>60 - 75</td>
</tr>
<tr>
<td>Third degree malnutrition or Severe</td>
<td>60</td>
</tr>
</tbody>
</table>

The grade three malnourished children need hospitalization, the grade II children can be treated at home by giving more food and grade I children could improve by feeding food.

Low weight for age may indicate either of the following two categories of malnutrition: firstly the children whose height for age is normal but weight deficit occurred as a result of an acute episode and secondly children who are retarded in linear growth showing height deficit for age as a result of underfeeding over longer periods and incidentally have low weight for age also. Thus the former is the result of acute and the latter is the result of chronic undernutrition. The Waterlow's Classification using height for age and weight for height distinguishes these two categories of undernutrition (Waterlow, 1973). The details are given as under:

<table>
<thead>
<tr>
<th>Height for age as per cent of standard</th>
<th>Weight for height as per cent of standard</th>
<th>Nutritional Grade</th>
<th>Type of Undernutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>790</td>
<td>790</td>
<td>Wasted and Stunted</td>
<td>Current long duration</td>
</tr>
<tr>
<td>790</td>
<td>780</td>
<td>Stunted</td>
<td>Long duration</td>
</tr>
<tr>
<td>790</td>
<td>780</td>
<td>Wasted</td>
<td>Short duration</td>
</tr>
<tr>
<td>790</td>
<td>780</td>
<td>Normal</td>
<td>Normal</td>
</tr>
</tbody>
</table>
The median values of height, weight and weight for height of well-to-do Hyderabad children are taken as standards (Hanumantha Rao et al., 1976).

**Dietary Intake**

The food consumption survey was carried out in every third household selected for demographic survey. The individual food intake of all the members of the previous day was assessed by oral questionnaire method. The mother or the elderly woman who had cooked and served the food was the respondent.

The quantity of raw foods used for various preparations and the volumes of cooked quantities of such preparations in terms of standardized cups were noted. The respondent was asked to indicate the quantities of different cooked items consumed by individual members on the previous day in terms of the standardized cups. The amount of raw food consumed by individual members was calculated as follows:

\[
\text{Quantity of raw food consumed by the individual member} = \frac{\text{Total quantity of raw food cooked for each item}}{\text{Total volume of cooked food}} \times \frac{\text{Volume of cooked food consumed by the individual member}}{}.
\]

After obtaining the quantities of different raw foods consumed by the individuals, the nutrients were calculated using the Table of Nutritive Value of Indian Foods (Gopalan et al., 1985) per capita food and nutrient consumption was also calculated.

Food consumption was expected to vary from with seasons in the tribals. The food consumption surveys were carried out in the same family thrice in the three selected seasons of the year: April to July (Summer), August to November (Rainy) and December to March (Winter).
Age Assessment

The age was assessed using the calendar based on local events. The calendar was formulated for each region separately. It contained the dates on which the festivals and other events occurred for the last 5-6 years. By finding out the festival during which the child was born and the number of such festivals that occurred after the child birth and the approximate date of birth of the child was assessed by referring to the calendar. This was used for children upto 5 years. For adults, the age was noted as completed years as given by the subjects.

The Statistical Tools

The different statistical tools used in the analysis of the data are dealt with as under:

Arithmetic mean and Standard Deviation

These have been calculated for various anthropometric measurements for different age and sex groups. The Analysis of Variance (ANOVA) technique coupled with multiple range test was used to test whether there was difference between the mean values of each measurement in the populations living in the three zones.

Univariate analysis was made to quantify the difference, significance of the differences in the mean values and to select or grade the three populations with respect to each variable (Snedecor and Cochran, 1975).

Correlation

The association between two quantitative measurements is known as correlation. This is commonly termed as zero order correlation. But often it is necessary to find correlation between three or more variates. For example, the body weight is influenced by height, fat, muscle. It is always worthwhile to know the contribution of height towards body weight. This can be done
by the method of partial correlation. The correlation between two variates when the linear effect of the other variates in them has been eliminated from both is called partial correlation. The partial correlation coefficients indicate the strength of the relationship between two variables once the effects of others have been held constant; their squared values indicate the proportion of the residual variance in the dependent (i.e., that variance not associated with the variables held constant) which is associated with the residual variance in the independent variable.

The zero order linear correlation coefficients between three variables at a time would be represented as $r_{12}$, $r_{13}$, $r_{23}$. The partial correlation would be denoted as $r_{12.3}$, the correlation coefficient between first and second variables keeping the third variable constant.

The partial correlation coefficients are computed in the following manner:

$$r_{12.3} = \frac{r_{12} - r_{13} \cdot r_{23}}{\sqrt{1 - r_{13}^2} \sqrt{1 - r_{23}^2}}$$

The partial correlation also lies between -1 to +1. The procedure outlined above for holding constant the effect of one independent variable can be extended to partial correlations involving several. Thus $r_{14,235}$ would indicate the correlation of $X_1$ on $X_4$ with the effects of $X_2$, $X_3$ and $X_5$ having been held constant. This would involve regressing the residual variance in $X_1$ not associated with $X_2$, $X_3$, $X_5$ against the residual variance in $X_4$ not associated with the same these variables.

Multiple Correlation

Partial correlation coefficient explains the relationship between two variables once the effects of others have been held constant; their squared
values indicates the proportion of the residual variance in the dependent which is associated with the residual variance in the independent variable. But what proportion of the total variance in the dependent variable can be accounted for by all of the independent variables together is denoted by the Multiple Correlation (R) and coefficient of determination (R² x 100).

Multiple Discriminant Analysis

The univariate analysis such as F test treats each anthropometric measurement as a discrete and independent unit of information. The interpretation of results became difficult and sometimes misleading. The human body is not made up of independently viable parts but it is a complex and integrated structure in which size and shape of all parts are in some way dependent on one another. Change in one variable is likely to influence the other variable one way or the other. In a situation wherein it is difficult to distinguish between two groups of individuals using a set of measurements it is often desirable to find a linear compound of the available measurements which would give the maximum power of discriminating the two groups or more. Discrimination function analysis is the appropriate statistical tool (Rao, 1952).

It has striking similarity to that of multiple regression. This method was essentially for selecting a linear function which would best discriminate between two groups on the basis of certain observed measurements. The discriminant problem is one of the classification and estimation of differences between two or more groups. The statistical theory of discriminant analysis assumes that the discriminating variables have a multivariate normal distribution and that they have equal variance, co-variance matrices within each group. In practice, the technique is very robust and these assumptions need not be strongly adhered to.
Step-wise Discriminant Analysis

This technique selects (a) the single best discriminating variable and (b) a second discriminating variable best to improve the value of discrimination criterion in combination with the first variable.

The procedure of locating the next variable that would yield the best criterion score, given the variables already selected continue until all the variables are selected or the addition of other variable does not improve the discriminating power. The step-wise procedure selects the bet and optimal set of discriminating variables.

Mahalonobis Distance

The method 'MAHAL' is used to maximise the Mahalanobis distance between the two close groups. The multivariate statistic is used to measure and test the significance of differences in the Mahalanobis Generalized Distance or $D^2$ (Mahalanobis, 1930). It is the square of the Euclidean distance in space obtained by transforming the original variables to uncorrelated standardized variables (Rao, 1952). The generalised distance is a summary statistic and conceals the relative importance of component variables.

Discriminant Function

Each discriminant function is an unique dimension meant to describe the location of one group in relation to the others. The maximum number of discriminant functions to be derived is either one less than the number of groups or equal to the number of discriminating variables whichever is less. Two discriminant functions could be derived in the present case. Both these discriminant functions could separate the groups.
Eigen Value and Canonical Correlation

These two measures judge the relative importance of the discriminant functions. The sum of eigen value is a measure of total variance and the relative percentage of eigen value indicates the relative importance of the associated function.

The canonical correlation is a measure of association between a single discriminant function and a set of (g-1) dummy variables which define the group membership. It indicates the closeness of relationship between the function and the 'group variable' and thus expresses the function's ability to discriminate between the groups.

Discriminant Coefficients

The standardized discriminant function coefficients represent the relative contribution of the associated variable to that function. The sign indicates whether the contribution is positive or negative.

Discriminant Scores

The unstandardized coefficients are useful for computational purpose. The discriminant scores are calculated by multiplying the raw values of the associated variables with unstandardized coefficients. These can be used for the classification of unidentified individuals into one group or the other.

Centroids

The means on all the functions are referred to as the group centroid. It is the most typical location of a case from that group in the discriminant function space.
Classification

This provides the percentage of individuals correctly classified by the variables being used.

Plot of Discriminant Scores

The 'territorial map' results because of two discriminant functions. Each point on the graph is classified according to the centroid to which it is closest.