In this chapter, we shall describe the materials and methods used in the present study. These materials and methods are related to those used for collection, analysis and interpretation of data.

Sampling

The present study was conducted among the Ao adults in the Mokokchung district of Nagaland between the months of September 2006 to April 2006. Mokokchung is the home of the Ao-Naga tribe.

The data were collected from both urban and rural areas of the Mokokchung district. For the urban sample, Mokokchung town was the universe of study and two localities or wards, namely, Alempang and Kumlong were selected randomly using random numbers given in Snedecor and Cochran (1967). For rural sample, villages were stratified according to three Rural Development Blocks, namely, Ongpangkong, Mangkolemba and Changtongya. The villages are Khensa and Settsü (Ongpangkong Block), Mulongyimsen ‘B’ Loyong and Yajang ‘C’ (Mangkolemba Block), and, Changtongya Yimsen and Wameken (Changtongya Block). The primary sampling units for each of the three strata are six villages randomly selected by using random numbers as given in Snedecor and Cochran (1967). The required number of villages for collecting data from each stratum was determined independently, following the optimum allocation method as suggested by Snedecor and Cochran (1967), which may be substituted as follows:

\[ R_h = \left( \frac{N_h \sigma_h}{\sum N_h \sigma_h} \right) \]  \hspace{1cm} (I)

Where \( R_h \) = relative sample size of villages in the \( h \) stratum, \( N_h \) = number of villages in \( h \) stratum, \( \sigma_h \) = standard deviation of the population size per village in \( h \) stratum.
Then, the required sample villages \( (n_h) \) to be selected from each stratum will be estimated as follows:

\[
n_h = \frac{N}{(R_{th} / \Sigma R_h)} \]

(2)

Where \( N \) = required number of villages to be covered from all three strata (i.e., about 5 or 6 villages), and \( \Sigma R_h \) = sum of relative sample size for all strata.

An attempt was made to cover more than 30% of the total households from each selected sampling unit (i.e., village or locality). No statistical sampling of individuals was applied for collection of data from each selected village or locality to avoid operational difficulties in the field. Instead, an attempt was made to include in our sample all those adults (aged 18-70 years) who are willing to co-operate with the present work. An attempt was also made to cover as many as 30 individuals for each age group. Table 3.1 shows the number of households and number of individuals covered for the present study. Altogether a total of 405 households and 1002 individuals were covered from rural area, and a total of 252 households and 802 individuals were covered from urban area.

<table>
<thead>
<tr>
<th>Village or Ward</th>
<th>Number of households</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khensa Village</td>
<td>134</td>
<td>302</td>
</tr>
<tr>
<td>Settsii Village</td>
<td>77</td>
<td>160</td>
</tr>
<tr>
<td>Wameken Village</td>
<td>43</td>
<td>127</td>
</tr>
<tr>
<td>Changtongya Yimsen Village</td>
<td>27</td>
<td>61</td>
</tr>
<tr>
<td>Mulongyimsen ‘B’ Loyong Village</td>
<td>77</td>
<td>191</td>
</tr>
<tr>
<td>Yajang ‘C’ Village</td>
<td>47</td>
<td>161</td>
</tr>
<tr>
<td>Alempang Ward</td>
<td>95</td>
<td>461</td>
</tr>
<tr>
<td>Kumlong Ward</td>
<td>157</td>
<td>341</td>
</tr>
</tbody>
</table>

Table 3.1. Number of villages and wards covered

**DATA ON ADULT BODY DIMENSIONS AND BODY COMPOSITION**

A cross-sectional method of anthropometric study was adopted for assessing the body composition and nutritional status of adults aged 18-70 years of age. Some selected anthropometric measurements from the basic list of measurements, which was recommended by the International Biological Programme (Weiner and Lourie, 1981) was taken into consideration for the purpose of the present study. Following are the anthropometric measurements taken on the selected subjects of both sexes wearing light apparel:
Weight (Kg)

Height (cm)

Sitting Height (cm)

Mid Upper Arm Circumference (MAUC) (cm)

Chest Circumference (cm)

Waist Circumference (cm)

Hip Circumference (cm)

Skinfold thickness:

Biceps (mm)

Triceps (mm)

Subscapular (mm)

METHODS OF TAKING MEASUREMENTS

Standard techniques of taking the anthropometric measurements as described in Weiner and Lourie (1981) and Sen (1994) were followed while taking the anthropometric measurements of adults. They may be briefly described as follows:

**Weight**

The body weight was taken with a spring weighing machine, asking the subject to stand on it bare foot with an erect posture and light apparel. The weighing machine was checked from time to time with a known standard weight. No deduction was made for the weight of light apparel while taking the final reading.

**Height**

It measures the vertical distance from the floor to the vertex. The subject was made to stand as erect as possible with his/her arms hanging at the sides with thumbs forward, heels holding together and eyes directing towards the horizon (Hooton, 1946). The anthropometer was
placed at the back and between the heels of the subject, taking care that it is kept absolutely vertical. The sliding sleeve of the anthropometer was then lowered down towards the middle of the head (Sagittal line) so that it would touch the vertex lightly. Reading in centimeter and its fractions were recorded.

**Sitting height**

It measures the vertical distance from the vertex to the sitting surface of the subject. The subject was made to sit on the stool, or a flat wooden chair, or at the end of a wooden bench. Then the subject was positioned in an erect sitting posture, with ankles crossed, knees spread at about 20 cm apart and hands rested on the thighs. The anthropometer was placed at the back and between the two buttocks, taking care that the lumbar curve of the subject was not flattened, but concave from behind. The sliding sleeve was the lowered down to touch the vertex lightly.

**Mid Upper Arm Circumference (MUAC)**

The measurement was taken with a steel tape at the middle (midway between acromion and elbow) part of the left upper arm on the naked skin (Sen, 1994), while the arms were hanging at the sides of the body.

**Chest Circumference**

It measures the circumference of the chest of the adult subject when he/she was breathing normally. This measurement was taken with a steel tape (Precision – 1mm) at the level of the meso-sternale and at the right angle to the axis of the body when the subject exhaled normally.

**Waist Circumference**

Waist circumference was measured midway between the lower rib margin and the superior anterior iliac spine. This measurement was taken with a steel tape at the right angle to the axis of the body when the subject exhaled normally.

**Hip Circumference**

Hip circumference was taken at the widest point over the greater trochanters. This measurement was taken with a steel tape at right angle to the axis of the body when the subject exhaled normally.
Biceps

The skinfold was picked up between the thumb and forefinger and the caliper jaws was applied at exactly the level marked. The measurement was read after the full pressure of the caliper jaws was applied to the skinfold. Harpenden Skinfold Caliper was used for taking the skinfold thickness. The skinfold was picked up on the front of the upper arm directly above the centre of the cubital fossa and the level marked on the skin for the arm circumference.

Triceps

The skinfold was picked up at the back of the upper arm about 1 cm above the level marked on the skin for the arm circumference and directly in line with the olecranon process.

Subscapular

The skinfold was picked up under the inferior angle of the left scapula. According to the natural cleavage of the skin, the fold was measured either vertical or slightly inclined downward and laterally.

Anthropometric Indices and ratios

Besides the above measurements, following indices and ratio were computed for both adult males and females for correlating with body composition.

1. Body mass index or BMI = weight (kg)/height (m)$^2$
2. Fat free mass index or FFMI = FFM (kg)/height (m)$^2$
3. Body fat mass index or BFMI = BFM (kg)/height (m)$^2$
4. Conicity index or CI = waist circumference (m)/0.109x√{weight (kg)/height (m)}
5. Conicity index or CI = waist circumference (m)/0.109x√{weight (kg)/height (m)}
6. Waist-to-Hip ratio or WHR = waist circumference (cm)/hip circumference (cm)

Anthropometric measurements were used to estimate the body composition (FM and FFM), using the prediction equations of Durnin and Womersley (1974) and Siri (1961) based on age, weight, height, and skinfold thickness. Body density was calculated according to Durnin and Womersley formula, which was in turn used to estimate the percent body fat (PBF) or percent BFM by using Siri’s equation:
%BFM = (4.95/density-4.50) × 100

BFM was calculated as body weight multiplied by percent FM and then divided by 100:

BFM = weight (kg) × %BFM/100

FFM was then calculated as body weight minus BFM:

FFM = weight (kg) - BFM (kg)

The BMI (body weight in kg divided by the square of height in meters) was separated into two components: body fat mass index (BFMI = BFM in kg divided by the square of height in meters) and fat-free mass index (FFMI = FFM in kg divided by the square of height in meters) to test the relationship between body composition in terms of BFMI and FFMI with morbidity and other parameters.

Bioelectrical Impedance Analyzer

The body composition was also estimated using Bioelectrical Impedance Analyzer with four-point tactile electrodes (HBF-302, Omron Healthcare, Co. Ltd., Japan). This device measures the electrical signals of undetectably low voltage as they passed through the body fat via handheld device. Since fat is a very poor conductor of electricity, a greater fat accumulation in the body would impede the flow of the current. By measuring the resistance to the current, the device estimates the percent body fat, which can be used for estimating fat-free mass (FFM) by subtracting from body weight.

Blood pressure

Mercury sphygmomanometer was used to measure blood pressure of the individuals included in the present study. All measurements were taken on left hand when subjects were being seated position. Each participant was asked to relax and take rest for 10 minutes before taking the measurement. Systolic blood pressure was recorded as the first Korotkov sound (phase I). Distolic blood pressure was taken as the disappearance of the Korotkov sounds (Phase V). Measurements were recorded for three times, and the average of the three was taken as recorded measurement. Digital blood pressure monitor (M2 Model, Omron Health Care Co. Ltd., Japan) was also used to cross-check the measurement. However, mercury type of measurement was reported for the present study.
Data on Morbidity

Data on morbidity were collected on the basis of "self reported illness" of the information taking into consideration the timeframe of two-week, three-week and four-week recalls of illness prior to the survey. Structured schedules were prepared by taking into consideration those described in different health studies conducted in India and abroad (IIPS and Macro International, 2000; Strickland and Tuffrey, 1997). Such schedules took into consideration the informant’s perception of illness rather than the Western medical definition of a specific disease. In order words, the present study did not include a clinician thereby morbidity is referred to as an "illness" rather than a "disease". The self-reported symptoms of illness were grouped into different categories as followed by many studies (Strickland and Ulijaszek, 1993; Strickland and Tuffery, 1997; Sadana, 2000). The categories include: (1) Cold/respiratory disorders: cough + runny nose + headache + fever, fever + cough, cough alone, swollen glands + cold, ear problem, breathing problem, chest pain, sore throat, tuberculosis. (2) Diabetes – Type I and Type II. (3) Cardiovascular problems including hypertension. (4) Miscellaneous disorders: sores/boils, fever alone, chicken pox, malaria, typhoid, scabies, jaundice, all body pain, osteoarthritis, rheumatism, headache alone, malnutrition, weakness, don’t know/unknown.

Socio-economic and demographic data

Rural and Urban

In the present study, the terms rural and urban were based on the definitions and concepts as given in Census of India, 2001. An urban area is defined as all places with a Municipality, Municipal Corporation, Cantonment Board, Notified Area/Town Committee, etc., and which satisfies the criteria such as a minimum population of 5000, at least 75% of the working population is engaged in non-agricultural pursuits and the population density is at least 400 per square kilometre. It also states that a town, whether statutory or non-statutory is an urban unit with a population below 100,000. Any place i.e., inhabited villages, which do not fulfil the criteria to be treated as urban units are treated as rural areas.

Thus, basing on this, Mokokchung town was classified as an urban area. While the six villages were classified as rural areas.
Education

The data on education of the individuals were classified into three broad educational levels, namely, primary, secondary and higher secondary and above. In the present study, the number of illiterates, i.e., those individuals who were not able to read or write, was negligible especially in urban areas. Therefore, we pooled some illiterate individuals in the category of primary level of education, which includes lower primary and upper primary, i.e., up to standard VIII. In the secondary level of education, we included those individuals who attended standard VIII to X. Higher Secondary level and above included other individuals who attended standard XI and other higher levels of education. This educational classification is highly arbitrary. However, our purpose is simply to examine the trend of body composition and nutritional status according to educational levels of the individuals. It is assumed that if education is really important in regulating body composition and nutritional status like in the western countries, its effects can be observed even if the individuals were dichotomized only into two categories, say, lower and higher levels of education.

Household Income

Data on monthly income were directly collected from the heads of the households and were cross-checked taking into consideration some aspects of socio-economic conditions like housing condition; house type, ownership of house, number of rooms, etc., household possession, sanitation, types of occupation, land holding, and monthly expenditure. Income groups were classified into three categories, namely, Low, Middle and High Income groups based on the per capita monthly income as follows:

- Above 75th percentile (>Rs.2200) = High income group (HIG)
- 50th to 75th percentile (Rs.1500-2200) = Middle income group (MIG)
- Below 50th percentile (<Rs. 1500) = Low income group (LIG)

Family size

Data on family size was classified into three groups: (1) Ideal or Small – family consisting of four or less members. (2) Medium – family consisting of five or six members. (3) Large – family consisting of more than seven members.
Physical Activity

Physical activity level was classified on the basis of occupations of the individuals, as described by the Indian Council of Medical Research (ICMR, 1991). The physical activity was classified into the following three categories for both males and females: (1) Sedentary - teacher, barber, housewife, student, nurses, executives, retired personnel, land-lord, tailor, peon, postman, pastor or priest, salesperson, shopkeeper, etc. (2) Moderate - agricultural labourer, farmer, fisherman, potter, fitter, tuner, welder, industrial labour, cooli, beedi-maker, carpenter, weaver, driver, plumber, electrician, basket-maker, maid servant, etc. (3) Heavy - stone-cutter, wood-cutter, blacksmith, etc. Due to limited sample size with respect to Heavy category from females, the physical activity level in the present study was classified into two categories, sedentary and moderate.

Statistical analyses

The basic design of the study is to analyse and present comparative data between urban and rural areas. In addition, the main focus of analysis was on the relationship between body composition and nutritional status, and their relationship with biosocial variables, such as age, sex, anthropometric variables, self-reported morbidity, blood pressure, physical activity, occupation, household income, education and family size.

All data was managed and analysed using SPSS/PC Software. The analysis was first carried out to present the basic descriptive statistics of anthropometric variables, blood pressure and morbidity prevalence in relation to socio-economic characteristics of the study samples for both rural and urban areas. The nutritional status was assessed, using the cut-off points for body mass index as recommended by the World Health Organization (WHO, 1995, 2000). The relationship between body composition and nutritional status was tested, using analysis of covariance (ANCOVA) and multiple regression analysis. For example, the differences in mean FM and FFM values according to nutritional groups by age and sex was determined, using ANCOVA after adjusting for socio-economic variables. Multiple regression analysis was used for testing the nature of such relationship, if any. Special attention was given to the relationship of body composition/nutritional status with morbidity, blood pressure and socio-economic conditions by applying appropriate statistical analyses. For example, the relationship between body composition/nutritional status and morbidity was tested, using odds ratios with 95% confidence interval from different models of logistic regression analysis after adjusting for socio-economic variables that would be quantified in
terms of appropriate dummy numbers to fit the logistic models. On the other hand, the relationship between nutritional status and blood pressure was determined, using ANCOVA and multiple regression analysis because blood pressure is a continuous trait.