CHAPTER VII

SUMMARY

This thesis is concerned with the body composition and nutritional status of Ao adults in the Mokokchung district of Nagaland. Body composition is defined as “the make-up of the body in terms of the absolute and relative amounts of adipose tissue, muscle mass, skeletal mass, internal organs and other tissues” (Bogin, 1999). In body composition research, body mass is considered as the sum of all components at each of the five levels namely, atomic, molecular, cellular, tissue-organ and whole-body (Wang et al., 1992). The earliest attempt for describing body composition and the most common method today is the two-component model that includes Fat Mass (FM) and Fat Free Mass (FFM). This method is commonly used because of simplicity, speed and low cost techniques for large field studies, and therefore it is one of the most widely applied models in body composition research (Norgan, 2005). Under this model, body composition can be assessed by using either anthropometry or other techniques like the bioelectrical impedance analysis (BIA). Anthropometry, which includes measurements of body weight, height, body mass index (BMI), mid upper arm circumference (MUAC) and skinfold thickness, is widely used in anthropological and biomedical studies for the assessment of body composition by using certain prediction equations.

The measurement of body composition is essential for studying human variation and adaptation, and it is being used increasingly in the assessment of growth and nutritional status, fitness, work capacity, disease and its treatment (Norgan, 1995). Recently, one of the major interests of research on body composition is the health problems of obesity, or an excess body fat due to over-nutrition, which has been declared as an epidemic in developed countries (WHO/FAO, 2003). In country like the United States, obesity is one of the leading causes of death and thereby has a large impact on public health (Stein and Colditz, 2004). In developing countries, although under-nutrition remains a major health problem, obesity is also emerging with the improvement in socio-economic condition and increasing urbanization (Popkin, 2002). Many countries in Asia are in this situation due to “changing dietary pattern towards energy-dense and high fat diets, together with a more sedentary lifestyle arising from increasing urbanization” (Florentino, 2002). The increasing
urbanization, changes in standards of living, dietary patterns and occupational work patterns are the key factors to risks of obesity and associated morbidity, such as diabetes mellitus, cardiovascular disease, hypertension and stroke, osteoporosis, and some forms of cancer (WHO/FAO, 2003).

In India, most of the body composition studies are concerned with the problem of under-nutrition, although there is evidence of socio-economic and nutrition transition that is likely to increase the epidemic of chronic diseases and obesity, particularly in the urban areas (Rao, 2001; Shetty, 2002). When this study was proposed about 6 years ago, there was a lack of specific population information about factors associated with obesity and its associated morbidity. Little was also known about the relationship between adult body composition and under-nutrition, except those studies carried by Shetty (1984) and Ferro-Luzzi et al. (1997) in South India. There was also dearth of information on the relationship between body composition and morbidity patterns (Campbell and Ulijaszek, 1994), although many studies were carried out on the relationship between body mass index and socio-economic conditions (Bharati, 1989; Reddy, 1998; Khongsdier, 2002). In addition, little works have been done on the relationship between body composition and body form (i.e., size and shape), except one study on the correlation between body mass index and corneal index in Northeast India (Khongsdier, 2001). Therefore, we undertook a study of body composition and nutritional status in relation to biosocial factors among the Ao adults aged 18-70 years in the Mokokchung district of Nagaland.

Chapterization
The thesis has been divided into seven chapters. The first chapter gives a general introduction relating to the scope and importance of the study. The objectives and statement of problem are also given in this chapter along with a brief description of the study population and study area. The II Chapter deals with the review of literature. Chapter III describes the materials and methods of data collection. The methods of data analyses are also presented in this chapter. Chapter IV gives the findings on adult body dimensions, body composition and nutrition status of the study population. Since our design of study is to compare the rural and urban differences in these characteristics, the chapter segregates the total sample size into rural and urban areas in order to examine the differences and the causes of such differences. In Chapter V, we described our findings on the effects of socioeconomic characteristics on adult body dimensions, body composition, nutritional status, blood pressure and self-reported morbidity. Chapter VI discusses the findings of the study in the light of
other studies. It also discusses the social and biological implications of the findings. Chapter VII gives the summary and conclusions.

OBJECTIVES OF THE STUDY
The study is more exploratory rather than testing hypotheses based on previous studies especially among the Ao population where no study has so far been carried out. The objectives of the study are as follows:

1. To assess the body composition and nutritional status of adults aged 18-70 years from rural and urban areas, using anthropometric indices and electrical impedance analysis.
2. To understand the relationship of body composition and nutritional status in relation to age, sex, anthropometric variables, self-reported morbidity, blood pressure and socio-economic variables.
3. To analyze the effects of socio-economic factors, such as physical activity, occupation, income, education and family size on adult body dimensions, nutritional status, self-reported morbidity and blood pressure.

MATERIALS AND METHODS
Study Area and Population
The present study was conducted among the Ao adults in the Mokokchung district of Nagaland between the months of September 2005 to April 2006. The present study was conducted among the Ao adults in the Mokokchung district of Nagaland. It became a full-fledged district in 1957. The district is situated in the north western part of the state, between 25°45' N and 26°30' N latitude and between 94°0'E and 94°45'E longitude. It covers an area of 1615 square kilometers with a total population of 2,27,230 (Census of India, 2001). Longleng and Tuensang districts bound Mokokchung on the East, Wokha district on the West, Assam state on the North and Zunheboto district on the South. Mokokchung Town is the district headquarters and it is located at a height of about 1,326 meters above sea level.

Mokokchung is the home of the Ao-Nagas. Besides the Ao tribe, a good number of other Naga tribes and also other communities reside in the district, especially in the district headquarters, i.e., Mokokchung town. Some of the Nagas who reside in this district include the Sumi, Lotha, Sangtam, Phom, Chang, Khamniungan and Chakhesang, while those from other communities include the Nepalis, Biharis, Bengalis, Marwaris, Assamese, etc. All these different groups have taken residence in the district because of various socioeconomic
reasons such as employment both in Central and State Governments, private institutions, as labourers, as businessmen and also because of marital reasons.

The data were collected from both urban and rural areas of the Mokokchung district. For the urban sample from Mokokchung town, two localities or wards, namely, Alempang and Kumlong were selected randomly by lottery method. For rural sample, six villages were randomly selected from three Rural Development Blocks, namely, Ongpangkong, Changtongya and Mangkolemba according to stratified random sampling. 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) based on the population size. 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 were willing to co-operate with the present work. 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.

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. Standard techniques of taking the anthropometric measurements were followed (Weiner and Lourie, 1981; Heyward and Wagner, 2004). The anthropometric measurements included weight (kg), height (cm), sitting height (cm), mid upper arm (MUAC), chest, hip and waist circumferences (cm), skinfold thickness at biceps, triceps and subscapular (mm).

Anthropometric measurements were used to estimate the body composition (BFM and FFM), using the prediction equations of Durnin and Womersley (1974) and Siri (1961) based on age, weight, height, and skinfold thickness. Anthropometric indices and ratios, such as body mass index (BMI), concic index, conicity index, waist-hip ratio, etc. were also calculated, following standard methods. The nutritional status was assessed, using the cut-off points for body mass index as recommended by the World Health Organization (WHO, 1995, 2000).

Bioelectrical Impedance Analyzer

The body composition was also estimated using Bioelectrical Impedance Analyzer (BIA) 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 in 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). Diastolic 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.

**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 the informant’s perception of illness rather than the Western medical definition of a specific disease. The self-reported symptoms of illness were grouped into different categories as followed by many studies (Strickland and Ulijaszek, 1994; Strickland and Tuffery, 1997; Sadana, 2000).

**SOCIO-ECONOMIC CATEGORIES**

In the present study, certain socio-economic variables were classified arbitrarily into different groups and/or categories with a view to understanding their influence on body composition and nutritional status. Our classification may be briefly described as follows:

**Income groups**

Data on household income were collected directly from the heads of the households and they were cross-checked taking into consideration some aspects of socio-economic conditions like housing condition, types of occupation, land holding, and monthly expenditure. The per capita monthly income of the households was classified 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)
Educational Level

Data on educational attainment of individuals in the present study were arbitrarily 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, we 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.

Family Size

The family size was classified into three categories. The individuals who lived in a household with less than 4 family members were considered as having a Small Family Size. The Average/Medium Family Size includes those individuals who lived in a household with 5-6 family members. The individuals who lived in a household with more than 7 family members were grouped in the category of Large Family Size.

Physical Activity

Two types of physical activity level were classified according to occupations of the individuals as described by the Indian Council of Medical Research (ICMR, 1991). These are: (1) Sedentary includes 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.

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 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.

FINDINGS OF THE PRESENT STUDY

As already mentioned, the findings of the present study were presented in chapters IV and V. Since our design of study is to compare the rural and urban differences, the chapter segregates the total sample size into rural and urban areas in order to examine the differences and the causes of such differences. I shall briefly present them as follows:

Socioeconomic characteristics

The findings on the important socioeconomic characteristics show that urban areas are more advanced in both education and economic condition. It is also observed that the proportion of participants with small family size is higher in urban than in rural areas, and a large proportion of women in urban area contributed to family income.

Anthropometric traits

1. The findings on anthropometric traits indicate that urban males are significantly heavier and taller than rural males. Urban males have also greater hip circumference
and biceps. Rural males have greater cromic index, conicity index and waist-hip ratio. It is also interesting to note that although there is no significant difference in body mass index (BMI) between rural and urban males, the fat free mass index was significantly greater in rural males than in urban males. This indicates that the greater muscle mass in rural males might be due to greater physical activity in rural areas.

2. As for females, almost all the anthropometric characters are significantly greater in urban than in rural areas. This clearly indicates that there are considerable differences between rural and urban areas with respect to body dimensions and composition among adult females in the present study.

Body Composition
In the present study, the body composition follows a 2-compartment model, and it is therefore divided into two major body components, namely, fat free mass (FFM) and body fat mass (BFM). Anthropometry and Omron bioelectrical impedance analyzer (OBIA) are used to measure the body composition.

1. It is found that FFM measured by OBIA is about 0.90 kg different from that estimated from anthropometry. The standard error of estimate (SEE) in FFM according to OBIA is reported to be $\leq 3.5$ kg for men and $\leq 2.8$ kg for women (Heyward and Wagner, 2004). Considering these values of SEE, we suggested that the body fat estimated from anthropometry is by and large similar to that measured by OBIA.

2. The mean values of BFM and FFM were 9.20 kg and 45.79 kg for rural males, and 9.70 kg and 47.16 kg for urban males, respectively. Therefore, both BFM and FFM are greater in urban males compared to their rural counterparts, despite the absence of statistical significance in respect of BMI and percentage of BFM and FFM. The rural-urban differences are more pronounced among females, which indicated that BFM and FFM, expressed in kg and percentage of body weight, are significantly greater in urban than in rural females.

Nutritional Status
The nutritional status of participants in this study was assessed by using BMI, taking into consideration the cut-off point of 23.0 kg/m$^2$ for defining overweight among Asian populations (WHO, 2000). On the basis of ROC curve analysis, we also found that this cut-off point is more appropriate in the present study. It is found that the BMI cut-off point for defining overweight among the Ao Nagas lies between $\geq 21$ kg/m$^2$ and $\geq 23$ kg/m$^2$ against the reference PBF $> 25\%$ for men and $> 30\%$ for women (Deurenberg et al., 1998, 1999).
It is found that the prevalence of underweight in males was significantly lower in rural (17.11%) than in urban (24.94%) areas. The rural-urban difference in the prevalence of underweight among women was not statistically significant, although it appears to be higher in urban (31.49%) than in rural (28.43%) areas. Pooling males and females, the overall prevalence of underweight is 22.95% in rural and 28.18% in urban areas. These values are lower than those reported from other tribal populations of Northeast India such as Boro-Kacharis, Lalungs, Miris and Pnars (Khongsdier, 2001) and War Khasi (Khongsdier, 2002). They are also lower than that reported for caste groups like Brahmins and Jogis (Khongsdier, 2001). In short, the nutritional status of the Ao Nagas is better than most of the tribal populations in Northeast India.

Following the international cut-off points (WHO, 1995), the prevalence of overweight (including obesity) was 5.98% and 7.90% in rural and urban adult males, respectively. These frequencies were 8.51% and 13.10% in rural and urban adult females, respectively. These results suggest the prevalence of overweight was higher in urban than rural areas, and also among females compared to males. Further, the prevalent rate increases considerably according to the cut-off points recommended for the Asia-pacific regions (WHO, 2000). It is found that the prevalence of overweight was 15.26% and 18.77% in rural and urban adult males, respectively. In the case of adult females, these frequencies were 17.21% and 24.94%, respectively.

### Relationship between Body Composition and Nutritional Status

1. It is found that both PBF and FFM have significantly increased with the increase in BMI levels. It also indicates that the urban males have a higher FFM than the rural males across levels of BMI, although it is expected that greater physical activity may increase FFM in rural areas. In short, it is difficult to conclude whether BMI is more related to PBF or FFM.

2. It may be noted that the major nutritional problem is the correlation between excess body fat and other chronic diseases. Secondly, BMI is a crude measure of both body fat and fat free mass. High BMI may also be due to high muscle mass, not necessarily because of high body fat. Accordingly, it has been suggested to split the BMI into two parts, body fat mass index (BFMI) and fat free mass index (FFMI) to understand the relationship between body composition and nutritional status (Van Itallie, et al., 1990). The present study indicated that BFMI was more correlated with PBF, whereas FFMI is more correlated with FFM for both the sexes in rural and urban areas. For example, the differences in scatter plots of PBF on BMI and BFMI in rural males...
shows the relationship of PBF is more curvilinear with BMI but more linear with BFMI. Therefore, the present findings suggest that the split of BMI into BFMI and FFMI may be important in understanding the relationship between body composition and morbidity, especially in a population with high prevalent of overweight and obesity.

**Body composition and body shape**

In the present study, body shape refers to the relative body dimensions that are commonly expressed as indices or ratios. We have taken into consideration three important indices and ratios, namely, cormic index, conicity index and waist-hip ratio.

1. Cormic index or relative sitting height is one of the most common bivariate indices of body shape. It has been suggested that the variation in cormic index between and within populations may be associated with variations in BMI and body composition (Norgan, 1994). In the present study, we have observed that the effect of cormic index on body composition of the present population is significant only with respect of PBF, but it is not clearly perceptible in the case of FFMI.

2. Both urban males and females with greater level of conicity index (≥1.10) are likely to have greater PBF than their rural counterparts. Similarly, PBF and FFMI are significantly higher among persons with greater waist-hip ratio compared with those having lower waist-hip ratio in both rural and urban areas. In addition, the means of PBF and FFMI are by and large greater in urban males and females compared with their rural counterparts.

Overall, the present study strongly indicates that body composition is significantly correlated with body shape in terms of cormic index, conicity index and waist-hip ratio. It is also observed that body composition is correlated with sex and rural-urban setting.

**Anthropometric Traits and Socioeconomic Factors**

In Chapter V, we analyzed the effects of socioeconomic factors on adult body dimensions, body composition, nutritional status, blood pressure and self-reported morbidity. The adult body dimensions, body composition and nutritional status are described in terms of anthropometric measurements and indices; whereas the socioeconomic characteristics are described in terms of occupation, household income, education, family size. Since our design of study is to look into the rural and urban differences in these characteristics, total sample size was segregated into rural and urban areas in order to examine the differences and the causes of such differences. Some of the major findings are as follows:
1. The means and standard deviations of anthropometric traits by age group in the present study show that with the exception of chest girth, waist and hip circumferences the mean anthropometric traits are higher significantly in the lower age groups for both adult males and females. Therefore, the present findings may be related to secular trend. By secular trend, we mean an increase in anthropometric measurements, particularly height and weight, from one generation to another due to improvement in economic condition of a given population. Nevertheless, the present findings clearly indicate that individual age should be taken into consideration when carrying out statistical analyzes on the effects of socioeconomic conditions on anthropometric traits, or while assessing the nutritional status of the study population in relation to socioeconomic conditions.

2. It is observed that the differences between income groups are highly significant in almost all anthropometric traits in both males and females. Most of the mean anthropometric traits are significantly higher in the higher income groups in both rural and urban areas. This observation is similar to those reported for other Indian populations (e.g., Bharati, 1989, Reddy, 1998; Khongsdier, 2002). Thus, anthropometric traits in the present study are to a great extent influenced by household income in both rural and urban areas for both the sexes.

3. In addition to household income, the present findings indicate that education has certain role in patterning anthropometric traits. In general, it indicates anthropometric characters are greater in adults with higher educational level, especially among females. However, household income seems to be more influential than education especially among males. However, the effect of family size was not clearly perceptible, except in respect of MUAC in rural females, and hip circumference and FFMI in urban females. It indicates that family size has little role to play in the variation of anthropometric traits in comparison with household income and education.

4. Physical activity is another important factor that affects anthropometric characters in the present study. As normally expected, sedentary individuals have greater body fat as indicated by body weight, skinfold thickness and BFMI, especially among urban females. Although the present study failed to identify different levels of physical activity, our findings suggest that anthropometric indicators of overweight and obesity are negatively influenced by physical activity as suggested by many studies.
Self-reported Morbidity

1. The overall prevalence of morbidity in rural and urban areas is 8.78% and 9.35%, respectively. It is found that the prevalence of morbidity increases with the increase in age groups in both rural and urban areas, suggesting that the older persons are likely to have higher morbidity. However, the effects of sex, education, income and family size on morbidity are not clearly perceptible in the present study.

2. It is found that the nutritional status is likely to be associated with morbidity, especially in urban areas where the prevalence of self-reported morbidity among overweight individuals was greater than that among the underweight individuals. Although self-reported morbidity refers here to different types of morbidity during the last one month, our findings suggest to certain extent the association between morbidity and overweight or obesity. Therefore, the present study supports the general observation that overweight or obesity is associated with different types of morbidity (e.g., WHO/FAO, 2003; Janssen, 2007). The positive relationship between self-reported morbidity and obesity was also observed in the individuals with greater conicity index and WHR as mentioned earlier, i.e., individuals with greater conicity index and WHR were likely to have a greater risk of morbidity. This justifies the need for taking appropriate action in preventing the emerging trend of obesity in the state.

Hypertension

1. In addition to self-reported morbidity, nutritional status in the present study is associated with hypertension in both rural and urban areas. It is also observed that the prevalence of hypertension associated with greater conicity index and greater waist-hip ratio as suggested by many scholars (e.g., Venkatramana and Reddy, 2002; Shetty, 2002; Das et al., 2008). In other words, the present findings confirmed that overweight and obesity is associated with hypertension.

2. We have also observed that the prevalence of hypertension is higher in males than in females in both rural and urban areas. Further, the prevalence of hypertension increased with the increase in age groups in both rural and urban areas, suggesting that older people are likely to be more hypertensive. It is also found that household income is positively associated with hypertension. However, the effect of education and family size on hypertension is not clearly perceptible in the present study. It may be mentioned that studies in developed countries have revealed that hypertension is negatively associated with socioeconomic conditions, showing that higher socioeconomic status was associated with lower blood pressure or a lower prevalence
of hypertension (for review see Colhoun et al., 1998). In developing countries, the relationship between blood pressure and socioeconomic status is not clearly understood. Some studies have revealed that blood pressure was positively associated with social class for men, but negatively for women (e.g., Dressler et al., 1988; Abdo and Leon, 2009). Other studies have shown that there was a U-shaped relationship between income and blood pressure, women with either high or low incomes had higher blood pressures than those with middle incomes (Mendez et al., 2003). Nevertheless, the present study indicated a positive relationship between hypertension and household income.

**Underweight and Overweight**

1. The prevalence of underweight and overweight in the present study is correlated with urbanization and household income. Individuals in the lower income groups are likely to have greater prevalence of underweight as observed in other Indian populations (e.g., Bose and Chakraborty, 2005, Kusuma et al., 2008). It is found that the prevalence of underweight decreases with increase in the age groups. It is also found that females are more underweight than males especially among low economic groups. In addition, the prevalence of underweight decreases with increase in the age groups. However, the effects of education and family size on underweight are not clearly perceptible in the present population.

2. As for overweight, it is found that the overall prevalence of overweight is higher among females compared to the males, in both rural and urban areas. This difference in sex is similar to that reported from other populations (Shukla et al., 2002, Das and Bose, 2006). The rural-urban differences suggest that the risk of being overweight is greater in urban than in rural areas, especially among females. This is similar to the findings reported from other populations in India (Shetty, 2002; Bhat et al., 2005). It is found that older adults had greater prevalence of overweight. The effect of education and family size is not clear. However, the prevalence of overweight increases with the increase in the income groups, in both rural and urban areas. This association between overweight and income is also reported from other Indian populations (e.g., Rao et al., 1995; Reddy, 1998). It is also found that overweight is associated with greater cormic index, conicity index and waist-hip ratio.
Concluding Remarks

The main purpose of the present study is to understand the relationship between body composition and nutritional status, and how certain demographic and socioeconomic factors could influence the body composition and nutritional status of the Ao Nagas. The findings clearly indicated that the relationship between body composition and nutritional status is compounded by different factors including urbanization, demographic and socioeconomic factors. In other words, body composition and nutritional status are just like two sides of the same coin, which are greatly influenced by urbanization, demographic and socioeconomic factors. These findings can be interpreted differently from different perspectives. From the anthropological point of view, the study of body composition and nutritional status is biocultural in nature within the framework of evolutionary perspective. From the nutritional and health points of view, the present study clearly reflects that the Ao population is under the double burden of underweight and overweight. The convergence between anthropological and nutritional perspectives is clearly reflected by the present study, which indicates how body composition and nutritional status are associated with different demographic and sociocultural characteristics of the study population. Although this study is cross-sectional in nature, it has evolutionary implications for understanding the health and nutritional status of the population.

From the evolutionary point of view, basic nutrients required for humans are relatively constant through different stages of human evolution, and there were no major morphological changes, except upright posture and development of brain capacity during the *Homo erectus* stage. However, there are two major stages of nutritional transition since the time of *Homo erectus*. Firstly, the widespread of agriculture during the last 10,000 years has a profound impact on nutritional and socio-cultural conditions of the people. They started consuming large amounts of grain, milk, and meat of domesticated animals and becoming more sedentary. Population growth started increasing and societies became larger. Secondly, with the advent of industrial revolution about 200 years ago in high-income countries, human populations have experienced another dramatic change in food production, processing, storage and distribution. These have brought about major changes in the nutritional composition of the diets. The traditionally plant-based diets have been quickly replaced by high-fat, energy-dense diets with high content of animal-based foods. These dramatic and rapid changes are believed to have a great impact on the health and nutritional status of the
people all over the world, although the rates of changes vary considerably within and among populations depending upon technological, demographic, social and economic conditions.

The major health implication of such rapid changes is the emergence of obesity and its associated morbidities (co-morbidities) in both developed and developing countries. In developed countries, obesity has become an epidemic. The situation is more serious in developing countries, where both underweight and overweight co-exist. This contention is clearly supported by the findings of the present study. It is observed that both underweight and overweight among the Ao Nagas are associated with urbanization and socioeconomic status.

It may be recalled that Popkin (1994, 1998) has called attention to the 'nutrition transition' in developing countries, or the shift from traditional diets and lifestyles to 'Western' diets (ie high in saturated fats, sugar and refined foods), and the combination of reduced levels of physical activity and increased stress, particularly in the rapidly growing urbanization. The feared outcomes of the nutrition transition are increased levels of obesity and chronic and degenerative diseases. In Nagaland, increasing rural-urban migration in the state could be associated with various factors especially in search of better jobs, education and living conditions. Consequently, there are changes in economic conditions, dietary intakes, physical activity and lifestyles, which may be responsible for overweight and obesity among urban individuals.

The lower prevalence of underweight in rural area compared to urban area is very interesting from the biocultural point of view. The egalitarian nature of society with a strong kinship bond and social responsibility to look after the poor in Ao villages may be one of the possible factors for the lower prevalence of underweight in rural areas. Therefore, the policy implication for reducing underweight in rural areas should be integrated with the cultural system of the society. In addition, the policy implication is not only to reduce underweight but also to prevent overweight and obesity especially in urban areas.

Another remark to be made with regard to the present study is the use of the BMI cut-offs for defining overweight and obesity. If the cut-off points for the Asia-pacific regions (WHO, 2000) are used, the prevalence of overweight increased about 9 to 12 percentage points. The ROC curve analysis on the basis of the risk factor like hypertension seemed to support the cut-off points recommended for Asian population. Consequently, the burden of overweight and obesity would increase in the population. This may have implication not only
for the emerging health problems of the present population but for the entire Indian population. Some studies in central and western India have shown that the prevalence of overweight according to the international cut-off points (WHO, 1995) ranges from 30% to 45% (Sidhu and Tatla, 2002; Tiwari et al., 2010). If the cut-off points for the Asia-pacific regions (WHO, 2000) are used, the prevalence of overweight and obesity would increase to the level equivalent or greater than that reported for western countries. In other words, overweight might have exceeded underweight in many Indian populations especially in urban areas. Accordingly, the health problems of underweight have been replaced with those relating to overweight and obesity in such populations. Future studies in India should pay more attention on how to identify the health risk factors of BMI at different levels, keeping in view the two recommended cut-off points mentioned above. In addition, the measures of central obesity in relation to BMI and risk factors are not clearly understood in Indian populations. More studies are needed to study the relationship between body composition and nutritional status. In the present study, we suggest to split BMI into fat mass and fat-free mass components to have a better understanding of the risk factors associated with obesity and overweight in Indian populations.

The present study has supported that body dimensions, nutritional status, self-reported morbidity and hypertension are associated with certain demographic and socioeconomic factors. However, the effect of economic status on the above measures seemed to be more pronounced. While it is negatively associated with underweight, on the one hand, household income is positively associated with overweight, hypertension and self-reported morbidity, on the other hand, especially in urban areas. These findings may have certain implications for understanding the dynamics and extent of socioeconomic disparity and its impact on health and nutritional status not only among the Ao Nagas, but also in our country as a whole. On the one hand, India with a population of more than one billion, the poverty has remained the greatest challenge related to health problems. On the other hand, recent studies have indicated that the country is facing with nutrition-related problems among the affluent, predominantly affecting the urban population. There is no denying the fact that the middle class and the affluent segments of the India’s population are increasing in recent years. As a result, India is faced with the double burden of under- and over-nutrition. Therefore, the policy implication is not only to reduce underweight due to poverty, but also to prevent the spread of overweight and obesity due to economic transition.