CHAPTER-I

INTRODUCTION

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). It may also be defined as the proportional amount of different body components in terms of water, masses, bones and tissues relative to the total body mass or body weight. 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). This five-level model is considered as the central model in the study of body composition. The interest is at the molecular level, because a number of models are created that ranges from two to six components (Shen et al., 2005). 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). The unquestioning popularity of this method is because of the apparent 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). The two-component model is also used in the field of clinical nutrition for over four decades (Pietrobelli et al., 2001). Models that include three or more components are referred to as multicomponent models. In multicomponent models, FFM is further sub-divided into several components.

In general, body composition is divided into major components, namely, FFM and FM. FFM refers to "body mass minus ether-extractable fat, and hence includes the stroma of adipose tissue" (Forbes, 1987). Thus, FFM includes water, muscles, bones, minerals, proteins and other tissues of the body; whereas FM includes essential and energy stores or storage fat. Essential fat is part of body structure found in nervous tissue, bone marrow, cell membranes that are associated with reproductive organs in females (Gibson, 1990). The remaining fat is usually known as energy stores which waxes and wanes with changes in nutritional status and
other physiological conditions (Poskitt, 1995). About one-third of energy stores in adults are deposited subcutaneously or externally.

Nevertheless, the main interest is to understand the relative proportion of body fat or FM to the total body mass of a person because FM has many medical and nutritional implications. The relationships among body weight, obesity and health are mediated by the increase in protein production, which is the metabolic characteristic of the Adipose Tissue (AT) and in turn results in several health problems (Sardinha and Teixeira, 2005). AT is a specialized connective tissue of loose lipid-filled cells or adipocytes, which functions as the major storage site for fat in the form of triglycerides (Albright and Stem, 1998). Excess body fat may lead to obesity and increases the risk of getting many diseases. On the other hand, inadequate body fat is indicative of deficiency in energy stores, which is often associated with morbidity and mortality (James et al., 1988). In sports, excess body fat hinders performance because it does not contribute to muscular force production, and it is an additional weight that requires energy to move about.

The study of body composition has its origin about 440 BC when Hippocrates postulated his idea about the four components of human body (skeletal, muscle, fat and liquid). The mid-19th and early 20th centuries saw the beginning of the modern era of body composition research, when some important conceptual advances are prepared (Shen et al., 2005). By the 1930s, body composition research has rapidly gained importance with the introduction of new sophisticated ideas and concepts for measuring body mass. Nowadays, it has become a very important field of research in Biological Anthropology and Medical Sciences and Sports. There are various methods for measuring and estimating FM and FFM. The common methods include anthropometry (especially skinfold thickness), bioelectrical impedance (i.e., an electrical analyser by which an electric resistance of FFM can be measured), X-rays, ultrasound, water displacement methods, computed axial tomography (CAT), magnetic resonance imaging (MRI), etc. Anthropometry, which includes measurements of body weight, height, body mass index (BMI), mid upper arm circumference (MUAC) and skinfold thickness, and bioelectrical analysis (BIA) are the most widely used methods for measuring body composition (Norgan, 2005). 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).
One of the major interests of current 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 countries 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; Grundy, 2004). Health risk diseases are the consequence of obesity. Although under-nutrition remains a major health problem in many developing countries, obesity is also emerging with the improvement in socio-economic condition and increasing urbanization (Popkin, 1998, 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). Obesity is not only a problem among adults but it is also very common among children. Studies have shown that there is a high prevalence of pediatric or childhood obesity in both developed and developing countries (Reilly et al., 2002; Sung et al., 2002; Riberio et al., 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). There is also lack of specific population information about factors associated with obesity and its associated morbidity, except for some studies (Misra et al., 2001; Kaur and Morga, 2006; Sidhu and Prabhjot, 2007). Little is also known about the relationship between adult body composition and undernutrition, except those studies carried by Shetty (1984) and Ferro-Luzzi et al. (1997) in South India. There is also dearth of information on the relationship between body composition and morbidity patterns (Campbell and Ulijaszek, 1994; Khongsdier, 2002), although many studies were carried out on the relationship between body mass index and socio-economic conditions (Bharati, 1989; Reddy, 1998; Khongsdier, 2002, 2005a; Chakraborty et al., 2006; Bose et al., 2007). 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 corroon 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.

**OBJECTIVES OF THE STUDY**

In view of the brief backdrop above and the overview of literature in Chapter - II, different research questions and objectives of study can be formulated with different research designs ranging from exploratory to explanatory types. In the present study, we are mainly concerned with the cross-sectional design of rural-urban differences that are by and large exploratory in nature to address the following objectives:

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.

**STUDY AREA**

“Nagaland” literally means the land of the Nagas. The Nagas belong to the mongoloid group of people occupying the present place. **Nagaland state is situated in the northeastern part of India.** The state lies between 26°20'N and 27°40’ N latitude and 93°20'E and 95°15'E longitude. It covers an area of 16,579 square kilometers with a total population of 19,88,636 (Census of India, 2001). **Myanmar country and Arunachal Pradesh state bound Nagaland on the East, Assam state on the West and North and Manipur state on the South.** Nagaland got its statehood on December 1st 1963, thereby becoming the Sixteenth State under the Indian Union. **Kohima is the capital of Nagaland and is located at a height of about 1,444 meters above sea level.** Nagaland is divided into eleven districts namely, Mokokchung, Dimapur, Kiphire, Kohima, Longleng, Mon, Peren, Phek, Tuensang, Wokha and Zunheboto. Nagaland state is the home of fifteen major tribes, they are, Angami, Ao, Chakhesang, Chang, Khamiuniangan, Lotha, Konyak, Phom, Rengma, Sumi, Sangtam, Yimchungru, Zeliang, Kuki and Pochury. The variations in the physical feature of the land have given rise to a widely
varied range of flora and fauna. Exotic species of orchids, rhododendrons as well as wild fauna such as *Mithun*, tragopan and hornbill are found in the forests.

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). The district is divided into three development blocks, namely, Ongpangkong, Changtongya and Mangkolemba. 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 headquarter, Mokokchung town. Some of the Nagas who reside in this district include the Sumi, Lotha, Sangtam, Phom, Chang, Khiamniungan 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.

**Topography**

Mokokchung district occupy a territorial land of long unbroken ranges of hills. Geographically, the entire territory is divided into six ranges, namely, *Ongpangkong, Langpangkong, Asetkong, Changkikong, Japukong and Tsurangkong*. There are glens or valleys between these ranges. Two such valleys are *Changki* and *Tuli*. Mokokchung is comparatively less elevated. Nonetheless, there are wild chaos of spurs and ridges, deep gorges and steep terrains. The vertical corrosion or down-cutting through soft and loose geological strata by heavy rainfall have resulted in the formation of numerous valleys. The soil is a mixture of sandy loam and clay loam in the hills, and as it goes down towards the valleys, the soil is silt loam and clay loam. The soil is acidic in nature, and the average pH content varies from 5.61 to 5.83. Rampant deforestation, exploitation of land and prolonged erosion has made the soil barren and the hardest strata of the soil are exposed. Landslides occur more as a result of this, especially during heavy rainfall. The area is also affected by
minor shocks and occasional earthquakes. Important rivers are Milak, Dikhu, and Tsurang. There are two natural lakes, Omoklushi and Yimyu Awatsung. Natural minerals such as coal, iron, sand and sandstones, glass sand, petroleum, etc. are found in some pockets of the district.

Climate

The district, like the rest of the state enjoys a sub-tropical humid and temperate climate with monsoon as a dominating factor. It receives an average rainfall between 200 cm and 250 cm. The rainfall is at its maximum during the months of July and August or in other words, during the monsoon season. The lower ranges and valleys become swampy and foggy during rainy season. The temperature differs locally with the variation of altitude, whereby the low lying valleys are comparatively hot and humid. The average relative humidity is about 90 per cent. During summer, the temperature varies from 20°C to 38°C. While during winter it drops to 2°C. Longkhum village, located at a height of about 1,500 meters above sea level is the only inhabited place where frost falls during winter. As such the summers are mildly hot and winters are cold.

Flora

Mokokchung district has a well suited geographical position and climatic condition to support good natural flora and fauna. Vegetation falls under sub-tropical semi evergreen type. The forest floor is dense and covered with a variety of herbs and shrubs. However, the centuries old practice of Jhum cultivation by the people as well as the introduction of artificial fertilizers and inorganic farming have destroyed much of the valuable forests leading to soil erosion, thereby making the hilly land less porous to retain the rain water. Also, the extreme cold during the winter season result in drying up of the vegetations. Under these circumstances, both deciduous and tropical evergreen forests exist. Some of the important floras commonly found in this district are teak, alder, sal, champa, bansom, hollock, golmohar, chakranda, etc. Plantations of fast growing tree species such as golmohar, chakranda, Eucalyptus, etc. are presently being planted in patches of land throughout the district. Rhododendron grows only in the forest of Longkhum village because of the higher altitude. A variety of tall grasses like bamboo, reeds and even ferns and orchids are also found. Seasonal fruits such as pear, plum, peach, passion fruit, jackfruit, cherry, mulberry, blackberry, gooseberry, papaya, grapes, oranges and banana are found abundantly both in the forests and in fields and garden. In the fields, besides paddy crop, a variety of vegetables and
tubers are cultivated. Some of which are, chilli, maize, brinjal, tapioca, bean, cabbage, cauliflower, carrot, sweet potato, potato, tomato, ginger and cucumber. Cash crops such as tea, coffee, sugarcane and rubber tree are also grown.

**Fauna**

As the major part of the district is covered by thick forest, a number of wild animals and birds are found. However, indiscriminate and illegal hunting of these animals have led many species to extinction. Animals that are found include wild boar, deer, Himalayan black bear, porcupine, tiger, python, elephant, monkey, jackal, fox, wild dog, wild cat, buffalo, mithun, toad, land tortoise, etc. Birds such as vulture, black partridge, grey partridge, eagle, jungle fowl, common pea fowl, owl, pigeon, hornbill, sparrow, spotted dove, etc. are found. Livestock plays a very important role especially for economic purposes. Goat, pig, buffalo, cattle and poultry are reared.

**THE PEOPLE**

**Origin and Characteristics**

The Ao people call themselves Aor which means, going or gone from the parent Chungliyimti village crossing over the Dikhu River. Chungliyimti Village is located in Sangtam-Naga area of Tuensang district. There is no specific evidence regarding the origin of the Ao tribe and it is still a matter of debate. According to a popular myth, the Aos are believed to have emerged out from six stones or Longterok at Chungliyimti. However, cultural traits indicate that they may have come from the South east in different succession of migration. Ao (1970), suggests that they first migrated towards north touching the outskirt of the present Chakesang area and entered Yimchung area, from which they went still northward through Sangtam area and reached Chungliyimti. According to Yonuo (1974), the Ao tribe comprised the second migratory wave of migrants, whose migration route is believed to be from Burma (Myanmar) through the Tangkhul, Chakhesang and Tuensang areas to the present Ao villages.

The Ao tribe belongs to Mongoloid race. Waddel (1900) reported that the Ao mean cephalic index (C.I.) is 80.11 and possess equal frequency of A and B genes according to the ABO blood group system. In his monograph, the Ao Nagas, Mills (1926) has described the general physical characteristics of the Ao people. According to him, the average height of men is about 5 feet and 8 inches, women being some 2 inches shorter. Their skin colour varies from light to dark brown. The face is broad with prominent cheek bones, low bridged
nose and broad nostrils, eyes are slanting and dark brown in colour, and hair type ranges from slightly straight to curled hair, with wavy hair as the prominent type. Their average cephalic index is 78.88 and average nasal index is 81.42. Their body is well proportioned and neither slight nor stocky. He further describes, “...the whole tribe gives one the impression of being well nourished.” Thus, physically they are medium statured, with Mongoloid physical features such as light to dark brown skin colour, broad face, flat to medium broad nose, black hair colour, with dark brown and epicanthic folded eyes.

The Ao people are one of the dominant tribal groups in Nagaland. Presently, they are distributed in about 106 villages in the Mokokchung district (Census of India, 2001). Ao-O is the language of the Ao tribe. They speak the Tibeto-Burman language. Ao-O has two distinct dialects, which are Chungli and Mongsen. The Chungli dialect is the standard Ao dialect and as such it is used for all official communications. According to Ao (1999), this is because the first American missionaries settled in a Chungli-speaking village and introduced the Roman scripture for translating the Chungli dialect. However, the folksongs are preserved and transmitted through the Mongsen dialect. Major clans of Chungli are Pongener, Longkumer and Jamir, while major clans of Mongsen are Imchen, Longchar and Wailing.

The Aos live is an egalitarian or classless society. The structure of the society is democratic in principle. A well articulated laws and customs govern the Ao social and domestic life. An Ao by birth inevitably becomes a member of the society. To be a part of the society means to be a member of a particular village. Therefore no matter in which place in the world he settles, he is by tradition a bona fide member of his clan and of his village. The Village Council or Putu Menden administers the respective village life. Putu Menden consists of the representatives of each clan. It looks after the welfare of the people, ensures security by maintaining friendly relations with the neighbouring villages. In fact, it is the sole duty of the Putu Menden to oversee the affairs of the village and to frame the rules and regulations.

Ao people follow the patrilineal system of society where lineage is traced from the male. Family is regarded as the most important social institution and it is a nuclear unit, where the father is the head of the family. Marriage is exogamous, in the sense that inter-clan marriage is prohibited. Therefore marriage among clan members is considered as incestuous and strict rules are laid down to the offenders. Marriage between cousins is even prohibited though they may belong to a different clan. Divorce or bala, is permissible, and it can be done for reasons such as incompatibility, adultery, barrenness, mutual dislike and impotency.
Das, 1994). Dowry or bride price is absent. In the Ao society, women do not play any important role in the social, political, religious and economic aspects. Nevertheless, although deprived of some fundamental rights, Ao women are always playing a significant partnership role and their contribution towards the well being of the society are always recognized and honoured (Aier, 1998). One unique character of Ao people is that an Ao woman retains her original clan name even though she marries to a man of another clan (Ao, 1999).

Moatsū and Tsüngrem-mong are the two major festivals of the Aos and they are celebrated to observe certain important stages in the yearly agricultural cycle. Moatsū is celebrated in the first week of May after the sowing is done in the fields. Tsüngrem-mong is celebrated in the first week of August or before harvesting. These festivals are observed to express their gratitude to the supreme God, for His blessing on their work. Such celebrations are occasions of singing, dancing and feasting by wearing their finest traditional costumes.

**Occupation**

Land and forest are the backbone of sustenance for the Ao tribe and forms the major source of economy. Originally land belongs to the clan. Therefore each clan member has a share of the clan land. Such land is not transferable and is inherited from one generation to the next. As a result of this land clan nexus, Ao people never face the problem of landlessness and therefore enjoys guaranteed hereditary rights to land and forests, which is ultimately linked with the kinship and descent groups (Das, 1994). However, lands are also owned by individuals. The main occupation of the Aos in rural area is agriculture, mainly practicing shifting or jhum cultivation. Terrace cultivation is also done in certain places such as in the foothills and valleys. Besides paddy, they grow a variety of vegetables in the field for consumption. Seasonal vegetables such as millet, maize, potato, sweet potato, bean, ginger, chilli, cucumber, pumpkin, bitter gourd, squash, tomatoes, mustard leaf, yam, etc. are grown along with the paddy in the field. Tea plantation in the foothills and valleys is presently a growing economy. Along with tea, seasonal fruits like orange, banana, pear, peach, passion fruit, etc, are grown for economic purposes. Apart from agriculture, the Aos engage themselves in handworks such as spinning and weaving, painting on cloth, pottery, woodwork, metalwork, stonework and basketry (Mills, 1926). These economic activities are still practiced by them.

Weaving is an important source of income and usually womenfolk are engaged in this work. Shawls and wrap around or lungi are woven with traditional motifs and designs.
Earlier, cotton was grown in the field and yarns were spun out of it to make the clothes. Nowadays the yarns are sold in the urban markets. Hand woven clothes are slowly disappearing as they are being replaced by modern weaving and sewing machines.

Creative wood works such as furniture, basket weaving and various handicrafts are made out of teak wood, bamboo and reeds. These are sold in the markets within and outside the district. Besides these, Aos are also engaged in various professions, both government and private sectors. Presently, many of the younger generations, who live in the town are also opting for private entrepreneurship by setting up modern restaurants and cybercafés, and a good number of shops, which sells groceries, household goods, electronics, cosmetics, foot wears and clothes.

**Food habit**

Rice is the stable food. The Aos are non-vegetarian. Pork, beef, mutton, chicken, fish and a variety of wild animals and birds are relished by them. Meat, especially pork, beef and fish are also smoked or dried in the fire-place. In a day, they consume two main meals, which is in the morning and in the evening. Meals include rice along with vegetables or meat. *Yam* vegetable is an essential source of food. The leaf, stalk and tuber are eaten. A traditional dish called *Anushi* is made out of the *yam* leaves, which can be preserved throughout the year. Tender bamboo shoots are also another delicacy and this also can be preserved for a long period. It is both fermented and dried for consumption. Meat dishes are always seasoned either with *Anushi*, fermented bamboo shoots or dried bamboo shoots, along with green chillies or dried chillies. Forest not only provides wild game but also a wide variety of tubers, roots, leafy vegetables and bamboo-shoots. They also domesticate and rear pigs, cattle, and chicken for the purpose of consumption as well as for economic purposes.

Local rice beer or *Yi* is still consumed by some people especially in the villages; although it is prohibited now. Tea is the most popular beverage. It is consumed with or without milk and sugar. Popular beverages such as soft drinks or cold drinks are increasingly in demand especially among the younger generations. Some Aos chew *tamul*, which is basically a concoction of betel leaf, areca nut, lime and dried tobacco leaves. Smoking of dried tobacco leaves, which is smoked through a wooden pipe, is still practiced by some people, particularly in the villages. Tobacco chewing, cigarette smoking and *paan* are also consumed by some, and these are readily available in the shops.
All the above mentioned activities are still practiced, although there has been a drastic change in tradition as a result of introducing a new religion, which is Christianity. They gave up their old belief and worship for the new one. A sense of consciousness to educate oneself and catch up with the rest of the world spread throughout the length and breadth of the Ao region. Dress code, economic status or way of living, profession and food habits underwent a drastic change as the people came in contact with the outside modern world. Market places in the town have opened an opportunity for the Ao people from different villages to come in contact with other communities. It has enabled them to trade their goods such as vegetables, wooden crafts, wild game, etc, for ready-made products and branded goods, especially food products. Traditional food habits are now more or less given up and are being replaced by protein rich processed food particularly in the town. In other words, the traditionally maintained Aos have emerged out of their social barriers and are mixing with the people of various communities. Migration from outside the district as well as within the district has been an important factor in this process. Aos staying in the rural villages are choosing to settle in the urban town, for the need to have a better lifestyle.

At present, almost all the villages are well linked to the main town, neighbouring state of Assam and districts of Nagaland by road. Basic amenities such as electricity and drinking water are provided. Institutions like schools, colleges, hospitals, dispensaries, etc are also being set up for the benefit of the people. Various Government aided development programmes such as Integrated Rural Development Programme (IRDP), Village Development Board (VDB), etc. have opened opportunities for the village people towards self-employment. Mokokchung town has a Government hospital, a military hospital and a private nursing hospital which caters to the need of the people. Nonetheless, not many of the villages have access to all the above mentioned facilities. Generally, most of the people choose to go for medical treatments to the better equipped private hospitals in big cities in various parts of the country.

Detailed statistics of the health status among the Ao people is not available to the general public as of now, except for the report by National Family Health Survey for the state of Nagaland as a whole. It is reported that in Nagaland state, less than one-third of the children are fully vaccinated, provision of iron and folic acid (IFA) supplement is far below the national average and only 51% to 52% of women have received tetanus toxoid injections (NFHS-3, 2007). This report also shows that in every 100,000 males, 1217 suffer from diabetes, 2464 from asthma and 725 from goitre or other thyroid disorders. While in every
100,000 females, 577 suffer from diabetes, 1414 from asthma and 629 from goitre or other thyroid disorders.

The survey also reports the nutritional status of adults in the state, and it shows that 15.9% of women and 10.8% of men have BMI below normal. BMI below normal is higher in urban men (11.3%) and urban women (16.9%) compared to rural men (9.6%) and rural women (13.1%). Also, 8.9% of women and 8.4% of men are either over-weight or obese. Rural men (16.8%) and rural women (17.5%) are more over-weight or obese compared to urban men (5.0%) and urban women (5.6%). General observation reveals that the Ao people are susceptible to air and water borne diseases such as malaria, typhoid, cholera, dysentery, influenza, etc. Nutritional deficiencies are also observed especially among some of the children in the rural areas or villages.