CHAPTER VI

DISCUSSION AND CONCLUDING REMARKS

In this Chapter, we shall briefly discuss our findings in the context of other findings on other populations including those from Northeast India. We shall also look into the implications of the present findings.

Rural-Urban Difference in Socioeconomic Conditions

It is clearly evident from the present study that urban areas are more advanced in both education and economic condition. Therefore, it is consistent with the earlier reports. For example, the National Family Health Survey-3 (IIPS and Macro International, 2009) revealed that more than one-third of households (35%) in urban areas of Nagaland belonged to the highest wealth index as compared to only 7% of households in rural areas. The same is true with regard to literacy rates, which were 63% and 85% in rural and urban areas, respectively (Census of India, 2001). Although data on wealth index are not available for Mokokchung district of Nagaland, 2001 census data indicated that the literacy rate was higher in urban (92%) than in rural (85%) areas. Nevertheless, on the basis of the present findings on education and household income, it is likely that urban areas are more advanced than rural areas.

It is further observed that there were significant differences between rural and urban areas in respect of anthropometric characters. With the exception of few cases, anthropometric characters are significantly greater in urban than in rural areas. Our findings, therefore, corroborate with earlier studies have also reported such findings from several countries such as in Mexico (Sánchez-Castillo et al., 2001), Guatemala (Torun et al., 2002), Papua New Guinea (Yamauchi and Umezaki, 2005), Eastern China (Weng et al., 2007), 26 sub-Saharan countries in Africa (Uthman and Aremu, 2008), India (Venkatramana and Reddy, 2002), Pune (Bhat et al., 2005), Calcutta (Das et al., 2008) and Northeast India among the Meitei women in Manipur (Devi et al., 2008).

In view of these findings on socioeconomic and anthropometric characters, it is clear that we cannot pool the rural and urban data without proper adjustment. Therefore, our
segregation of rural and urban data seems to be justified as far as the present study is concerned.

**Body Composition and Nutritional Status**

One of the main objectives of this study is to address the relationship between body composition and nutritional status, and how body composition is related to age, sex, anthropometric variables, self-reported morbidity, blood pressure, and socio-economic variables. Our findings with respect to this objective are presented in Chapter IV. The 2-compartment model was followed for estimating the body composition by using both anthropometric measurements and Omron bioelectrical impedance analyzer (OBIA-306). 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 ≤ 3.5 kg for men and ≤ 2.8 kg for women (Heyward and Wagner, 2004). Considering these values of SEE, we may suggest that the body fat estimated from anthropometry is by and large similar to that measured by OBIA-306. Therefore, we have used in this thesis the body composition estimated from anthropometry not only because the estimation is similar to that obtained through OBIA, but also to make our studies comparable with other anthropological studies of body composition.

**Body Composition**

It is found that 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. It holds true from the statistical point of view also. These values of BFM and FFM among adult males are lower than those reported for adult males from Pune (Bhat *et al.*, 2005), Marwaris of West Bengal (Das and Bose, 2006), but are higher than those reported for adult males of the Kora Mudi (Bisai *et al.*, 2008), the Bathudis and Savars (Bose *et al.*, 2008), and the War Khasis (Khongsdier, 2005a).

As for females, it is observed that the mean values of BFM were 11.48 kg and 12.68 kg in rural and urban areas, respectively. And the mean values of FFM were 35.91 kg and 36.43 kg in rural and urban areas, respectively. These values of body composition variables in the present study is higher than those reported for females from the tribes of the Kora Mudi (Bisai *et al.*, 2008) and the Bathudis and Savars (Bose *et al.*, 2008).
Nutritional status

The nutritional status of participants in this study was assessed by using BMI, taking into consideration the cut-off points recommended for the Asia Pacific region (WHO, 2000). The reason for this is given in chapter IV on the basis of the ROC curve analysis. According to this analysis, the BMI cut-off point for defining overweight lies between $\geq 21 \text{ kg/m}^2$ and $\geq 23 \text{ kg/m}^2$ against the reference PBF $> 25\%$ for men and $>30\%$ for women (Deurenberg et al., 1998, 1999). It may be noted that the World Health Organisation (WHO) has recommended the BMI cut-offs of $25.0 \text{ kg/m}^2$ and $30.0 \text{ kg/m}^2$ for overweight and obesity, respectively (WHO, 1995). But there is considerable evidence that these cut-off values are not applicable across ethnic groups, especially among Asian populations. It has been reported that Asian Indians, for example, have higher PBF, waist-to-hip ratio (WHR) and abdominal fat at a lower level of BMI compared with the Caucasian populations (Ramachandran et al., 1997; Deurenberg-Yap et al., 2000). Among Asian populations, the risk of association with diabetes and CVD occurs at lower levels of BMI compared with the Caucasians (McKeigue and Shah, 1991; Banerji et al., 1999; Chandalia et al., 1999). Accordingly, The WHO Regional Office for Western Pacific Region, along with the International Association for the Study of Obesity (IASO) and the International Obesity Task Force (IOTF), has recommended new BMI cut-off points of $23.0 \text{ kg/m}^2$ and $25.0 \text{ kg/m}^2$ for defining overweight and obesity, respectively, in Asian populations (WHO, 2000). Considering the results of ROC curve analysis and this recommendation for the Asian populations, we propose to use the BMI-cutoff $\geq 23.0 \text{ kg/m}^2$ for defining overweight and obesity in the present population. However, we have also presented our results as per the international cut-off points (WHO, 1995) for comparative purposes (WHO Expert Consultation, 2004).

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). Moreover, the prevalence of underweight is also lower compared to those reported from other populations in the country such as the Bathudis in Orissa (Bose and Chakraborty, 2005), adult males in Central India (Adak et al., 2006), Saharia tribe of Rajasthan (Rao, et al.,
2006), backward populations in the districts of Madhya Pradesh and Chhattisgarh (Gautam et al., 2006), from the slum dwellers in Midnapore, West Bengal (Bose et al., 2007), and from low socioeconomic tribal populations from South India (Kusuma et al., 2008). Thus, from these comparisons the nutritional status of the present population is better than most of the populations in the North-East and also most of the tribal populations in the country.

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. The prevalence of overweight among rural males was lower compared with those studies from rural Pune (Bhat et al., 2005), but it was higher compared to the Bhil tribe of Maharashtra (Adak et al., 2006). The prevalence of overweight among urban males was also lower compared to urban Mumbai (Shukla et al., 2002), urban slum dwellers and urban middle class of Pune (Bhat et al., 2005), Marwaris of Howrah (Das and Bose, 2006) and slum dwellers of West Bengal (Chakraborthy et al., 2006). For rural females, the prevalence of overweight was lower compared to the rural females of Delhi (Reddy et al., 2002). The prevalence of overweight among urban females was higher compared to the female Muslims of West Bengal (Ghosh et al., 2005). However, the prevalence of overweight among urban females were lower compared to those females of urban Mumbai (Shukla et al., 2002), Hindus of West Bengal (Ghosh et al., 2005), Bengalee Hindu women, Kolkata (Bhadra et al., 2005), female Marwaris of Howrah (Das and Bose, 2006) and females of Jalandhar, Punjab (Khokhar et al., 2010).

These findings on nutritional status have clearly indicated three major aspects, namely, (i) differences due to BMI cut-off points, (ii) differences between the sexes, and (iii) rural-urban differences.

**Different prevalence due to BMI cut-off points:** Earlier studies in India and other developing countries have paid more attention to the problem of under-nutrition as compared to that of over-nutrition. However, during the last decade or so, there has been a shift of attention from meeting nutritional needs to the biological effects of nutrition on lifetime health, especially
with the emerging trend of obesity that has been declared an epidemic in developed countries (WHO/FAO, 2002). Recent studies from India have also revealed that overweight is very high, especially in urban areas (e.g., Sidhu and Tatla, 2002; Tiwari et al., 2010). What we need to mention with respect to the present findings is that the prevalence of overweight (including obesity) seems to increase significantly when we use the cut-off points recommended for the Asia-pacific regions (WHO, 2000). It may be noted that the health ministry of the Government of India has also recommended the use of BMI ≥ 23.0 kg/m² as the cut-off point for defining obesity in the country (The Times of India, 26 Nov'08). However, many studies have still used the international cut-off point of ≥ 25.0 kg/m² (WHO, 1995), showing that the prevalence of overweight was very high in some urban areas of India. For example, Tiwari et al. (2010) have reported that reported that 34.4% of males and 31.3% of females aged 30 years and above were either overweight or obese in Gwalior city. Other studies have reported even higher rates, e.g., a study conducted by Sidhu and Tatla (2002) has revealed that the prevalence of overweight was about 45.3% among Punjabi females aged ≥30 years in Amritsar and Ludhiana cities. The point is that these studies have used the international cut-off point of ≥ 25.0 kg/m² for defining overweight and/or obesity. If the cut-off point of ≥ 23.0 kg/m² is used, it is likely that the prevalence of overweight would increase considerably in the above mentioned studies. Although future studies on risk factors of BMI cut-offs are needed in India, it is likely that the prevalence of overweight in India increased considerably during the last decade or so (IIPS and Macro International, 2009). In Northeast India, under-nutrition still remains as the major nutritional problem but over-nutrition is also emerging rapidly as indicated in the present study.

Sex differences: According to the WHO Global Infobase (WHO 2010), the estimated prevalence of overweight (≥ 25.0 kg/m²) in India was higher in men (20.1%) than in women (18.1%) who are in the age group 15 years and above. In the present study, the overall prevalence of overweight was 6.85% in men and 10.50% in women according to the international cut-off point of ≥ 25.0 kg/m². This sex difference is observed in both rural and urban areas, although the prevalence is higher in urban than rural areas. Therefore, our findings are inconsistent with the WHO estimate for the whole country. It is also inconsistent with a study reported from Gwalior city (Tiwari et al., 2010), which indicated higher prevalence of overweight among males. However, some other studies from India indicated that the prevalence of overweight is higher in females than in males (e.g., Kaur et al., 2010). A study of urban population in Mumbai (Shukla et al., 2002) also indicated that the
prevalence of overweight was higher in women (30%) than in men (19%). It may be noted that the sex differences in the prevalence of overweight and obesity are different from one country to another. In South Africa, Puoane et al. (2002) reported that about 60% of African women in 1998 were either overweight or obese, which was about five times higher than for African men. Therefore, it is likely to be associated with different biological and environmental factors. It is generally reported that although both the sexes are susceptible to obesity, women and men differ in the proportion and distribution of body fat. Women have greater adipose store than men irrespective of cultures and races (Power and Schulkin, 2008). These differences begin early in life, and are more pronounced during puberty due to differences in metabolic and hormonal processes. However, it is reported that the prevalence of cardiovascular disease is greater in obese men than obese women (Wingard et al., 1983; Lerner and Kannel, 1986), and the reason for this gender difference is not fully understood. The point to be made here is that the sex differences in overweight and obesity in India may vary from one region to another or from one culture to another. Future studies are needed to understand the etiology of such differences.

Rural-urban differences: In the present study, the prevalence of underweight is lower in rural than in urban areas, although it was not significant for females. On the other hand, the prevalence of overweight is higher in urban than rural areas. As for the prevalence of overweight, it is according to the general expectation that urbanization may predispose the people to overweight due to greater degree of changes in diet and lifestyles. As described in Chapter II, various factors are associated with overweight and non-communicable chronic diseases (NCDs). Nutritionally related factors associated with increasing urbanization and sedentary lifestyles are generally considered to be responsible for the increasing prevalence of overweight/obesity and NCDs in developing countries. According to WHO/FAO Expert Consultation (WHO/FAO, 2003), “Increasing urbanization will distance more people from primary food production, and in turn have a negative impact on both the availability of a varied and nutritious diet with enough fruits and vegetables, and the access of the urban poor to such a diet.” It may be mentioned that Nagaland is one of the states in Northeast India with very high rate of migration from rural to urban area (Khongsdier, 2008). This increasing rural-urban migration in the state could be associated with various factors especially in search of better jobs, education and living conditions (DPC, 2004). Consequently, there are changes in economic conditions, dietary intakes, physical activity and lifestyles, which may be
responsible for overweight and obesity among urban individuals of the present study. Future studies should pay more attention on how to prevent overweight and obesity.

Another major concern with respect to the findings of the present study is that underweight is also still high among the urban adults compared to their rural counterparts. This is also consistent with the report of the 3rd National Family Health Survey (IIPS and Macro International, 2009). Although it is difficult to explain the reason of this phenomenon, it is clearly obvious that there exists a double burden of under- and over-nutrition, especially in urban areas. One possible explanation of the lower prevalence of underweight in rural area may be related to the egalitarian nature of economic life in Nagaland. There is a strong community spirit and social responsibility to look after the poor as well as to provide an access to equal opportunities, because the kinship bond is very strong among the Ao villages. According to Nagaland Human Development Report (DPC, 2004), “Due to strong community spirit and social capital, the poor are looked after, and cared for, by kith and kin and the community. As a result, there is no case of starvation deaths and no one is shelterless.” This may have implication if we take into consideration the way of life in urban areas where the degree of social stratification in terms of education, income and other socioeconomic factors is more prevalent. The Nagaland Human Development Report (DPC, 2004) has pointed out that the increased migration from rural to urban or town areas has “put a strain on the limited urban services and infrastructure in these towns and has resulted in increased urban poverty and unemployment levels.” Another possible explanation of the lower prevalence of underweight in rural areas may be related to natural resources of nutrients. In rural areas, many types of fruits, vegetables and animal foods are gathered from jungles. The combination of forest resources of foods with the egalitarian aspects of the Ao society may be responsible for the better nutritional status in rural areas compared to urban areas. We hope that future studies will throw much more light on this area of rural-urban differences in nutritional status of the Ao Nagas. As far as the present study is concerned, we can only suggest that there exists a double burden of underweight and overweight, which are indicative of differential resources especially in urban areas.

Relationship between Body Composition and Nutritional Status

Our findings in Chapter IV have clearly indicated that it is difficult to conclude whether BMI is more related to PBF or FFM. 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. 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, 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. Therefore, the present findings suggest that BFMI can also be used to detect changes in fat and fat-free body stores (Schutz et al., 2002; Wells et al., 2004; Khongsdier, 2005). 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 four important indices and ratios, namely, cormic index, conicity index and waist-hip ratio. In Chapter IV, we have presented our findings on the relationship between body composition and body shape in relation to age, sex, self-reported morbidity, blood pressure, and socioeconomic variables.

*Cormic Index and Body Composition:* 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). For example, Africans have proportionately longer leg (average of 0.51), whereas Asians have shorter legs with means of 0.52 to 0.54, although there exists considerable variation within each group (Norgan, 1994; Khongsdier, 2001). It has been suggested that a change of 0.88 kg/m in BMI for the variation of 0.01 in cormic index (Norgan, 1994). Therefore, the variation in cormic index may have certain implication for the differences in BMI and body composition between and within populations. In the present study, we have observed that persons with shorter leg length would have a greater percentage body fat body (PBF) than those with longer leg length. However, shorter leg length does not seem to play a major role in bringing about the differences in FFM. Therefore, we may conclude 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 FFM.

**Abdominal obesity measures and Body Composition:** In the present study, we have considered two abdominal obesity measures, namely, conicity index and waist-hip ratio (WHR) that are commonly used in assessing the nutritional status of population. Our purpose is to see how these measures are related to body composition in terms of PFB and FFM. We have observed that both PBF and FFM are significantly correlated with conicity index. In addition, both urban males and females with greater level of conicity index ($\geq 1.10$) are likely to have greater PBF than their rural counterparts. Similarly, PBF and FFM are significantly higher among persons with greater waist-hip ratio compared with those having lower waist-hip ratio in both rural and urban areas. Also, the means of PBF and FFM are by and large greater in urban males and females compared with their rural counterparts.

Conicity index is one of the measures of abdominal obesity. It is derived from height and weight of the individual relative to waist circumference. It describes the deviation of the abdomen from the circumference of an imaginary cylindrical shape with constant body density (Valdez et al. 1993). The more central a person is in fat distribution, the higher the value of conicity index (Mueller et al., 1996), ranging from 1.00 (perfect cylinder) to perfect double cone of 1.73 (Valdez, 1991). The conicity index has been shown to be associated with various risk factors for CHD to a similar extent as the waist to hip ratio (Valdez et al., 1993; Mueller et al., 1996). Similarly, many studies have indicated that WHR is associated with increased risk of hypertension, diabetes mellitus and coronary heart disease (e.g., Cassano et al., 1992; Valdez et al., 1993; Han et al., 1995). As a matter of fact, it is not yet fully understood whether conicity index or WHR is more important in prediction of abdominal obesity and its associated morbidity and mortality risks. Some studies from India suggested that waist circumference should be preferred over WHR and conicity index (e.g., Bose, 2006). With respect to the relative importance of conicity index and WHR, many studies have indicated that the former is no better than the latter (e.g., Mantzoros et al., 1996; Bose and Mascie-Taylor, 1998, Heyward and Wagner, 2004).

In the present study, our objective is not to find out the relative importance of conicity index and WHR in prediction of risk factors. Our study is mainly concerned with the relationship between these measures and body composition as well as to analyse the differences in the prevalence of self-reported morbidity and hypertension according to these measures. What we can suggest is that both conicity index and WHR are positively correlated
with body composition in terms of body fat and fat-free mass. We have also observed that the prevalence of morbidity and hypertension is greater in those individuals with higher levels of conicity index and WHR for both rural and urban areas.

**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.

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 (Damon, 1968; Tanner, 1992; Ulijaszek, 1999; Bogin, 1999; Cole, 2003). The secular trend may be positive or negative. Since human growth and body size are highly sensitive to environmental conditions, positive secular trend is considered to be largely influenced by improved nutrition and health conditions, whereas negative secular trend can be observed in a situation where the environmental conditions are deteriorated (Eveleth and Tanner, 1990; Ulijaszek, 1999a; Roche and Sun, 2003; Ozer, 2008). Secondly, 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.

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 populations in India from West Bengal (Bharati, 1989), South India (Rao, et al., 1990; Naidu and Rao, 1994; Rao et al., 1995; Reddy, 1998; Kulkarni et al., 2010) and Northeast India (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.

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. Nevertheless, the findings of present study corroborated to some extent with those reported for other Asian populations including India (e.g., Yoon et al., 2006; Khongsdier, 2002; Kulkarni et al., 2010). It may, however, be mentioned that 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. Thus, it is clearly evident that family size has little role to play in the variation of anthropometric traits in comparison with household income and education.

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. Therefore, the present study is consistent with many cross-sectional studies that have generally shown the inverse effect of physical activity on body mass (Miller et al., 1990; Tremblay et al., 1990; Klesges et al., 1991; Fitzgerald et al., 1997; Weng et al., 2007; Gregory et al., 2007; Nicklas et al., 2009). In addition, physical activity is reported to improve glucose tolerance even in the absence of weight loss (Oshida et al., 1989; DiPietro et al., 1998). Some studies have even suggested that physical activity would also reduce the risk of cancer (Michaud et al., 2001; Bao and Michaud, 2008).

**Self-reported Morbidity**

The overall prevalence of morbidity in rural and urban areas is 8.78% and 9.35%, respectively. This prevalence of morbidity in the present study is lower than those reported from the War Khasis (Khongsdier, 2002). In rural areas, it is higher in females (9.28%) than in males (8.25%). The situation is, however, reversed in urban area where the prevalence of morbidity is slightly higher in males (9.63%) than in females (9.07%). 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.

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; Sullivan et al., 2005; 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**

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.

We have also observed that the prevalence of hypertension is higher in males than in females in both rural and urban areas. Further, it is observed that 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
that blood pressure was positively associated with social class for men, but negatively for women (e.g., Dressler et al., 1989; 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**

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 populations (Khongsdier, 2002; Roy et al., 2004; Bose and Chakrabarty, 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.

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 males. This is similar to the findings reported from other populations in India (Venkatramana and Reddy, 2002; 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 (Bharati, 1989; Rao, et al., 1990; Rao et al., 1995; Reddy, 1998). It is also found that overweight is associated with greater cromic 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.