CHAPTER I
INTRODUCTION

DEFINING SOMATOTYPE, PHYSICAL GROWTH AND NUTRITION

SOMATOTYPE

Sheldon et al. (1954) defined somatotypes as “morphophenotypic ranges along continua of variation which possess constantly recognizable characteristics and are the functional end products of the whole genetic and developmental complex”. On the other hand, according to Heath and Carter (1967 pp 57-64), “A somatotype is a description of the present morphological conformation. It is expressed in a three numeral rating, consisting of three sequential numerals, always recorded in the same manner. Each numeral represents the evaluation of three primary components of physique which describe individual variation in human morphology and composition”

As a measure of body form, the somatotype can be easily determined and may be related to other conditions and characteristics, such as environment, disease, behaviour, and physical performance. Although body build per se is only one of several constitutional approaches, its study may help in the search of causative mechanisms underlying associations related to the human conditions (Bailey et al., 1982)
GROWTH

Bogin (1988) defined growth as a quantitative increase in size and mass. Development is a progression of changes, either quantitative or qualitative, that lead from an undifferentiated or an immature state to a highly organized, specialized and mature state. Growth is a highly organized natural process occurring in all the living organisms. Though predetermined by heredity, it also depends upon various environmental conditions. Of these factors, the influence of nutrition is of considerable importance. It is due to the various adaptive problems faced by the human population in their stressful environmental conditions (Singh and Kulkarni, 2001).

Children’s growth is often used as an index of the overall health of a population. Since growth is affected by a variety of adverse environmental conditions, it is a sensitive indicator of children’s health, and a population with healthy children is generally considered to be well adapted to its environment. However, this very sensitivity to the environment makes it difficult for researchers to disentangle the many factors that affect growth, including differences in growth potential between populations (now thought to be relatively small), nutrition, disease, altitude, temperature, and psychological factors, to name only the most important ones (Dettwyler and Fishman, 1992).

Child growth is a useful index of the health and well being of a population. Growth parameters are also important tools to estimate the extent and nature of malnutrition among children, particularly in the developing
nations. In situations where environmental factors have not influenced growth, the body size of groups of children generally reflects their genetic potential for size (Martorell and Habicht, 1986).

NUTRITION

The New Encyclopedia Britannica (1983, pp 401-417) defines nutrition as, "the process of assimilating food". The study of nutrition is the study of foods and their use in diet and therapy. Furthermore nutrition includes the study of the composition of different foods to know how best to provide the needed materials in the diet, and how to provide it. It has been said that through better nutrition not only have years been added to our lives but life to our years (Wilson et al., 1959)

Relationship of food to health has been made from the research conducted by chemists, microbiologists, pathologists and nutritionists from several centuries now. The effect of food on our body is explained in nutrition. In other words, nutrition is defined as food at work in the body (Begum, 1991).

Nutrition and diet are not synonymous though they are popularly used in that fashion. Diet consists of the various items of food, which are ingested and converted for use in the body for building up and maintaining it in a vital condition. Nutrition is the end of the process by which these are assimilated and produce the desired results (Broker, 1975). It is concerned with learning the kinds and amounts of materials to be supplied in the food to keep the cells of the body operating properly.
Eveleth and Tanner (1976) have referred that a child’s growth rate reflects, better than any other single index, his state of health and nutrition, and often indeed his psychological situation also. Similarly, the average values of children’s heights and weights reflect accurately the rate of a nation’s public health and the average nutritional status of its citizens. Thus a well-defined growth study is a powerful tool to monitor the health of a population.

According to Gopalan (1992), there are two practical approaches to the measurement of undernutrition: (a) through a survey of diets of representative households (supported by diets of individual members of the family in a sub-sample of households), in order to derive information about the nutrient intake; and (b) through an anthropometric and clinical examination of children, especially the under-fives. These two procedures, when combined with a broad survey of socio-economic and environmental status of the community, will yield data which, when properly interpreted and evaluated, could provide valuable practical leads for combating undernutrition in the community.

Socio-economic status is often cited as the most important factor influencing nutritional status in children, and, in general, national rates of malnutrition are negatively correlated with per capita income.

Child growth detects a problem but not its cause. The growth of children is widely recognized as one of the most sensitive and reliable index of health and nutritional status in human populations. Nutritional problems in developing countries are currently a major focus of anthropologists and
anthropometry is recognised widely as an effective means of assessing nutritional status.

**AN OVERVIEW OF RELATED STUDIES**

**SOMATOTYPE**

Somatotyping emerged quite late in the history of morphological taxonomy and constitutional investigation. Physicians have been prominent in the history of constitutional investigation, particularly in studies of interrelations of morphology and susceptibility to disease. In the 5th century BC, the Greek physician Hippocrates described people with long thin bodies as of *habitum phthisicus*, and observed that they were susceptible to tuberculosis. Other early physicians turned their attention to relationships between temperament and susceptibility to disease [cf. Carter and Heath, 1990].

In the recent years, somatotyping has been established as useful measure of describing body shape and form. In earlier studies, somatotype was assumed to be genetically determined constant body form not underlying any change (Sheldon et al., 1940) Later studies, however, proved that somatotype ratings do undergo major change, especially during adolescence (Heath and Carter, 1971).

In 1940, W. H. Sheldon and his collaborators introduced the concept of 'somatotype' in *The Varieties of Human Physique*. In this book they defined
somatotyping as the quantification of three components, which they called *endomorphy, mesomorphy* and *ectomorphy*. They rated each component on a 7-point scale. The ratings were made from standardized photographs and were expressed as a series of three numerals. They endeavoured to relate their ratings to a series of measurements and indices, and gave guidance on descriptive features to assist rating. Following this, Aldous Huxley popularized the words ‘somatotype’, ‘endomorphy’, ‘mesomorphy’ and ‘ectomorphy’ and so publicized the idea of easily recognizable relationships between physique and temperament [cf. Carter and Heath, 1990].

Inspired by the works led by Sheldon, B. H. Heath stirred up a good deal of interest in the potential of somatotype research, and in the process she somatotyped very many subjects following Sheldon’s Method. In due course, she worked out the basic modifications of the Sheldon’s somatotype method. During the early 1960s, she came into contact with J.E.L. Carter. Both Heath and Carter shared some reservations about Sheldon’s methodology. They agreed to explore on the possibilities of collaborative research. Meanwhile, there were further developments in somatotyping, which led to the emergence of Heath-Carter method. This method defines somatotype as a quantitative description of the present shape and composition of the human body. It is expressed in a three-number rating, representing the components of physique: (1) endomorphy refers to relative fatness; (2) mesomorphy refers to musculoskeletal robustness relative to height; and (3) ectomorphy refers to relative linearity. This somatotype can be used to record changes in physique.
and to estimate gross biological differences and similarities among human beings. It is an anthropological identification tag, and this method is sensitive to changes in physiques over time and is used for rating both the sexes at all ages. A modification of the original one of Sheldon, the Heath-Carter method gives a dynamic and more useful physique classification (Carter and Heath, 1990).

Heath (1963) had proposed the following modifications: (1) Redistribution of the somatotype ratings so that there would be a linear relationship between somatotype and the height-weight ratio. For this she used as a reference framework Sheldon's table of somatotype distribution according to the criterion of height divided by the cube root of weight. (2) Elimination of the distribution tables that extrapolated height-weight ratios according to age. (3) Adoption of the modified table for both sexes at all ages. (4) Adoption of an open-ended rating scale. Finally, Lindsay Carter's interest led to the collaborative project that produced the Heath-Carter somatotype method.

Subsequent comparison of the results obtained by both the methods confirmed Heath's hypothesis that in many cases subjects could change so dramatically between ages 11 and 18 years that accurate prediction of somatotype at age 18 was out of the question. In many cases somatotypes were also seen changing as unpredictably between ages 18 and 33 as between 11 and 18. (Carter and Heath, 1990).
In England, James Tanner used somatotyping in much of his research. His most notable contributions in somatotyping are *The Physique of the Olympic Athlete* (1964) and *Atlas of Children's Growth* (1982, with Whitehouse).

Another Englishman, Richard Parnell, carried out substantial research on somatotype. The scope of his work is best reflected in his book *Behaviour and Physique* (1958), in which he investigated a wide range of topics and made a clear statement of hypotheses and research methodology, accompanied by appropriate statistical analyses. His work includes somatotype data for children, family relationships, disease entities, and mental diseases. He continued this line of inquiry in his other book, *Family, Physique and Fortune* (Parnell, 1984).

In India, different authors initially took considerable interest in somatotyping of sportspersons. A study on somatotype distribution of sportsmen in India specializing in different events was reported by Sidhu and Wadhan (1975). Sodhi and Sidhu (1984) reported that sport pattern differences within countries are similar to each other and to Olympic values, however, in selected sports, the magnitude differ between countries.

As far as anthropometric studies of novice Indians are concerned, only a handful are seen to consider somatotypes (Berry and Deshmukh, 1964; Berry, 1972; Sigh and Sidhu, 1980; Singh, 1981; Singh et al, 1986,1988; Bhasin and

Bhasin and Singh (1991) in a comparative study among the Gujjars and Tibetans reported that there is not much change in the somatotype during adolescence. Ectomorphy remain dominant through growth phase followed by mesomorphy and endomorphy. On somato-chart, they found the Gujjars lying in meso-ectomorph sector and Tibetans in balanced mesomorph sector. Examining the similarity of somatotype between Gujjars and other populations of the same area, the study showed that to some extent, somatotype is influenced by environmental factors.

Singh (2001) made a study on the somatotype and body composition of Manipuri elite athletes and found them as predominantly mesomorph-endomorph. Ectomorphic component is relatively weak among them.

Dkhar and Pathak (2001) made another study on the somatotypes of the Khasi and the Jaintia men of Meghalaya and found that in both the communities the mesomorphic component was dominant over ectomorphic and endomorphic components, while ectomorphic component was dominant over the endomorphic component.

Singh and Singh (2001) found that the affluent Meitei boys show higher ratings of endomorphy than the non-affluent counterparts, whereas the non-affluent boys are more ectomorphic than the affluent boys. Mesomorphic ratings have no notable difference between the two socio-economic groups
during different ages. Among the affluent boys endomorphic constituents are more frequently found whereas the frequency of mesomorphic ectomorph dominates over others among the non-affluent boys. In the affluent group, the somatotype changes from mesomorph-ectomorph (12-15 years) to balanced ectomorph (16-18 years). The non-affluent boys belong to mesomorphic ectomorph at all ages except at 13 and 15 years during which they are mesomorph-ectomorph. They observed no specific trend with the change of age.

PHYSICAL GROWTH

Bogin (1988) in a brief review highlighted some advances in the study of human growth. By the time of Boas and D'Arcy Thompson, many of the basic principles of biological growth and development were known. It was also acknowledged that all normal, healthy and well-nourished children followed the same basic pattern of growth from birth to maturity.

During the nineteenth and early twentieth centuries growth research was used for the first time to characterise the state of health of groups of children. Lambert Adolphe Quetlet (1935) published the first statistically completed study of the growth in height and weight of children. After this a vast number of growth studies were initiated with the accumulation of dimensional data mostly from the schools, prisons, hospitals and the military personnel. Along with this, several longitudinal studies also made their entry between 1927 and 1932 [cf. Tanner, 1981]. These include the famous Fels Longitudinal Study at
the Fels Research Institute, Yellow Spring; the Bolton-Brush Study at the Western Reserve University, Ohio; the Berkley Growth Study and Oakland Growth Study at the Institute of Human Development at the University of California (Barkley), the Child Research Council Study at the University of Colorado (Denver), and the Harvard School of Public Health Growth Study (Boston, Massachusetts).

After this, there was a major shift of emphasis from purely descriptive growth studies to problem oriented growth studies. Accordingly, attention shifted from the affluent to the economically less favoured ones. In this connection, Pre-school Nutrition Survey by Owen et al. (1974) can be considered as a trendsetter.

Mascie-Taylor (1984) reviewed geographical and social mobility in England and found that the effects of selection are additive; migrants tended to be the taller individuals of any geographic area and the taller individuals within any social class. Higher socioeconomic status can, by itself, lead to increased body size and rate of maturation.

Ashcroft and Lovell (1964) and Ashcroft et al. (1966) found that the Chinese children aged between 4 to 17 years are significantly shorter and lighter than the children and youth of European, African, Afro-European background living in Kingston, Jamaica. All the children were from upper middle to upper socioeconomic status. This suggests a difference due to heredity.
Growth and development of populations living at high altitude have been studied all over the world including Ethiopia (Lichty et al., 1957), India (Malik, 1976, 1979; Malik and Singh, 1978, 1979, 1984; Duarah, 1985; Sidhu et al. 1985;), Peru (Baker, 1969; Hoff, 1974;), Nepal (Pawson, 1974, 1976) and United States (Frisancho, 1976; Beall et al., 1977). The studies have shown quite equivocal results, some showing the high altitude children to be taller and heavier than low altitude controls (Malik, 1976; Malik and Singh, 1984). In others, growth appears to be similar between high and low altitude samples (Hoff, 1974; Pawson, 1976) and in still others hypoxia is said to produce inhibition in stature growth (Beall et al., 1977) with larger chest measurements.

Kimura (1984) and Takahashi (1984) have included nutrition, health care, sanitation and socioeconomic status causing a major influence on growth change during the 1960s and 1970s.

Harrison et al. (1990) in a comparative study of Ethiopian and English children suggested that differences in variability between populations can indicate comparative environmental quality.

Benefice and Malina (1996) in a study of Senegalese children found that girls show more favourable growth status compared to boys and opined that girls have better resistance to adverse environmental conditions and their growth is less sensitive to inadequate nutrition than boys. Similar pattern of growth has also been reported by Zverev and Gondwe (2001) among Malawi children.
In India growth studies were initially confined to some basic parameters like height, weight and some physiological variables (Mukherjee and Gupta, 1930; Krishnan and Vareed, 1932; Rahman, 1936; Macferlane, 1937; Chatterjee, 1938; Shourie, 1939).

As mentioned earlier, quite a few studies on growth and development of populations living at high altitudes have also been undertaken in India during the 1970s and 1980s.

Rural-urban differences in growth and development of children has also been studied by many. Kaul and Corruccini (1985) found that the differences in growth reflect the economic difference between the two population. The ICMR (1972) in a nation-wide survey of growth showed the urbanites to be slightly larger.

Malik (1987) found that there is a faster growth in a number of anthropometric measurements including stature, weight and sitting height among the highlanders than the lowlanders.

The effect of microsociocultural factors associated with conditions was studied by Bharati and Basu (1990) on the Mahishya caste population of West Bengal. They found an increase in the anthropometric measurements with the improvement of economic conditions in both the sexes.

Sachdeva and Nath (1995) in a study of developmental pattern of different body segments among Bengali females reconfirmed the fact that
growth and differentiation do not take place at the same rate and time in constitutional components of the body (Tanner, 1962).

In India, during the nineties of the last century, there are several studies dealing with central body fat patterning, distribution and related clinical conditions. Shelgikar et al. (1991) concluded that in native Indians, central obesity seems to be more associated with hyperglycaemia than generalized obesity.

Ramachandran et al. (1992) reported that the mean BMI and subscapular skinfold ratio were significantly lower in rural men and women compared with the urban populations.

Nirmala et al. (1993) studied the effect of five measures of adiposity, three measures of fatness - body mass index, the sum of six skinfolds and the sum of three trunk skinfolds – and two measures of fat patterning – the ratio of trunk-extremity subcutaneous fat and the ratio of the subscapular and suprailiac skinfolds – and found all measures of adiposity except relative fat pattern index as positively correlated with blood pressure.

Rao and Busi (1993) found that among the Vadabalija boys of Visakhapatnam, fat fold at triceps region increases from age 1 to 4 years after which skinfold thickness shows a gradual decline upto 9 years, and then increase from 10 to 17 years.
Kapoor et al. (1998) in a study of fat distribution pattern on Jat Sikh boys found that the subcutaneous fat distribution pattern as depicted from skinfold thickness change with age.

Vaz et al. (1999) determined body fat topography using anthropometric techniques in young healthy Indian and Tibetan adults. The Indian subjects had significantly higher fat contents with greater abdominal obesity, which, according to them, may contribute, in part, to the greater cardio-vascular risk of Indians.

Hussain and Roy (2003) reported observations on physical growth, maturational sequence and nutritional status among Asur boys. The study focused in the adolescent spurt at 14 years.

Growth studies in North East India started with the work of Das (1966). She studied growth in respect of somatometric characters of the Kalita caste children of Assam. Das and Das (1969-71) measured the school going Assamese boys of Guwahati. A few more notable studies can be highlighted as under:

Das (1974) while studying the growth of height, weight and chest circumference of the Brahmin, Kalita, Baishya and the Kaibarta boys of Assam revealed that the growth trends of all these castes are more or less identical.

Hazarika (1974) reported that the Ahom children had a greater body dimension and body weight than the Kalita children of Dibrugarh district,
Assam. In the same district, Das (1978) found that Assamese children had greater body dimension and body weight than their Rajasthani counterparts.

Growth patterns of the Rabha boys in respect of certain somatometric characters were studied by Choudhury (1979). The study revealed that the Rabha children were taller and heavier than the caste children during their early age period whereas the adult Rabhas were shorter and lighter than the caste people. This difference to him is due to the difference in culture, which further leads to the difference in their nutritional status.

The first mixed longitudinal study in North East was done by Das and Choudhury (1982) on growth in height and weight of the Assamese children from 1 to 7 years. They found that the growth in height was most rapid from 1 to 3 years in both the sexes, which was followed by a slower increase for the boys between 3 and 4 years, while among the girls it is between 4 and 5 years. The girls were taller than the boys at 4 years but between 5 and 7 years the height for both the sexes becomes more or less the same, the boys are slightly taller than the girls.

Devi (1985) while studying the physical growth of the Meitei Kshatriya and Muslim girls of Imphal, Manipur found a more or less similar growth trend among both the groups with a varying rate at all ages.

Growth study in varying altitudes were done among the Monpas of Arunachal Pradesh by Duarah (1985). He found that it was not the differing
altitudes in which the Dirang, Tawang and Kalaktang Monpas were residing but socioeconomic factors which played a large part in determining growth.

The second semi-longitudinal study on growth in height, weight and sitting height vertex was done by Das and Choudhury (1992) among the urban Assamese children from 8 to 16 years of age. The adolescent spurt was found among the boys occurring at 13 to 14 years, whereas the girls passed through the spurt two years earlier than the boys.

NUTRITIONAL STATUS

The first studies of nutritional status and food intake in developing countries were conducted before the Second World War. However, only in the 1950s and 1960s, when several studies were undertaken on the nutrition problems of people in developing countries, did the first large and comprehensive nutrition surveys appear.

By the end of the 1960s, however, the serious limitations and drawbacks of these large surveys were becoming progressively apparent. Since the early 1970s, a new and more pragmatic approach has evolved. Sophisticated and time consuming surveys have given way to less precise, but also less costly and much quicker, procedure for “assessing” a nutritional situation, its causes and its trends. These were designed for the rapid identification of priority areas and groups (on which a diagnosis in greater depth could be performed if necessary. (Beghin and Dujardin, 1990).
Rao et al. (1980) found an association of severe forms of anaemia with poor grades of growth status which to them might be due to general dietary inadequacy, poor utilization from food and unavailability of storage iron caused by infections and infestations.

Assessment of the distribution patterns of various nutrients in a community among the vulnerable segments of other members of a community has been done by Swaroop and Taskar (1959), Tasker (1963), Gopalan et al. (1971) and Rao et al (1980). Some other notable diet survey studies in India are those done by Aykroyd and Krishnan, 1936; Ray and Sircar, 1987; Bhat and Dahiya, 1985; Anne and Begum, 1985; Sarupriya and Mathew, 1985; Rao, 1980, 1987 and Bhattacharya et al., 1981.

Based on the results of a WHO sponsored study, Gopalan (1987) reviewed the major nutrition problem and experiences with nutrition programmes of nine countries of South-East Asia, namely, Bangladesh, Bhutan, Burma, India, Indonesia, Maldives, Nepal, Sri Lanka and Thailand. He reported that over 11 million of the babies born every year are of low birth-weight, and among children under 5 years, almost 100 million have kwashiorkor or marasmus (PEM), 10 million vitamin a deficiency, and about 17 million mental handicaps as a result of goiter (iodine deficiency). About 126 million women of childbearing age have been reported to have nutritional anaemia (iron deficiency).
A number of ethnographic studies have highlighted the role that cultural beliefs and practices regarding infant feeding and care also play in determining health and nutritional status in young children (Daniggelis 1987; Guldan, 1988; Zeltin and Guldan, 1988).

Applying different anthropometric parameters, nutritional status of the children as well as adults have been assessed in different parts of the globe since the last three decades (Himmelgreen et al., 1991; Kathryn et al., 1983; Choudhury and Rao, 1983, 1984; Cole et al., 1981; Rao et al., 1981, 1986; Rao, 1978; Seth et al., 1975; Cherian et al., 1988; Sen et al., 1980; Prasad and Rangaswamy, 1975; Frisancho et al., 1971; Malina et al. 1991; Ramakrishnan et al., 1992; Al-Hazza, 1990; Kapoor and Aneja, 1992). Prevalence rates of undernutrition and overnutrition were found to vary by age, sex and socioeconomic status (Rao, 1974, 1980; Rao and Satyanarayana, 1976; Banik, 1982; Gopalan and Srikantia, 1973; Satyanarayana et al., 1980; Rao et al., 1986; Majumdar and Roy, 2001).

INTRODUCING THE PROBLEM

Physical anthropology, having been frozen in a typological paradigm from the first half of the twentieth century, shifted to a dynamic, phenotypical viewpoint (Hunt 1981). As a result, a number of emerging sub-fields got
incorporated into the contemporary province of physical anthropology. The study of human physique makes one among many other such emerging areas.

Somatotyping is a valuable technique to quantify the overall morphological conformation of the human physique where many characteristics can be summarized in the form of ratings of fatness, muscularity and linearity. The application of somatotyping is diverse, especially in the field of sports and physical performance. Its application has been recognized widely in the study of sportsmen. The Olympic athletes have been studied comprehensively by various authors for their somatotypes (Tanner, 1964; de Garay et al., 1974; Carter, 1984). Many of the known diseases such as cardiovascular disease, Down’s syndrome, growth disorders, etc. are associated with different somatotypes. Temperamental freaks including delinquency, schizophrenia, criminality, physical and behavioural displasias also have specific physiques (Carter and Heath, 1990). The somatotype provides a type of soil in which certain diseases flourish more vigorously than in others. The somatotype, which reflects the relative development of different tissues, seems to influence habitual activity and professional choice of a carrier, which may require higher or lower amounts of such tissues. But such studies have not been made among general populations as widely as among sportsmen. In the context of Northeast India, such studies are a negligible few. Therefore, in the present study, an attempt has been made to explore the somatotype characteristics of the Bengali Muslims of Hailakandi district of Barak Valley.
In the less developed countries of the world today, the association between human physical growth and the physical, economic, and social environment is clear for all to see. Poverty, malnutrition and disease shape the bodies of the people from birth to death. Both at the micro level, where the health of the individual child is monitored, and at the macro level, where group or population means are calculated, physical growth is clearly seen to be responding to changes in the environment and to social and medical intervention.

For these reasons, the study of monitoring of physical growth is of particular interest in developing countries. It is also worth considering, however, whether physical growth is of interest in the industrialized and more developed countries, and how far insights from the developing countries can reasonably be applied to countries where levels of income and of health are far different.

Human physical growth is studied for many reasons. To pediatricians and other medical researchers, the primary focus is on the impact of the environment on the individual or the small group and the aim is the cure or alleviation of ill health or distress. To human biologists, growth is a central concern in understanding the complex of nutritional and hormonal mechanisms that control changes in the human body. To the epidemiologist, growth is of interest as a summary measure of environmental influences and increasingly as a proxy for environmental influences during childhood and adolescence, which may affect later health. To the practical nutritionist, growth is a measure of the
success of intervention in diet. To the economist, physical growth and strength help to determine individual labour productivity. To the anthropologist, growth is a measure of man’s adaptation to his physical environment. To the historian, growth is a measure of changing nutritional status, which is closely related to the concept of the “standard of living”, the subject of many historical controversies.

The different concerns of social and biological scientists are naturally reflected in their modes of investigation of the phenomena of physical growth. The different aims determine the problems to be addressed, the variables to be measured, and the period of growth to be studied. Thus, the vast majority of medical investigations are concerned with the first years of life, few with adolescence, and fewer still with the later phases of growth and then shrinking in middle and old age. Studies of nutritional intervention and of the impact of malnutrition is concerned almost entirely with the less developed countries, studies on height differences between occupational groups almost entirely with the more developed countries. Economists concentrate on contemporary societies, historians and some anthropologists on societies of the past.

In addition, auxologists (as students of human growth are called) study many aspects of growth and use many indicators – height, weight, height-for-age, weight-for-age, weight-for-height, and skinfold thickness, to name but some.
Growth status may be studied by cross-sectional investigation, but growth rate and variance can only be estimated from longitudinal observations. However, WHO (1986) states that a deficit in growth is not necessarily the most sensitive indicator of inadequate nutrition, e.g., a marginally inadequate energy intake may cause a reduction in physical activity before there is any impairment of growth. It is also recognized that the extent to which genetic factors, both within and between populations, may affect growth cannot be ignored.

Malina and Little (1985) while studying the relationship between body composition and performance found that changes in body compositions under conditions of mild-to-moderate undernutrition do not alter the relationship between lean body mass and performance compared to well-nourished children. The lack of an influence of relative fatness on performances involving displacement of body mass in these moderately undernourished boys were suggestive of a threshold level above which an excessive percentage of fatness exerts a negative influence on performance. On the other hand chronic undernutrition is associated with reduced body size and changes in body composition (Spurr et al., 1978). Here the importance of exploring the nutritional regulation of somatotype as well as physical growth needs to be asserted.

One of the most important resources of any community is its children. Children are the citizens of tomorrow who would substantially contribute to
the social, economic and all-round development of the country. Invariably the parents would desire that their children should possess healthy body and mind.

Poor nutritional status of children reflects poor development potential and prospect. Nutrition plays an important role in national development. People with malnutrition contribute little to national progress and become a big burden. Malnourished children who grow into adulthood have poor stamina, poor mental and psychomotor competencies. Chronic malnutrition in the early years of life causes not only stunt in growth of children but leaves permanent mental and physical scars which hinder the process of brain development to its optimum, affect their intelligence and make them unable to attain their full intellectual potential. So it is very imperative to assess the nutritional status of school-going children who are the future citizens of the country.

The nutritional studies are necessary in different communities and regions. These factual data of the incidence of malnutrition in the different communities and regions are very useful in order to make the fund-controlling administrators and politicians realize the extent of the problem. That helps them undertake corrective measures. In addition, the data on nutritional assessment of communities are necessary for any country, especially to provide an input to policy makers who ultimately prepare the National or State level planning.

Although the mechanisms are not well understood, there is substantial evidence that, given similar treatment in terms of access to dietary resources
and healthcare, females exhibit lower levels of malnutrition than males. In cases where males fare better than females for any of these factors, it is usually possible to document cultural preferences for male children. The concept of physiological "buffering" of females has been proposed as a proximate explanation. According to Eveleth (1975), under adverse environmental circumstances, the phenomenon of female buffering will lead to lower sexual dimorphism in adults. Therefore, an attempt to look at the sexual dimorphism regarding growth parameters may not be out of place and has been incorporated into the study.

THE AREA AND THE PEOPLE

In common parlance, the undivided Cachar district comprising presently of the districts of Cachar, Hailakandi and Karimganj is known as Barak Valley. These three districts are inhabited by 1,442,141, 542,978 and 1,003,678 persons respectively according the Census of 2001. About a fifth of Valley population live in Hailakandi district from which the subjects of the study were selected.

Hailakandi was one of the oldest subdivision is the state of Assam. It was constituted as a civil subdivision on June 1, 1869. Subsequently, it was upgraded to a district in 1989. The district is geographically located between 24°5' 24°55' North latitude and 92°25' and 92°47' East longitude.
There are two reserve forests in Hailakandi district viz. Inner line reserve forest and Katakhal reserve forest. The district has got inter-state border with Mizoram on its south having a length of 76 km besides inter district border on other sides with Karimganj and Cachar districts. It comprises of two notified towns viz. Hailakandi (district headquarters) and Lala and one industrial township viz. Panchgram. A Municipal Board governs Hailakandi town and a town Committee governs Lala. It has five development blocks viz. Algapur, Hailakandi, Lala, Katlicherra and South Hailakandi development Block. There is a Mahkuma Parishad named Hailakandi Mahkuma Parishad covering these 5 Development Blocks. There are total of 62 Gaon Panchayat under these five blocks. The district is divided into four revenue circles comprising a total of 393 villages (including 27 forest villages). Nearly half the district area is covered by forests. Out of the remaining half, 33.2% is under cultivation. Rice is the main crop. The District has 4 Police stations, 2 Police out post, 2 Colleges, 43 HS/High Schools, 247 ME/ MV Schools and 937 LP Schools.

In the organized sector, Tea is the main Industry of the District. It has 17 Tea estates with 5570.38 hectares under Tea plantation employing more than 1,30,642 persons as per 1991 Census. Production of Tea was 87.62 Metric ton. The Hindustan paper Mill at Panchgram comes to the second place where people get employment opportunities in the district.

According to 1991 census, Hailakandi, with an area of 1327 sq. km. is inhabited by 449048 persons, of whom 369896 (82.37 %) are Bengali speakers. Out of the total population of 449048 persons, 414910 (92.40 %) are
rural (215176 males and 199734 females) and 34138 (7.60 %) are urban (17559 males and 16579 females). The Muslims and the Hindus are the two major religious groups constituting 54.79% and 43.71% respectively of the total population. According to the Census of 2001, it has a total population of 5,42,978, of whom 2,80,912 are males and 2,62,066 are females. As per 2001 Census, over all literacy rate is 59.80. The figure for Males is 68.47% and for females, it is 50.64 %.

The forefathers of the numerically dominant Bengali people of the present day Barak Valley had migrated to this place during pre-independence period from different parts of the then East Bengal, particularly Syhlet district. Culturally, these immigrant people (both Muslims and Hindus) are conspicuously different from the indigenous Assamese Muslims and Hindus.

Like the most of rural India, agriculture is the mainstay of their livelihood, with a small number having business (usually small scale) and some government jobs as their primary occupation. Though agriculture is the mainstay of livelihood, it is generally observed that the low-income households fail to produce food grains sufficient to feed them throughout the year because of limited cultivable land possessed by them. They have to opt for some subsidiary occupations like wage earning, carpentry, etc. to make both the ends meet. Share cropping (baagi) in the lands possessed by affluent families is also done by the poor households having insufficient cultivable land. Males are engaged in most of the agricultural activities.
Fig. 1. Map of Assam showing the study area
Nuclear family is the common existing pattern, but a few joint families are also met with. A few cases of consanguineous marriages, both matrilineal and patrilineal, are also noted among the Muslims of the present day Barak Valley which is a feature conspicuously different from the indigenous Assamese Muslims among whom the presence of consanguinity is totally absent (Begum and Choudhury, 1996). Presence of consanguinity among the Bengali Muslims had also been reported earlier (Mukherjee, 1996).

The people are basically non-vegetarian. Rice is their staple food. They eat all kinds of available fruits and vegetables. Milk is a favourite drink but those families who are economically backward are unable to include it as a regular item in their diet due to its high price. Eggs, fish, meat of fowls, ducks and goats are considered as delicacies. One more delicious food item is beef. Sometimes the villagers catch fish from nearby rivers, rivulets, ponds and other water bodies. Meat consumption is not very common barring the economically well off families due to its high price. The economically better off families sometimes purchase meat and fish from nearby market also. In general, rice as a major meal is taken twice a day. The daytime meal is finished around 2 p. m. while night meal is finished around 10 p. m.

Prolonged breast feeding has been noticed among these Muslims. They continue the breast-feeding upto about 2½ years. It is a belief that prolonged breast-feeding is beneficial to the baby’s health.
AIMS AND OBJECTIVES OF THE STUDY

The diverse application of somatotyping has already been discussed. As many of the known diseases are associated with different somatotypes, a study of somatotype can be reasonably expected to have its implication in health perspective. The somatotype provides a type of soil in which certain diseases flourish more vigorously than in others. The somatotype, which reflects the relative development of different tissues, seems to influence habitual activity and professional choice of a carrier, which may require higher or lower amounts of such tissues. As has already been referred to, such studies have not been made among general populations as widely as among sportsmen. It also appears that the studies of somatotype in relation to other auxological variables such as general growth pattern or nutrition are not very many. Therefore the study aims at assessing the somatotype characteristics of the Bengali Muslims inhabiting Hailakandi district of Barak Valley.

Growth studies have attained a considerable age when taken from their inception. With its considerable degree of maturity, problem oriented studies in human growth are on the increase in the global context. This is in contrast to the picture in Northeast India where very few growth studies have been conducted. Applied research in the modern perspective of human growth remains a far cry as even the exploratory work on the general growth pattern among many of the Northeast Indian populations is yet to be undertaken. The Bengali population of Barak Valley is one such population among whom the
assessment of anthropometric growth has not been made till now. Therefore, physical growth pattern of the Muslim sect of Bengali population of Hailakandi district has been a major component of the present study.

Physical growth is one of the best indicators of child health and continuous monitoring of growth of children in under and over-nourished population is a major concern of all public health authorities and government. Failure to attain optimum growth is a characteristic of mild to moderate protein calorie malnutrition (Gopalan, 1963). Inadequate physical growth among the children are generally presumed to be due to poor health and nutritional conditions. Therefore, the prevalence of protein-calorie malnutrition can be assessed by looking at the extent of growth failure as indicated by body measurements, when compared with levels of reference for age. Therefore, in the present study, nutritional status of the Bengali Muslims has been considered.

As has been pointed out earlier, physical growth is regulated by a variety of factors like heredity, socio-cultural behaviour, economy, nutrition etc. Therefore, in the present study, physical growth has been looked upon in relation to socio-cultural factors.

Thus the study aims at understanding the growth pattern of Bengali children with the following objectives:

1. To explore the somatotype characteristics of the Bengali Muslim children of Hailakandi district.
2. To explore the pattern of growth among the Bengali Muslim children of Hailakandi district.

3. To explore the nutritional status of the Bengali Muslim children of Hailakandi district.

4. To look into the variations, if any, in somatotype, physical growth and nutritional status between the different income groups.

5. To examine the sexual dimorphism, if any, in somatotype, physical growth and nutritional status.

6. To see how far the growth pattern of children belonging to the Bengali Muslim community differ from that of the other populations such as the Assamese Muslims, Assamese Hindus, the general Indian Muslims, and the general Indian Rurals.

7. To provide a logical explanation of the results obtained, and to spell out areas identified for future research/action, if any, emanating from the results.

MATERIALS AND METHODS

A purposive sampling frame has been used for the present study. Hailakandi, the district lying amidst the two other districts of Barak Valley, i.e., Cachar and Karimganj, was selected as the study area at the first step of sampling. This district has a larger concentration of Muslims (54.79%) than the other two (Cachar – 34.49% and Karimganj 49.17% according to 1991 census).
The field study was conducted during the year 2001 from 12 villages, each at least 10 km away from the main Hailakandi town. As the study was exclusively on the rural Muslims, villages that were just adjacent to the town, as well as the two villages immediately following them were excluded from the study in order to avoid the intricacies of peri-urban influences. The selection of villages for data collection was also based on numeric dominance of Bengali Muslim inhabitants and availability of children aged between 3 to 20 years. Information regarding the above was collected from the elderly persons of the village and such other knowledgeable persons. After selecting the villages, the households having children from 3 to 20 years of age were selected. Only completed ages have been considered for the respective age categories. Cross-sectional somatometric data were collected on 1001 boys aged 3 to 20 years inhabiting an equal number of households.

The subjects were observed for 14 anthropometric traits. These are body weight, height, sitting height, horizontal head circumference, chest circumference, mid-upper-arm circumference (both relaxed and flexed), calf circumference, skinfolds at triceps, subscapular, suprailliac, supraspinale and medial calf. Height was taken with an anthropometer and body weight with a portable weighing machine. Circumferential measurements were taken with the help of a non-stretchable measuring tape, and skinfold thickness with a Holtain caliper. Subjects below 3 years of age have not been included because it is often seen that they get frightened to a concerning limit after seeing the anthropometric instruments, which makes the observation prone to errors.
In order to look into the sexual dimorphism to a feasible extent, a total of 711 girls between the ages 3 and 15 years were also measured. The girls who were up to ten years of age were observed for all the measurements like the boys, but the girls beyond 10 years could be measured only for their body weight and height. The number of children measured in each age category is as follows:

<table>
<thead>
<tr>
<th>Age</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>46</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>51</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>39</td>
<td>53</td>
</tr>
<tr>
<td>6</td>
<td>55</td>
<td>48</td>
</tr>
<tr>
<td>7</td>
<td>53</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>62</td>
<td>56</td>
</tr>
<tr>
<td>9</td>
<td>78</td>
<td>62</td>
</tr>
<tr>
<td>10</td>
<td>64</td>
<td>59</td>
</tr>
<tr>
<td>11</td>
<td>64</td>
<td>56*</td>
</tr>
<tr>
<td>12</td>
<td>74</td>
<td>60*</td>
</tr>
<tr>
<td>13</td>
<td>68</td>
<td>55*</td>
</tr>
<tr>
<td>14</td>
<td>62</td>
<td>60*</td>
</tr>
<tr>
<td>15</td>
<td>52</td>
<td>57*</td>
</tr>
<tr>
<td>16</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1001</td>
<td>711</td>
</tr>
</tbody>
</table>

*Girls aged between 11 and 15 years were measured only for weight and height

The study, being the first of its kind, was fraught with certain limitations. For a male researcher, it was not convenient to measure the girls in a society, which is very conservative in nature. It is often seen that the girls of the area, particularly the Muslim girls hesitate to come in front of a male, more so if he is unknown to them. In such a situation, it was not possible to take all the
measurements among the girls aged from 11 to 15 years, nor it was possible to
measure girls aged beyond 15 years for any measurement.

The methods followed while taking the anthropometric measurements
were those of de Garay et al. (1974). Somatotyping of children has been done
by Heath-Carter method.

The different component ratings have been calculated by the following
equations of Carter (1980):

Endomorphy = -0.7812 + 0.1415(X) - 0.00068(X)² + 0.0000014(X)³
where X is the sum of triceps, subscapular and suprailiac skinfolds.

Mesomorphy = (0.858 * humerus width + 0.601 * femur width + 0.188 *
corrected arm girth + 0.161 * corrected calf girth) - (Height * 0.131) + 4.50.,
where corrected arm girth = upper arm circumference (cm) – skinfold at triceps
(cm) and corrected calf girth = calf circumference (cm) – skinfold at calf (cm).

Before rating ectomorphy, height-weight-ratio (HWR) has been
calculated by diving the height by cube root of weight.

Ectomorphy = HWR * 0.732 – 28.58 (when HWR > 40.75)

Ectomorphy = HWR * 0.463 – 17.63 (when HWR < 40.75 > 38.25)

Ectomorphy = 0.1 (when HWR < 38.25)
As far as rural India is concerned, parents are difficult to be relied upon for recalling the exact age of their offspring, which is one of the most important aspects of studying physical growth. Different methods had to be employed regarding the assessment of age, because of lack of uniformity regarding the availability of birth certificates. In some cases the assessment of age was made from written records or the birth certificates issued by the physicians, whichever was available. Whereas, in other cases, it was assessed by relating the subject’s birth with some major events like construction or establishment of a village school or such other landmarks. In still some other cases, the subject’s age was assessed by relating it to someone whose exact date of birth was known.

Apart from anthropometric measurements, income per person in each household, family size and marriage type were also recorded. The households were classified into low, middle and high-income group. This classification was made following the scale designed by the National Council for Applied Economic Research (New Delhi) according to 1994-95 prices, (not revised till date). This scale reads the different income group families having five members as a standard norm as follows:

Table 1.2. Classification of households as per annual family income

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Annual family income(Rs. in 1993-94 prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Upto 22,500</td>
</tr>
<tr>
<td>Lower Middle</td>
<td>22,501 – 45,000</td>
</tr>
<tr>
<td>Middle</td>
<td>45,001 – 70,000</td>
</tr>
<tr>
<td>Upper Middle</td>
<td>70,001 – 96,000</td>
</tr>
<tr>
<td>High</td>
<td>Above 96,000</td>
</tr>
</tbody>
</table>
For convenience, this scale was re-designed taking per-consumer income as the criterion as follows:

Table 1.3. Classification of households as per annual income per consumer

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Per consumer annual income (Rs. in 1993-94 prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Upto 4,500</td>
</tr>
<tr>
<td>Lower Middle</td>
<td>4,501 – 9,000</td>
</tr>
<tr>
<td>Middle</td>
<td>9,001 – 14,000</td>
</tr>
<tr>
<td>Upper Middle</td>
<td>14,001 – 19,200</td>
</tr>
<tr>
<td>High</td>
<td>Above 19,200</td>
</tr>
</tbody>
</table>

Among the above categories, the families having an income of Rs. 45,001 or above, and per consumer income of Rs. 9,001 and above are considered as middle to high-income group. Therefore, household having per consumer income ranging from Rs. 9001 to 19,200 could be categorized as the middle-income group. To this effect, the scale was again simplified as follows:

Table 1.4. Simplified classification of households as per annual income per consumer

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Per consumer annual income (Rs. in 1993-94 prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Middle</td>
<td>Upto 9,000</td>
</tr>
<tr>
<td>Middle</td>
<td>9,001 – 19,200</td>
</tr>
<tr>
<td>High</td>
<td>Above 19,200</td>
</tr>
</tbody>
</table>

The above scale has been followed throughout the study.

Statistical methods have also been applied in interpreting the data. The statistical constants and measures of dispersion used in the present study are: mean, standard error for mean, standard deviation, standard error for standard
deviation, coefficient of variation, standard error for coefficient of variation, absolute growth, growth per cent per annum and growth gradient.

The age dependent parameters used for assessing nutritional status are: weight-for-age and height-for-age. Weight was classified according to the suggestions of the nutrition sub-committee of the Indian Academy of Pediatrics (1972). Children with more than 80% of the expected weight-for-age, [i.e., 50th percentile of the reference population defined by the US National Centre for Health Statistics (NCHS) taken as 100% of the expected weight-for-age] were termed as normal. Those weighing between 71-80% were taken as suffering from Grade I malnutrition, between 61 – 70% as suffering from Grade II malnutrition and less than 60% as suffering from Grade III malnutrition. (WHO, 1986).

Children with more than 90% of the expected height-for-age, [i.e., 50th percentile of the reference population defined by the US National Centre for Health Statistics (NCHS) taken as 100% of the expected height-for-age] were termed as normal. Those weighing between 80-89% were taken as suffering from Grade I malnutrition, between 70 – 79% as suffering from Grade II malnutrition and less than 60% as suffering from Grade III malnutrition. (WHO, 1986).

The age independent parameters used for assessing nutritional status are: weight-for-height, body mass index (BMI) and mid-upper-arm/head circumference ratio. Children with more than 80% of the expected weight-for-
height, [i.e., 50th percentile of the reference population defined by the US National Centre for Health Statistics (NCHS) taken as 100% of the expected weight-for-height] were termed as normal. Those weighing between less than 80% of the expected weight-for-height were considered as wasted (WHO, 1986).

Body mass index was calculated by dividing body weight by the square of height. The ratio of 0.0015 was used as the cut-off point. The children with a ratio of 0.0015 were considered as normal and below this point were considered as suffering from protein-calorie malnutrition (Rao and Singh, 1970). Children with a ratio from 0.00149 to 0.00145 were considered as suffering from Grade I malnutrition, those with 0.0014 to 0.00131 as suffering from Grade II malnutrition and those with a ratio of 0.00130 or less were rated as suffering from Grade III malnutrition.

Children with a mid-upper-arm/head circumference ratio of 0.310 and more were rated as normal and below this point were considered as suffering from protein-calorie malnutrition (Kanawati and Mc. Laren, 1962). Children, when arranged in descending order, with a ratio from 0.30 to 0.28 were considered as suffering from Grade I malnutrition, those with 0.27 to 0.25 as suffering from Grade II malnutrition and those with a ratio less than 0.25 were rated as suffering from Grade III malnutrition.

Student's t-test has been performed to see whether the children of two defined categories differ significantly from each other regarding metric traits.
For looking at the differences regarding qualitative data, Chi-square test has also been performed.

While giving statistical treatment to the data, the computer package Microsoft-Excel - has been used.