STUDY ON DEMOGRAPHY AND GROWTH PATTERN AMONG THE KHASI CHILDREN OF SHILLONG, MEGHALAYA

By

NANDITA MUKHERJEE
DEPARTMENT OF ANTHROPOLOGY

THESIS SUBMITTED
TO
THE NORTH-EASTERN HILL UNIVERSITY
FOR PARTIAL FULFILLMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
ANTHROPOLOGY

NORTH-EASTERN HILL UNIVERSITY
SHILLONG - 793 014
MARCH, 2002

DEPARTMENT OF ANTHROPOLOGY
NORTH-EASTERN HILL UNIVERSITY
MAYURBAHNJ COMPLEX, NONGTHYMMAI
SHILLONG-793 014

Dated: 15th March, 2002

CERTIFICATE

Certified that the thesis entitled " **Study on Demography and Growth Pattern among the Khasi Children of Shillong"** *is the record of the original work done by Smt Nandita Mukherjee. To the best of my knowledge, the contents of this thesis did not form a basis of the award of any previous degree to her, and that the thesis has not been submitted by her for any research degree in any other University, or Institute.*

In habit and character, Smt Nandita Mukherjee is a fit and proper person for the degree of doctor of philosophy.

(R. Khongsdier)
Supervisor

Dated, Shillong, the 27/15 March, 2002

DECLARATION

I, Smt Nandita Mukherjee, hereby declare that this thesis entitled **"Study on Demography and Growth Pattern among the Khasi Children of Shillong"** *is my bona fide research work, and that the thesis has not been submitted by me for award of any research degree in any other University.*

(Smt Nandita Mukherjee)
Candidate

ACKNOWLEDGEMENT

I wish to express my deep heartfelt gratitude to my supervisor Dr. R. Khongsdier, Reader, Department of Anthropology, NEHU for his valuable suggestions and untiring guidance with constant encouragement throughout the study, without which this work could not have been brought into its present form. I am very much grateful to Dr. A. K. Ghosh, my former guide, for his unhesitating help and personal encouragement throughout the period of the work. I am also very much thankful to Dr. H. Lamin, Head of the Department of Anthropology, NEHU, for helping and providing necessary facilities.

I specially wish to express my gratefulness to Dr. Chumki Piplia and Dr. B. Mondal for their interest and sustained help in supplying the secondary materials related to the present work.

In the field areas, I received substantial help and co-operation from many people and organisations. Special thanks are due to Mr. Jamir Hussain Nongrum, Miss Saira Kharbuli, Miss Piecefully Kharkongor and Mr. P. Lyngdoh.

I am also grateful to my friends of Anthropological Survey of India, Shillong, Calcutta and I.S.I. Calcutta who extended their help in carrying out this work.

Last but not the least, I am very grateful to all my family members particularly my father for his constant interest in and encouragement to this study. I owe my special gratitude to my husband without whose help and encouragement this assignment could not have been completed.

CONTENTS

List of Tables

List of Figures

CHAPTER - 1
INTRODUCTION

The study of human evolution and variation are the two major objectives of physical anthropology. These two objectives of study are overlapping in physical anthropology, and they cover a vast area of biological interest ranging from simple anthropometric study to molecular study of human evolution and variation. Recently, efforts have also been made to understand the relationship between human biology, especially to those aspects relating to health and nutrition, and various socio-cultural factors (Strickland Tuffrey, 1997). In fact, it is now believed that the human biological processes are largely influenced by various sociocultural aspects of the human society. Thus, it is quite imperative on the part of physical anthropologists to undertake such studies with a view to having a better understanding of not only the processes of human evolution, but also the health and nutritional aspect of human population.

From an evolutionary point of view, demographic parameters like fertility and mortality are very important to understand the genetic make up a population. It is theoretically belied that natural selection, one of the major evolutionary forces, is operating on human population through differential fertility and mortality (crow, 1958, Johnston, 1973). Similarly, other demographic parameters like population size, mating patterns admixture rate, migration, etc., are very helpful for understanding the biological characteristics of the population (Basu, 1969; Ghosh, 1976; Khongsdier and Ghosh, 1994). However, it may be noted that demographic parameters like fertility and mortality are also largely influenced by various socioeconomic factors (Davis and Blake, 1956; UN, 1967, Mandelbaum, 1974, Mitra, 1978; Mosley and Chen, 1984; Mahadevan, 1986; World Bank, 1999; Caldwell *et al.*, 1999; and others). So, it is quite imperative on the part of physical anthropologists to undertake a study on the effect of socioeconomic conditions on demographic parameters, particularly on fertility and mortality.

Besides demographic aspects of population physical growth and development of children is another important field of anthropological research. By the term growth, we mean " quantitative increase in size or mass" of an organism, while development refers to "progression of changes, either quantitative or qualitative, that leads from an undifferentiated or immature state to a highly organized, specialized, and mature state" (Bogin, 1999). The pattern of human growth serves as a type of mirror that reflects the biocultural evolution of human population. "Human biocultural evolution produced the pattern of growth and development that converts a single fertilized cell, with its complement of deoxyribonucleic acid (DNA) into a multicellular organism composed of hundreds of different tissues, organs, behavioral capabilities and emotions" (Bogin, 1999).

According to Tanner (1988), "The study of growth is important in elucidating the mechanism of evolution, for the evolution of morphological characters necessarily comes about through alteration in the inherited pattern of growth and development. Growth also occupies an important place in the study of individual differences in form and function of man, for many of these also arise through differential rates of growth of particular parts of the body relative to others ". Further, Eveleth and Tanner (1990) have also observed " A Child's growth rate reflects, perhaps 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 height and weight reflect accurately the state of a nation's public health and the average nutritional status of its citizens, when appropriate allowance is made for differences, if any, in genetic potential. This is especially so in developing and disintegrating countries". Therefore a well-designed growth study is very important tool for assessing the health status of the population concerned. Since human growth and development is also largely influenced by socio-environmental factors like nutrition, infection, occupation, income and religion, it is very vital for understanding the biocultural variation and evolution of human populations (Tanner 1988, Eveleth and Tanner, 1990, etc.)

In the light of the above circumstances, demographic parameters and physical growth are not only helpful in understanding, the process of human evolution and variation, but also reflect the health and economic condition of a population. In India, growth studies are very recent in origin (as reviewed by Sharma, 1992), which still warrants further researches. So, it may be essential to conduct more researches on physical growth and development of children with a view to understanding the economic conditions and health and\or nutritional status of the different populations\communities. It may be worthwhile to mention here that in the North-Eastern Region of the country, very few growth studies have so far been published (Das and Das, 1969-71; Das, 1973, 1974; Hazarika, 1974;Choudhury *et al.*, 1992). Moreover, all these studies have been carried out among some populations of Assam only (Khongsdier and Ghosh, 1998). Similarly, demographic studies of populations are very few in number in this part of the country (Nag, 1965; Baruah, 1983; Khongsdier, 1991, 1992, 1993, 1995;Das and Das 1992)

With this end in view, we have undertaken a study on demography and growth pattern among the Khasi children of Shillong in Meghalaya with a view to understanding the following objectives:

1. To understand the demographic structure of the three religious groups of the Khasis, namely, Christians, Muslims and Niam Khasis of Shillong.
2. To understand the growth pattern and nutritional status of children aged 3 to 18 years.
3. To assess the effects of some socioeconomic factors like religion, income of household, etc., on demographic parameters, and growth patterns of children.

AREA OF STUDY

Location and Topography

Meghalaya is essentially a small tribal state in the north eastern region of India. It lies between 25° 47' and 26° 10' N latitude and 89° 47 and 92° 87 E longitude. The state covers an area of about 22, 429 km. It is bounded by Assam on the north, east and north west, and by Bangladesh on the south and south west.

Initially, Meghalaya was a part of Assam, which was composed of only two districts, namely, the united Khasi and Jaintia Hills district and Garo Hills district. It was bifurcated from Assam as an autonomous state of April 2, 1970, and subsequently a full fledged Statehood was given on January 21,1972. The Khasi Hills district was itself bifurcated on 12th October 1976 into two districts known as East Khasi Hills district with its headquarters in Shillong and the West Khasi Hills Districts with its head quarters at Nongstion.

Several hills in the Khasi Hills district have a firm place in mythology and traditions of the Khasi people. For example, Shillong peak (Lum Shillong) is the highest peak (1964m) in the Khasi Hills. It associated in the legends of the Khasi with U 'Lei Shillong (Lei being the abbreviated form of Blei God), the tulelar deity of the old kingdom of Shillong and progenitor of the royal family, *Ka Pah Syntiew*. The base of the peak is the source of four important rivers – the Umngot, Um-Iew, Um-Jasai (an important tributary of the Um-lam or Barapani) and Um-Khen, from which water supply of Shillong is obtained.

Climate: Because of the considerable variations in altitude and exposure, differences in climatic condition do exist within the Khasi hills. Shillong is situated about 1500 m above sea level. Its climate is pleasant, neither extremely cold nor hot. The temperature rises above 24° C – 34° C in the summer and falling below 4° C in winter. The average temperature and annual rainfall vary from one region to another. But Cherrapunji and Mawsynram areas receive the heaviest rainfall in the world (1270 cm).

Geological Composition

Meghalaya may be broadly divided into five Geological formations, namely Archean Gneisses complex, Shillong group of Rocks, Lower Gonduana Rocks, Cretaceous Tertiary Sediments and sylhet Traps (Bhakta, 1992). Shillong Group of Rocks are exposed in the central parts of the Khasi hills comprising mostly quartzite. Rocks of this group rest unconformably over the gneissic rocks with basal thick bed of conglomerate in the western part. The mildly folded sediments have suffered low grade metamorphism and are dissected by numerous faults. These rocks are intruded by ultra basic and acidic sills and dykes. The granite intrusive along the axial region of the Shillong group of rocks around Mylliem is termed as Mylliem granite. Several other granite bases such as Kyllang Plateau are intrusive into the gneissic complex in different parts of the region.

The Khasi hills area is endowed with a number of economically important minerals, the major ones being limestone, coal, uranium, sillimanite and clay.

Flora and Fauna: The vegetation of Khasi hills may be broadly classified into two major types, viz., the Tropical and warm temperate types. The forest of Mehglaya is the rich source of timber. The important timber-yielding free species are Khasi pine (*Pinus Khasiya*), sal (*Shore robustra*), teak (*Tectana grandis*) gamari (*Gmelina or borea*) etc. Different types of bamboo also grow in abundance.

Major .crops of this state are paddy, maize, millet, pulses, potato, and ginger, turmeric, black pepper, sugarcane and oil seeds. Among the vegetables, cabbage, cauliflower, bean, radish, chilly, onion, lady's finger, carrot, peas and brinjal are extensively cultivated. The cultivated fruits include guava, orange, lemon, banana, naspati (*Pyrus senensis*), papaya (*Carica papaya*) black berry (*Prunus nepulems*), etc.

About 250 species of orchids have been reported form this region which include species ranging form tiny ones to tall one or more meters high (Gazetteer of India, 1991) Ferns are also found in abundance. The above mentioned flora of Khasi hills are mostly found in Shillong area.

The fauna of Meghalaya include a unique assemblage of Indo-Chines elements of Oriental and Palaearctic fauna (Gazetteer of India, 1991). The tropical and subtropical evergreen forests ensure the survival of rich mammals and also other groups of animal life. Of mammals, the Khasi hills possess some interesting animals like the hillock (*aibcon*), the only ape in India (*Hylobates*), the golden cent (*Felies temminckei*), the leopard (*Felids bengalensis veer*), the jungle cat (*Felis chaus*), the Himalayan black bear (*Selenarctos thebethanus*), the banking deer (*Muntiacus muntjak*) and the Panglen (*Manis pentadaetyla*).

Different types of birds are also found in East Khasi hills of Meghalaya. Snakes and lizards are also abundance. Besides, the Khasi Hills also reveal a number of interesting amphibians and fish species. Insects of the region present an equally interesting assemblages of fauna in the state. It may however be noted that most bird and animal species tend to decrease in number due to increasing deforestation.

THE PEOPLE

According to 2001 census, the total population in 2306069 of which 1167840 are males and 1138229 females. In East Khasi Hills, the total population is 6,60,994 of which males-

3,33,187 are males and 327807 females. The sex ratio is 984 females per 1000 males with a literacy rate of 76.98%.

The people of Meghalaya are mostly tribals, among which the Khasis and Garos are the most dominate tribal groups. The other tribal populations like the Hajongs, Nagas, Mizos, etc. along with some non-tribal populations like Bengalis, Assamese, Nepalis, Biharis, Panjabis, etc. have also settled in Shillong.

The Khasi tribe consists of five major sub-groups, namely, the Wars, Khynriams (Upland Khasis), Jaintias (Pnars or Syntengs), Bhois and Lyngngams. The Khynriams are mostly found in upland region of the East Khasi and West Khasi districts of the State. The Jaintia Hills district is dominated by the Jaintias. The Bhois predominantly live in the Ri-Bhoi district on northern parts of the Khasi Hills. The Lyngngams are mainly confined to the southern and western parts of the West Khasi Hills district.

Physical Characteristics and Affinity

Form the anthropological point of view, the Khasis (or Khynriams, Pnar, Bhois, Wars and Lyngngams) belong to the Indo-Mongoloid of the Mongoloid racial stock (Das, 1981). Das (1987) has described that the "Khasis have brown skin color. Their head hair is dark brown with a reddish tinge in color, straight or flat, wavy in form and coarse in texture. They have scanty beard and moustache. The color of eye is brown to dark brown. The eye slit is mostly oblique and palpebral fissure is medium. Eye fold is present in most of the cases. They are short in stature. Their head is mosocephalic and nose in mesorrhine". Regarding the four sub-groups of the Khasis, Das (1978) says that these four divisions (i.e., Khynriams, Pnars, Bhois and Wars) do not deviate much form the average Khasis in relation to stature and trunk height. He, however, points out that the "Pnars and the Bhois show most often deviation in higher magnitude and that these two populations are standing porpoise to one another in relation to average Khasis". It may be mentioned that the people have so far treated the Khynriams, Pnars, Bhois, Wars and Lyngngams as one and the same ethnic group. Marwein (1987) says that the Khasi are" known sometimes by different names at different places. The names are either confined to a particular Syiemship or state or a particular geographical region". All these sub-groups claim to have descended from the same origin, i.e., *U Hynniew Trep Hynniew Skum* (Seven Huts). Recently, the government of Meghalaya has published one volume of Meghalaya (DIPR, 1991). In this volume, it is clearly stated that these Khasi groups are of the same ethnic origin. They share common traditions and customs, though there may be some variations, owing to different geographical conditions and admixture with other communities.

All the sub-groups of the Khasis follow the matrilineal system of the society and linguistically they speak a different dialect of the Monkhmer language, which belongs to the Austric (Austro-Asiatic) group. So far as the Austric language in concerned, it is believed to be spoken by the earliest inhabitants of the country, particularly the Australians and their descendants (Ghosh and Khongsdier, 1997). At present, besides the Khasis, other peoples like the Kols, Mundas, Nicobarese of Nicobar islands, etc., are the Austric speakers in India. Das (1987) has reported that the Wanchoo of Arunachal Pradesh also use some Austric words in their language.

With regard to the position of the Khasi, Dixon (1922) says"... the Khasis in spite of their linguistic isolation among the peoples of Assam, are racially closely related to the majority of the Burmese tribes. With them they represent a very old western drift of south-western Asia peoples unlike their neighbours, however, they have succeeded in retaining their old speech". Haddon (1924) has also tentatively suggested the presence of ancient dolichocephalic platyrrhine (Pre-Dravidian) type among the Khasis. Linguistically, Chatterjee (1951) says "In Burma Indo-China lived speakers of Austric language, who are largely of Proto-Australoid race from India". Accordingly, Das (1978) has proposed that that the "Khasi is an Australoid population speaking the Austric language. Their physical features were modified by a strong intrusive Mongoloid strain. They have retained their language but have undergone remarkable changes in physique".

The other possibility is that the Khasis are a Mongoloid people, who came from south-east Asia as suggested by many scholars like Gurdon (1907), Chatterjee (1951), Bareh (1967), Das (1979), and others. According to Gurdon (1907). "The Khasis are an offshoot of the Mon people of Further India in the light of historical fact." Chatterjee (1951) says, " They would appear to be a Mongoloid people who have adopted the language of the earlier race, the Austrics (or Proto-Australoids), after they have come down from south Tibeto-Burman area of dispersion. They may have changed their speech to the Austric (Mon khmer) Khasi even while they were in Burma." He has also pointed out that the admixture of proto-Australoids and Mongoloids "in very early times in Burma and Indo-China is very likely, this mixture producing the ancient Rmen or Mon people of central and southern Burma, the Palaungs and Was of upper Burma, as well as the Khmers, the Chams, the Stings, the Bahnars and other Austric or Austro-Asiatic speakers of Saim and Indo-China". It may be mentioned here that the Proto-Australians are known by different names like Pre-Dravidians, Australoids, Veddids and Nishadas. The Proto-Australoids are similar to Caucasoids in respect of many characteristics. Sometimes, they are also considered a sub-division of the Caucasoids known as Archaic Caucasoids (Das, 1970). In view of the above suggestions, it appears that the Khasi are a Mongoloid people, who might have learned their language form the Australoids (or Proto-Asutraloids) on their way to India or they might be one of those peoples resulting form the admixture between the Mongoloids and Proto-Austraoids (Australoids), somewhere in Burma or Indo-China. Some scholars (like Gurdon, 1907; Bareh, 1967; Das, 1970; and others) have also supported this view on the basis of cultural evidence. It may however, be noted that there are also some cultural similarities between the Khasi and the Kolarian tribes of Central India.

Occupation

The community was basically a land owning community, the land belonging to the individual proprietress. Along with the advent of Christianity, drastic economic changes also came about in this area. Previously, jhuming (shifting) was the chief mode of cultivation besides the dry land cultivation of rice. The forest resources were immense and the supply of wood, bamboo and cane was another lucrative business. However, after independence and the opening up of greater opportunities there was a rapid rate of urbanization with the result that people got attracted toward towns. Those who were educated got white-collar jobs. The young are usually attracted by vehicles and take up driving as a profession. The men take up job as laborers at various construction sites. Some people are also engaged in business and services. Traditional industries were never important as occupations (Syiemlieh, 1994). The main occupations today are jobs in offices, teaching, contractor and the professional services where there are a large number of Khasis as university and college teachers, engineers, doctors, etc. There is no bonded labour, child labour exists but not in disturbing proportions and there has been little change in the occupational pattern, as industrialization has made no important in terms of the employment.

Religion

The majority of the Khynriam Khasis of Shillong have embraced Christianity, while next to Christian group are the Niam Khasis- believers of Khasi traditional religion (Ka Niam Khasi). There are also a few Khasi Muslims in Shilling, i.e., those Khasis who have converted to Islam through marital alliance with the Muslims who migrated from Bangladesh and other parts of India.

Among the Khasis, Christianity dates back to about 150 years when Krishna Chandra Pal converted two Khasi people in a village, called Pandua (Pyrdiwah) on the border of the Khasi hills and Sylhet District (Bhat, 1975)

But the number of converts to Christianity among the tribal was few, until Thomas Jones of the Wales Presbyterian Mission in 1841 propagated the use of the Latin alphabet to write the tribal dialect. At present there are different Christian denominations like Presbyterian, Roman Catholics, Church of God, Church of Christ, Seven day Adventist, United Pentecostals church, etc. In the present study, data on various denominations were not be taken into consideration. By 'Christians' we mean only those Khasis who believe in Christianity. The spread of Christianity in the Khasi and Jaintia Hills has brought about tremendous change in the field of education (Nag, 1965; Das Gupta, 1984). Nag (1965) has shown that the Christian Khasi have better education standard and economic condition that their non-Christian counterparts. "The spread of education is perhaps the most significant effect of Christianity among the Khasi" (Nag, 1965).

The people, who are still following their traditional religion, are monotheistic, though others are of the opinion that the Khasi religion is animism (Gurdon, 1907; Bareh, 1967, Bhowmik, 1971) and demon worship (Natarajan, 1977) and so on. This is due to the fact that the others have a vague understanding of the Khasi religion as said by Gurdon (1907), "The Khasi have a vague belief in God, the Creator". They believe in one Supreme God, the Creator and Master of Universe (*U Blei Nongbuh Nongthaw*). They also believe in life after death and the presence of God and evil spirit (Marwin, 1987). The breaking of eggs and sacrifice of birds and animals like fowl, pig, cow, goat etc., are their important religious rites and ceremonies. The priest locally known as *U Nongknia or Nongshat Nongkhein* performs these religious rites either for the individual cause or for that of the community as a whole. They do not have any religious scripture, or any common place of worship. "To a khasi, religion is a personal contract between man and God," (Hipshon Roy, 1990). It may also be mentioned here that the movement for revivalism of the traditional religion (Ka Niam Khasi) has also been started under the leadership of the *Seng Khasi Organization*, established first on August 23, 1899.

As already mentioned, some Khasis have also embraced Islam through the marital relationship mainly between the Khasi females and other Muslim males who migrated from Bangladesh and other parts of India like Assam, Uttar Pradesh and Bihar. Historically, the Khasi are also believed to have trade relationship with the Mughal emperors through their viceroys at Murshidabad during the 17th century (Irshad Ali, 1992). So, the Khasis came into contact with the Muslims mainly through trade and commerce. Some of them also visited the Khasi hills as wonderers and hunters. As a result, a good number of them have settled in the Khasi hills and, in course of time, these Muslims adopted the Khasi customs (Irshad Ali, 1992). Gradually, they have settled down in the area and accepted the local women as spouses. This group so mainly confined within the state capital of Meghalaya. No specific census work has ever been attempted amongst them. Hence even rough estimate of the number of individuals is not available. Unlike the Muslims of the other states, the Khasi Muslims do not share a common dialect. The dialect varies form household to household (Roy, 1994). The Khasi Muslims are non-vegetarians, beef-eaters, but they abstain form taking pork. The staple food is rice. They regularly consume available vegetables and fruits. After marriage, most of the women adopt the elaborate style of cooking as praised by the Muslims, especially on festive occasions. Due to religious sentiments, they try to abstain form alcoholic beverages (Roy, 1994). The marriage is performed according to Islamic rules (Roy, 1994). In fact, the Khasi mothers, who get converted to Islam and her children, are known as Muslims. "But for all practical purposes they are treated as Khasis". (Irshad Ali, 1992). Nowadays, it has been reported that among these Muslim Khasi there is a compromise between Islam and matrilineal system of society with regard to patterns of Kinship, residence, inheritance, etc (Mathur 1975, Ali Irshad, 1992).

Food Habits

The food habits of the Khasis are simple. Rice is their staple food. The Khasis are non-vegetarians and take pork, beef, chicken and fish, depending upon their economic status. They are rice eater, but have also taken wheat flour as snack. The principal pulse taken taken by the people is lentil, which is available in local market. In the case of vegetables, potatoes, sweet potatoes, pumpkin, tomato, onion and various kinds of green leafy vegetables are some of their favorites. Besides a variety of mushroom, which is found in abundance in this hilly regions, form a part of their regular diet. Milk is not a part of their regular diet. Instead, tea without milk is a beverage which is continuously taken duting the day. Traditionally, rice bear or Ka-kiad used to be fermented in each house for daily consumption. With the increased urbanization, rice beer has been replaced by distilled liquor and other spirits bought from the market. Seasonal fruits, available locally, are consumed by the Khasis. They have also the habit of taking betel nut leaf and lime.

CHAPTER 11
REVIEW OF LIERATURE

In this Chapter, we shall make a brief review of the literature related to the present study. The review is far from being exhaustive, but the main purpose is to get the general idea of the ongoing researches related to the present study, especially in India in general and in Northeast India in particular.

DEMOGRAPHY

In Chapter I, we have already pointed out that demographic parameters like fertility and mortality are very important to understand the genetic structure of a population. Thus, demographic study of population is a very important part of anthropological research. In the meanwhile, demographic parameters are also largely influenced by various socioeconomic factors. As such, demographic parameters are very vital for understanding not only the genetic structure, but also the socio-economic condition of a population. In the present study, we are not concerned with the genetic structure of the population, but we shall look into certain socio-economic factors that may influence fertility and mortality of the population.

It is widely accepted that fertility and mortality are influenced by a large number of biosocial factors like maternal age, parity, education, religion, economic conditions and so on (Caldwell, 1979, 1983; Lee, 1979; Nag, 1981; Cochrane, 1983; UN, 1985; Kost and Amin, 1992; Bicego and Boerma, 1993; Freeny and Feng, 1993; and others). For example, demographic transition from high to low levels of fertility and mortality is considered to be associated with the economic development of a population, or rising in the income of a household. However, recent studies have also suggested that the effect of economic condition is rather slow in comparison with other social variables like education, particularly female education (Murthi *et al.*, 1995). For example, Kerala recorded the lowest fertility rate in India during the 1980s, though the per capita income in the state was lower than that in many other states. Similarly, according to the National

Family Health Survey in 1993, the per capita income in Mizoram is the lowest in Northeast India, but the state has recorded the lowest fertility rates. The studies in Bangladesh by the World Bank (Cleland *et al.*, 1994) have also indicated that the lower fertility in that country with low per capita income is mainly because of the efficient implementation of family planning programmes.

Age at marriage

The negative effect of age at marriage on fertility has been reported many studies (Bumpass, 1969; Busfield, 1972; Mandelbaum, 1974; Mahadevan, 1979; Patnaik, 1981; Choudhury, 1984; Bharati and Dastidar, 1990; Sengupta and Gogoi, 1995; Verma *et al.*, 1999; Khongsdier, 2001)

Dore (1953) has conducted a study on the population of Japan and found fertility is reduced with the rise of age at marriage. A negative relationship between age at marriage of woman and her intended family size at marriage in Britain has also been reported (Peel, 1970). A similar observation has also been made by Freeny and Feng (1993). Zathar (1988) has observed that the "Initial rises in mean age at marriage of women to around 18 in Pakistan may lead to higher marital fertility owing to higher fecundity and other factors which seem to lead to vary spacing between consecutive births."

Many studies conducted in India have also revealed that fertility rate declines with the increasing mean age at marriage (Balakrishnan, 1951; Majumdar, 1960; UN, 1961; Mukherjee, 1962; Agarwala, 1962; Driver, 1963; Gulati, 1969; Raman, 1973; Patnaik, 1981, Bharati and Dastidar, 1990; Verma *et al.*, 1999; Khongsdier, 2001; etc).

In Northeast India also, Khongsdier (2001) has shown that the mean number of live births per mother decreases with the rise in age at marriage of the mothers. It may however be noted that age at marriage is also associated with different socio-economic factors. Husain (1970) has suggested that age at marriage has an inverse effect on fertility, but educational status of the mother exerts in turn a great influence on age at marriage. Some studies also show that age at marriage is associated with socio-economic conditions thereby it is difficult to assess its direct impact on fertility (Gulati, 1969, 1988). Nevertheless, it is obvious from the findings on other populations that age at marriage has significant inverse association with fertility rate. In northeast India, especially Meghalaya, there has been hardly any study on age at marriage and its effect on fertility rate (NFHS, 1999; Khongsdier, 2001). Thus, it is imperative on the part of not only demographers but also the anthropologists to look into this problem in order to have a better understanding of the fertility trend in a population.

Education

Education, especially female education, is generally considered a key factor to development. It is closely related to demographic parameters and other indicators of health and socioeconomic conditions of a population, or a nation as a whole. Female education is believed to have a great influence on the maternal and child health as it enhances the knowledge and skills of the mother concerning age at marriage, contraception, nutrition, prevention and treatment of diseases (Mosley and Chen, 1984). This also means that the higher infant and child mortality rates among the poorly educated mothers are due to their poor hygienic practices and lack of connection with the modern medical facilities. Moreover, maternal education is related to child health because it reduces the cost of public health programmes relating to information on health technology, increases household income and productivity of health inputs (Schultz, 1984, McIntosh and Finkle, 1995). Thus it is suggested that the best health development agenda for the developing countries is to increase investment in formal education, particularly female education (Caldwell, 1979, 1982; Cochrane, 1983; Bicego and Boerma, 1993). In fact, the 1994 International Conference on Population and Development (ICPD) in Cairo has strongly recommended that all countries should take immediate steps to achieve the goal of universal primary education before the year 2015, and to ensure that girls and women should get the widest and earliest possible access to secondary and higher levels of education (McIntosh and Finkle, 1995; Knodel and Jones, 1996). It is argued that about 75 per cent of 960 million illiterate persons in the world are women. India is one of the best examples of such a country with sex disparity in literacy rate till the last census, despite research evidences of the important role of female education in regulating demographic transition and other socio-economic parameters.

Besides, several studies have revealed that female education is more important than paternal education in exerting a negative effect on fertility, though the influence of the latter is also significant in certain studies (Murthi *et al.*, 1995). Female education is expected to reduce birth rates for the following reasons: First, educated women are likely to have more voice with regard to lightening the burden of repeated pregnancies because they have more control over household resources and personal behaviour. Second, educated women are likely to be less dependent on their children as a source of social status and old age security, thereby leading to a reduction in a desired family size. Third, educated women have higher aspirations for the better achievements of their children, which is conducive to a reduction in a desired family size. Fourth, educated women often have a higher age at first marriage, which is in turn affecting fertility rate. Fifth, educated women often have higher rate of adoption of family planning method, despite certain contradictory results.

Economic Condition

The effect of economic condition on fertility has been revealed in many studies (Dutta and Seal, 1974; UN, 1976; Caldwell, 1977; Chang *et al.*, 1979; Bharati, 1981; Smith and Ward, 1984; Choudhury, 1988; UN, 1985; Lloyd, 1991; Adamchak and Mbizvo, 1994; Verma *et al.*, 1999; Das and Saikia, 1999);

Many studies revealed that there is an inverse relationship between fertility and occupation and/or economic condition (Johnson, 1960; Stoeckel and Choudhury, 1969; Chang *et al.*, 1979). In United States, during the period of urban growth and industrial development, higher economic status was typically associated with lower level of fertility (Freedman, Thompson and Lewis, 1980). The World Bank (1974) has reported that the average fertility rate as well as the average gross reproduction rate in the low income countries is about two times higher than those in the high income countries. Rao (1976) has observed that some countries in South East Asia like China, Srilanka, Philippines, and Thailand have experienced a rapid decline in birth rate with the increase in national income. Recently, it has been reported that the high fertility rate in Sub-Saharan Africa is the most acute symptom of poverty (Dasgupta, 2000). Becker (1981) has suggested that the increase in household income owing to an increase in labour productivity would lead to a decline in fertility if the substitution effect were to dominate the income effect.

The United Nations' (UN, 1985) study outlines several conceptual frame works on the relationship between women's employment and fertility. The major finding of the study was that the relationship between women's occupation and fertility appears to be strong in countries at higher levels of socioeconomic development, particularly in countries with strong family planning programs, and where women's status is relatively higher as measured by age at marriage and educational attainment. A similar observation was also made by Lloyd (1991) and Adamchak and Mbizvo (1999). Recently, the decline in fertility rate in China and Taiwan has also been attributed to higher level of social and economic development (Poston, 2000). In fact, many studies have made an attempt to correlate between low fertility and economic development. However, there is also considerable literature suggesting that standards of living as reflected in basic measures of social welfare like level of education and health care can be more relevant to fertility than the degree of economic prosperity and modernization (Freedman, 1982; Malhotra *et al.*, 1995). This suggests that there has been controversy among the scholars regarding the relationship between fertility and economic condition (Dasgupta, 2000).

In India also, many studies have revealed that fertility rate is higher among the lower income groups than that among the higher ones (Agarwala, 1972; Mukhopadhyay, 1981; Ghosh *et al.*, 1983; Choudhury, 1988; etc). Verma *et al.* (1977) observed that settled agricultural Santals were economically better off and had relatively higher fertility than the economically depressed hunting gathering nomadic Birhors. But Driver (1963) observed that economic status had only some indirect effects on fertility in Central India. Jain (1975) has also suggested that the effect of income particularly that of occupation on fertility is "fragmentary and inclusive." Thus, it is necessary to carry out further studies on the relationship between fertility and economic condition of the populations, especially in Northeast India where there has been a lack of such studies (NFHS, 1999).

With respect to mortality, several studies have revealed the effects of biosocial factors such as household income, education, religion, maternal age, sex, and birth order (Ekanam, 1972; Puffer and Serrano, 1975; Newman, 1975; Ayeni and Oduntan, 1978; Basu *et al.*, 1980; D'Souza and Bhuiya, 1982; Martorell and Ho, 1984; Rutstein, 1984; Rao, 1987; Amin, 1988; Aly, 1990; UNICEP, 1991; Redaiah and Kapoor, 1992; Kost and

Amin, 1992; Nath *et al.*, 1994; Arnold *et al.*, 1998; Rao *et al.*, 1998; NCHS, 1999; Wagstaff, 2000; Khongsdier, 2001; and many others).

Improvement in socioeconomic status is generally considered to be essential for improvement in children's health condition, thereby reducing infant and child mortality. In other words, improvement of the health of the poor can lead to reducing the health inequality between the poor and non-poor, and this is the central goal of many internal organizations, including the World Health Organization (Wagstaff, 2000). It is reported that infant and child mortality has been declining in many developing countries from the mid 1980s and throughout the 1990s. Rutstein (2000) has suggested that such a trend in infant and child mortality is no doubt associated with improvement in socio-economic status along with the improvement in a number of factors like nutritional status, environmental health conditions, breastfeeding and the use of health services. In this connection, it may also be mentioned that the World Bank (1974) has reported that mortality rate is independent of economic development. It has suggested that the decline in mortality rate in many developing countries is mainly due to important in the fields of public health and disease control methods.

In India, Murthi *et al.* (1995) have suggested that the relationship between mortality and poverty may deserve careful examination. They have observed that the association between poverty and child mortality is rather weak in India. "The question remains whether poverty has a strong effect or mortality or fertility after controlling for other explanatory variables." The general opinion is that infant and child mortality is lower in the higher economic groups as they are able to afford better health care facilities, and they have higher educational standard, thereby becoming more conscious of the health of their children. Thus, although different factors are associated with mortality, the effect of household income has been revealed in many studies (Miller, 1981;Chen, 1982; Mosley and Chen, 1984). The above suggestion given by Murthi *et al.* (1995) may be taken into consideration with a view to having a better understanding of the effect of family income on infant and child mortality. Such type of further study is likely to be more important especially in Northeast where there has been lack of information, except those given by the NFHS (1999) and few researchers (Saikia *et al.*, 2001).

Religion

Several studies have revealed a relationship between fertility and religion (Nag, 1962; Westoff, 1962; Kirk, 1968; Mandelbaum, 1974; Rele and Kanitkar, 1977; Mahadevan, 1979; Choudhury, 1982; Irudaya Rajan and Rao, 1991; Kollehlon, 1994; Knodel *et al.*, 1999).

Balakrishnan and Chen (1990) have observed that more religious women are less likely to use contraceptives, thereby having higher fertility rate. Most studies revealed that Muslims have higher fertility rate than that of non- Muslims (Davis, 1951; Sinha, 1957; UN, 1961; Nag, 1962; Driver, 1963; Kirk, 1968; Rele and Kanitkar, 1977; Choudhury, 1982). Some have observed the absence of significant difference in the fertility between Muslims and non- Muslims (Irudaya Rajan, and Rao, 1991). The Koran states that good deeds are better than wealth or children, Islam considers Children to be 'among the richest blessings granted by Allah,' and the Koran makes references to marry and generate (Kirk, 1968). Among the Muslims, the traditions (hadiths) and legal opinion (fatwas) of Islam support temporary measures to prevent conception. But, abortion after quickening of the embryo is forbidden.

In India, many studies have indicated that among the religious groups, the Christians have the lowest fertility rate, which is followed by Hindus and then by Muslims (UN, 1966; Rele, 1963; Agarwala, 1964; Kirk, 1968; Mandelbaum, 1974; Ghosh *et al.*, 1983; Irudaya Rajan and Rao, 1991).

Srinivasan (1967) have observed that in all age groups except in the age group 25-29 and 35-39 years, the Muslim married women have higher fertility rate in comparison with the Hindu and Christian married women. A similar observation was made recently by Dastidar and Gupta (2000) among the Slum dwellers of Kolkata city where fertility is higher among the Muslims as compared to the Hindus. National Sample Survey (NSS, 1977) has conducted a study, which indicates that of the religious groups in India, the Christians have the lowest birth rate, which is followed by Sikhs, and it is highest among the Muslims. The higher fertility rate among the Muslims is believed to be associated with the lower acceptance rate of family planning methods (Khan and Prasad, 1983; Dastidar and Gupta, 2000). However, some studies do not confirm the observation that the fertility rate is always higher among the Muslims than that among the other religious groups (Nag, 1962; Rao and Mather, 1970).

Northeast India, there is hardly any study on the religious differences in fertility rates. Khongsdier (1993) conducted a study among the war Khasi of Meghalaya and he observed that Christian have higher fertility rate than the non-Christian. He explained the higher fertility rate of Christian is not because of religious effect, but due to differences in educational attainment.

As far as mortality is concerned, only few studies have revealed the effect of religion on infant mortality. Ewbank *et al.* (1986) have reported that there is no significant difference between the Muslim and the Roman Catholics in respect of mortality rate. It is, however, higher in the Muslims than in the Protestants. In India, the National sample survey (NSS, 1970) has shown that the mortality rate in rural areas, is high among the Hindus, but low among the Sikhs. But in urban areas, the death rate among the Hindus is found to be similar to that among the Muslims. Also, the Christians are similar to the Sikhs in respect of infant and child mortality.

According to Hindu tradition, sons are needed for the cremation of deceased parents because suns can light the funeral pyre. Girls are often considered to be an economic burden because of the dowry system, as well as the high cost of weddings. Son preference is believed to be the principal cause of excess female mortality that often manifests during childhood. Research studies suggest that parents with strong son preference consider their daughters to be less valuable and provide inferior care to daughters in terms of food allocation, prevention of diseases and accidents. (Arnold *et al.* 1998).

Chandrasekhar (1972) has suggested that although the Christians form a small part of the total population, the low infant mortality rate among them is more perceptible than that among the Muslims due to better child care and higher standard of education in the former.

In the north eastern region of the county, as study conducted by Das & Das (1982) among the rural Assamese women revealed that the mortality rate varies even within the same religious group, i.e, the Hindu religion.

PHYSICAL GROWTH

The study of human growth has been an essential part of anthropological research since the birth of the discipline itself. Early anthropologists, especially Franz Boas are well known for their contribution to growth studies. One of the main reasons for such an interest in growth studies is that human growth serves as a mirror that "reflects the biocultural evolution of our species" (Bogin, 1999). Of course, as mentioned in Chapter I, the basic objective of anthropology is to understand the biological and cultural evolution of human population. Besides, the study of human growth is also essential to understand not only the health and nutritional status of a population, but also the interaction between biology and culture. For example, the pattern of human growth is indirectly influenced by several socio-economic factors through their direct influence on nutrition and infection. Several studies have revealed that children belonging to different socio economic groups have shown differences in their growth pattern (Tanner, 1962, 1966; Garn, 1966, 1980; Scrimshaw and Gordon, 1968; Goldstein, 1971; Eveleth and Tanner, 1976; Frisancho, 1978; Musaiger *et al.*, 1989; Hazzaa, 1990; Terrell and Mascie-Taylor, 1991; Hauspie *et al.*, 1992; Rao and Busi, 1993; Misuraca *et al.*, 1995; Edward *et al.*, 1996; Russo and Toselli, 1997; Dasgupta *et al.*, 1997; Milani *et al.*, 1999; Reddy and Rao, 2000; and many others).

Nutrition

Eveleth and Tanner (1990) have shown that populations living under chronic low dietary intakes have a pattern of growth characterized by (1) slow growth during childhood and adolescence, (2) late adolescence growth spurt and (3) a prolonged period of growth. Adequate nutritional intakes are generally considered to be necessary for normal growth and development as well as for prevention of deficiency diseases (Mitchell *et al.*, 1976; WHO, 1986). Inadequate intake of protein and other nutrients during the preschool age period had an adverse effect on the child, leading to retardation in both physical growth and mental development (Downs, 1964; Grounds, 1964; Jelliffe, 1966; Winick, 1968). In Kenya, Ongeri (1975) has suggested that malnutrition, particularly protein calories, is a common cause of poor growth in preschool children. Hertzig *et al.* (1972) have observed through a controlled study of children in Jamaica that malnourished children were shorter, and had lower intelligence and smaller head circumference than controlled children in the same school or their sibs. In fact, small body size of children in developing countries is largely due to effects of poor diet and frequent infection (Martorell and Ho, 1984).

Greulich's (1957) study on Physical growth and development of the American born and the native Japanese children has revealed that those children brought up in the United States were taller and heavier than their counterparts in Japan because of improved standard of nutrition and physical environment. Data from Malaysia (Chong *et al.*, 1984) have also shown a positive effect of protein energy malnutrition on growth pattern of the pre-school and primary school children. In Nigeria (Antinmo and Hart, 1980; Nnanyelugo, 1983) have indicated that malnutrition in primary school children could be attributed to low nutrient intake, low socio economic conditions and unfavourable environmental factors. A relationship between chronic childhood malnutrition and scholastic backwardness has been demonstrated by Botha-Antom (1968) and Barnes (1969).

Lampl *et al.* (1978) have reported that among the New Guinean school children, protein supplement has contributed largely to a faster growth and malnutrition. Similar observation has been made by Addo *et al.* (1987) while studying the school children of Nigeria. Thus, in developing countries, low socio-economic status of the family, poor nutrition, and vigorous physical activity are seen as major factors affecting childhood growth (Beall *et al.*, 1977; Stinson, 1980, 1982).

Turning to Indian situation also, Rao (1961) pointed out that the pattern of growth was strongly influenced by dietary intakes. Easwaran *et al.* (1972, 1974), observed that boys and girls in the 'better fed' groups were heavier and taller than those in 'poorly fed' ones. A study conducted by Satyanarayana *et al.* (1980) has indicated that the main cause of growth retardation among the pre-school boys in rural Hyderabad is nutritional deficiencies. However, it is suggested that in a vast and multiethnic country like India, the extent and type of malnutrition among children varies from region to region, depending upon the geography, socio economic factors, food habits, level of literacy, climate, and religious cultural practices (ICMR, 1972; Gopalan, 1988; WHO, 1989).

Economic condition

Socioeconomic status plays a dominant role in determining growth and physical development of children as it has a positive relationship with nutritional intakes. Many studies have revealed the association between physical growth and socio economic condition of a population (Hamill *et al.* 1972; Lindgren, 1976; Smith *et al.*, 1980; Garn *et al.*, 1984; Johnston, 1986; Lasker and Mascie-Taylor, 1989; Rao *et al.*, 1990; Terrell and Mascie-Taylor, 1991, Hauspie *et al.* 1992; Khongsdier, 1993; Misuraca *et al.*, 1995; Mockus *et al.*, 1995; Post *et al.*, 1997; Milani *et al.*, 1999).

Bransbey *et al.* (1956) observed that children from homes defined as 'poor' were consistently smaller and lighter than those from 'good' homes. Some studies suggest that within a given country children from economically advanced areas are taller and heavier than children belonging to the economically underprivileged areas (Ferro-Luzzi, 1967; Ferro-Luzzi *et al.*, 1979). In American children, height and weight were found to increase with increasing annual income or educational level (Hamill *et al.*, 1972).

It is generally agreed, on the basis of data from different continents, that variation in growth pattern of children in developed countries of Europe and North America on one hand and in the developing countries of Asia, Africa and Latin America on the other are mostly due to differences in their socio-economic status, and not because of genetic differences (Habicht *et al.*, 1974, Stephenson *et al.*, 1983; Eveleth and Tanner, 1990; Gopalan, 1992). In fact, the World Bank (1986) conducted a study on 20 countries and concluded that about 730 million people in developing countries did not have adequate energy intakes and nearly 340 million of them were at the risk of stunted growth and health problem.

Fry *et al.* (1965) suggested that Chinese children from higher socio economic groups tended to have thicker skin folds than those from the lower ones. Desai *et al.* (1970) observed that a strong relationship between socioeconomic status and growth in Jamaican children. A similar observation has also been made by Campbell (1978) while studying the Jamaican children. Verghese *et al.* (1969) have pointed out that head, chest circumferences and weight of North-American Negro children belonging to the low income families are significantly lower than those belonging to the middle income families. Abraham *et al.* (1975) also observed that in the United States, the boys and girls aged 1-17 years of above poverty level were taller, heavier and greater in skinfold thickness than those belonging to the below poverty level group. Rona *et al.*(1978) reported that children of unemployed fathers were shorter on average than those of employed ones. In England, it has been reported that children, belonging to the middle and upper classes are taller than those belonging to the unskilled working class (Goldstein, 1971).

Amirhakimi (1974) conducted a study among the Iranian school children and found that the children of better economic condition are heavier and taller than those with low economic status. A similar observation has also been made by Lampl *et al.* (1978) while studying the New Guinean school children. Groenewold and Tilahun (1990) have observed the effect of income and father's occupation on weight for age and weight for height of Ethiopian children.

A study conducted on Malaysian children by McKay (1969) has also revealed that the mid upper arm circumferences of the higher income group children are greater than those of children with lower socio economic status.

In developing countries such as Bolivia, low socioeconomic status of the family, poor nutrition, and vigorous physical activity are seen as major factors affecting children growth (Beall *et al.*, 1977; Stinson, 1980,1982; Yep *et al.*, 1988). Post *et al.* (1997) carried out a study among the high altitude Bolivian children and suggested that nutritional intake was influenced by socioeconomic status, but not by altitude.

Although many studies have suggested the positive effect of socio-economic status on growth pattern of children, there are also certain controversies which need to be better understood through further studies. For example, Rona and Chin (1982) have suggested that father's social class and mother's education are not related to the variation in triceps skinfold thickness and weight for height of the children. Similarly Sukkar *et al.* (1979) have also observed that weight and height of the children have hardly changed owing to improvement in economic condition. The rural Zapotec children living in the valley of Oaxaca (Mexico) have similar height and weight to the well nourished U.S. children (Malina and Himes, 1978). Lindgren (1976) have also found that, in Swedish urban area, the girls from the lowest socio-economic status have more weight for height than the higher strata. Mackus *et al.* (1995) have reported that there is no correlation between socioeconomic status and height or weight. The negligible prevalence rates of wasting and low hemoglobin levels suggests that acute undernourishment in preschool children of Libya is not related to economic deficiency but to nutritional habits on the part of the caretaker (Bredan *et al.*, 1984). Therefore some studies have also revealed that there are less difference between socio-economic groups in respect of growth rate.

Turning to Indian situation some studies have shown that within the same community children from the well-to-do sections had higher values of height and weight than their counterparts in poor economic groups (Mitra, 1938; Mitra, 1939; Mukherjee, 1951; Dutta Banik *et al.*, 1970; Bharati and Basu, 1990). Rajyalakshmi (1981) has also observed that the children of higher income groups are heavier and taller than those of lower income groups. The Indian Council of Medical Research (ICMR, 1972) has also reported that height, weight, subcutaneous tissue and other anthropometric variables are positively associated with socio-economic status. Similarly Vijayaraghavan *et al.*, (1974) and Rao (1980) reported that the arm circumference and fat fold at triceps of Indian children belonging to low socio-economic groups were considerably smaller than those of well to do children of corresponding ages. The effect of socio-economic condition on growth pattern of Indian children also been revealed in other studies (Rao and Sastry, 1977; Satyanarayana *et al.*, 1980; National Nutrition Monitoring Bureau, 1980; Bharati and Basu, 1990).

In north-east India, some growth studies have been published (Das, 1969-71,1972; Hazarika, 1974; Das 1973, 1974; Choudhury *et al.*, 1992; Das and Choudhury, 1992; Khongsdier, 1996a; Begum and Choudhury, 1999; etc). But there is hardly any study, which shows the effect of nutrition and other socioeconomic factors on growth pattern of children. Besides, most of the studies have been carried among a different populations of Assam only (Khongsdier and Ghosh, 1998). Khongsdier (1993) conducted a study on War Khasi of Meghalaya and found that "anthropometric variables are more sensitive to environmental factors (which include nutrition, socio-economic conditions, etc)."

Religion

There are very few studies which are concerned with the effect of religion on growth and nutritional status of children. In Northeast India, Das and Devi (1982) have pointed out that the female babies of Hindu Assamese origin are heavier than those of their Muslim counterparts. Khongsdier (1994) have also observed that the Christian War Khasi children are heavier and taller than their Non-Christian counterparts.

The brief review given above has revealed that a large number of studies have been carried out all over the world with a view to understanding how socio-economic factors like household income, education, religion, etc., affect the demographic and growth and nutritional status. With respect to demographic parameters, i.e., fertility and mortality, most studies are carried out in other parts of the world and some parts of India. Besides, there has been controversy regarding the role of certain economic factors like income in influencing fertility and mortality. For example, infant and child mortality is reported to be negatively associated with improvement in environmental conditions and health care services rather than with economic growth.

With respect to growth and nutritional status, the review indicate that it is greatly influenced by such factors like nutrition and economic condition. But such studies are limited in India, especially in Northeast India. Thus, it is imperative on our part to undertake this study with a view to how demographic parameters and growth pattern of children, which reflect the health status of a population, are subject to the influence of various environmental and socioeconomic factors.

CHAPTER III
MATERIALS AND METHODS

In this chapter, we shall describe the materials and methods adopted in the present study. These materials and methods are related to those adopted for collecting, analysing and interpreting the data in the present study.

Selection of area and population

Khasi population is mainly distributed in Khasi and Jaintia hills of the State of Meghalaya. As has been pointed out in Chapter I, the term "Khasis" is a generic name referring to any one or all the four major subgroups, namely, Khynriams, Pnars, Bhois, Wars and Lyngngams. However, in the present study, we are mainly concerned with the Khynriams, who are also known as the Khasi proper. No sampling technique was applied for the selection of samples at both individuals and population levels. But an effort was made to include in our study the three major religious groups, namely, Christian Khasis, Khasis of traditional religion (Niam Khasis), and Muslim Khasis. The Christian Khasis and Niam Khasis are distributed all over Khasi hills, but the Muslim Khasis are mainly concentrated in Shillong, the capital of the state. Therefore, the present study was confined to Shillong only. According to our list of Muslim households prepared with the help of Islamic Organization of Shillong, the Muslim Khasis are restricted to certain localities such as Laban, Bishnupur, Garikhana, although some of them are also scattered in Nongthymmai, Laitumkhrah, Lawsohtun and Lummawbah areas. In the present study, we are concerned mainly with the three religious groups inhabiting in the above mentioned localities of Shillong.

The fieldwork was conducted in different intervals between November 1996 and February 1998.

NATURE OF DEMOGRAPHIC DATA

The nature of demographic data collected for the present study was based on those parameters suggested by the World Health Organization Working Group (WHO, 1964, 1968). These may be briefly described as follows:

Individual records: These include name of informant, age, sex, marital status, relationship to head of the household, date and place at which record was taken, clan, tribe, religion, community affiliation, total number of family members, place of birth, place of residence, etc.

Fertility records: They include pregnancy history of each married woman or mother, present age of mother, approximate age at each conception, total number of live-births, birth order; age, sex and marital status of each offspring.

Mortality records: These include total number of conception, number of dead children, sex, date of birth, age at death, causes of death, if any, number of reproductive wastage (abortions and still- births), etc.

Social proximates: These include occupation, education, monthly and annual income of the household, monthly expenditure of the household, age at marriage, and religion.

DATA ON GROWTH OF CHILDREN

A cross-sectional method of study was followed for collection of data on physical growth of 2719 children aged 3 to 18 years (Eveleth and Tanner, 1990), taking into consideration the following anthropometric measurements:

Weight (kg)
Height vertex (cm)
Sitting height (cm)
Biacromial diameter (cm)
Bi-iliac diameter (cm)
Head circumference (cm)
Mid upper arm circumference (left) (cm)
Chest girth (cm)

For assessing the nutritional status of children, we have adopted three anthropometric indices - weight for age, height for age and weight for height - which are considered as the indicators of nutritional status. These indices were derived as percentage of the international standard or reference, i.e., the growth reference of the U.S. National Centre for Health Statistics (NCHS, 2000). The body mass index (BMI) was also calculated as weight in kg divided by square of height in cm (i.e., weight in kg/height^2 in cm).

Since the exact dates of births were not available for some children, the age grouping of children is done according to the method suggested by Sen (1994), that is, 5 year age group includes children of 4.50 (i.e., 4 years 6 months) to 5.49 (i.e., 5 years 5 months 29 days) years of age, where 30 days = 1 month, and 12 months = 1 year.

METHODS OF TAKING THE MEASUREMENT

Standard techniques of measurements described in Hooton (1946) Weiner and Lourie (1981) and Sen (1994) were followed while taking the anthropometric measurements of children. These may be briefly described as follows:

Weight

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

Height

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

Sitting height

It measures the vertical distance from the vertex to the sitting surface of the subject. The subject was made to sit on the stool, or a flat wooden chair, or at the end of wooden bench.

Then he/she was positioned in an erect sitting posture, with ankles crossed, knees spread about 20 cm apart and hands rested on the thighs. The anthropometer was placed at the back and between the two buttocks, taking care that the lumbar curve of the subject was not flattened, but concave from behind. The sliding sleeve was then lowered down to touch the vertex lightly.

Biacromial Diameter

This measurement is the maximum breadth of the bony shoulder girdle taken from acromion to acromion. The measurement was taken from the back of the subject with the rod compass (i.e., the first segment of anthropometer), while he/she was standing in an erect posture with his/her arms hanging at the sides. When the two acromion points were located by palpating along the outside edge of the scapular spine, the measuring points of the left and right hand bars were pressed against the left and right acromia, respectively. Reading was then recorded. This measurement was taken with moderate pressure to indent the deltoid muscle, but not to cause discomfort to the subject.

Bi-iliac diameter

It measures the straight distance between the two most lateral points of the iliac-crests. The measurement was taken from the back of the subject with a rod compass, holding the fixed sleeve of the compass on the left hand and the sliding sleeve on the right hand. As in the case of biacromial diameter, the most lateral points on the illiac crests were palpated with fore-fingers while holding the two sleeves of the rod compass.

Mid upper arm circumference

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

Head Circumference

The measurement was taken with a steel tape taking into consideration the glabella and opisthocranion points in such a way so as to get the maximum circumference.

Chest Girth

It measures circumference of the chest of subject when he is breathing normally. This measurement was taken with a steel tape (Precision~1mm) at the level of the mesosternale, at the right angle to the axis of the body and reading was taken.

SOCIO-ECONOMIC CATEGORIES

In the present study, three important socio-economic variables were taken into consideration. These include religion, monthly income of the household and level of education. These socio-economic variables were classified arbitrarily into a different group and/or category with a view to understanding their influence on demographic characteristics and growth and nutritional status of the study population. Our classification may be briefly described as follows:

Religious groups: The Khasi population (mostly Khynriams) of the present study is divided into three broad religious groups, namely, the Christian Khasis, Niam Khasis and Muslim Khasis. By *Christian Khasis*, we mean those Khasis who have embraced Christianity or those Khasis who are Christians by faith, and the *Niam Khasis* refer to those Khasis who have followed and maintained their traditional religion. On the other hand, the Muslim Khasis are those Khasis who have embraced Islam, and the children belonging to this religious group are by and large the product of the intermixture between the Khasi females and Muslim males.

Income groups: Data on household income were collected directly from the head of the household and they were cross-checked taking into consideration some aspects of socio-economic conditions like housing condition, types of occupation, land holding, and monthly expenditure. The interval estimation based on standard deviation of the per capita monthly income of household was adopted for classifying the three economic groups (Khongsdier, 1997), which is as follows:

Above ($\bar{X}$ + 4SD/√N) = High income group (HIG)

($\bar{X}$ - 4SD/√N) to (Mean + 4SD/√N) = Middle income group (MIG)

Below ($\bar{X}$ - 4SD/√N) = Low income group (LIG)

Where N stands for the number of households and $\bar{X}$ is the average monthly per capita income of the households. In the present study, the average per capita monthly income for 584 households was found to be Rs.581.67/- with a standard deviation (SD) of Rs.326.32. Thus, following the above interval method, the households with per capita monthly income of below Rs. 525/- were classified as LIG, while the range of Rs.525/- to Rs.636/- were considered as MIG, and those households with per capita monthly income of above Rs.636/- were classified as HIG.

Educational Level: The data on educational attainment of individuals in the present study were arbitrarily classified as follows: Individuals who were unable to read and write were classified as **Illiterate.** The individuals who were able to read and write and those who attended school up to standard IV were grouped into **Primary** level of education. **Secondary level** of education includes all those persons who attended school up to below matriculation. The individuals with education of matriculation and above are included in the category of **Higher level** of education due to inadequacy of data.

STATISTICAL METHODS

The data collected for the present study are quantified and analysed statistically, using SPSS Window software. The data are presented in terms of means, standard deviation, standard error and proportions or percentages. The differences between two means were tested, using t-student test, while the differences between more than two means were determined, using one-way analysis of variance (ANOVA). Analysis of covariance was also carried out for testing the differences among means, allowing for the effects of other covariates. The differences between proportions were tested, using chi-square test. Multiple regression analysis was also carried out for understanding the effects of socio-economic factors on demographic parameters and growth patterns of children. Logistic regression analysis was used for analyzing the effects of maternal age, education, income and religion on infant mortality. Some of these may be briefly described as follows:

Mean: The mean is also known as arithmetic average. It is defined as the value which can be obtained by dividing the total values of various items in a series by the total number of items. It is worked out as under:

Mean ($\bar{X}$) = $\Sigma X_i/N$ = ($x_1 + x_1 + \ldots + x_n$)/N, where is the value of the i-th item X_i, i =1, 2, ..., n, and N stands for the total number of items.

In the case of frequency distribution, the mean is obtained as follows:

Mean ($\bar{X}$) = $\Sigma f_i x_i / f_i N$ = ($f_1x_1/f_1 + f_2x_2/f_2 + \ldots + f_nx_n/f_n$)/N, where f_ix_i is the product of the mid value (x_i) of i-th class-interval and the frequency (f_i) of the i-th item.

Standard Deviation (SD): Standard deviation is defined as the square root of the mean of the squares of the deviation of observations from their arithmetic mean. It is computed as follows:

$SD = \sqrt{\{(X_i - \bar{X})^2/N - 1\}}$

Where X_i is the value of the i-th item, $\bar{X}$ stands for the mean, and N is the total number of cases. In the case of frequency distribution, the SD is obtained as follows:

$SD = \sqrt{\{(\Sigma fd^2/N - 1) - (\Sigma fd/N-1)^2\}} \times C$

Where fd is the product of the deviation from the assumed mean (d) and the frequency (f) of item in the i-th class-interval; while C stands for class interval.

The divisor was taken as (N – 1) but not as N because we did not know the true mean and standard deviation of the population. So the mean and standard deviation were estimated through samples collected for the present study, and in doing so we lost what is known as a degree of freedom (Parker, 1973).

Standard Error of Mean (SE): It is calculated as $SD/\sqrt{N-1}$.

Differences between two means: In the present study, the number of observations in two sample means are almost more than 50. Therefore, the statistical difference between two means is worked out according to standard t-test given as follows:

$$t = (\bar{X}_1 - \bar{X}_2) \div \sqrt{\{(SE_1)^2 + (SE_2)^2\}}$$

where $\bar{X}_1$ and SE_1 are the mean and standard error of a given variable for the first sample, while $\bar{X}_1$ and SE_2 are the mean and standard error of the same variable for the second sample of the same population or different populations.

Differences between proportions: In the present study, the differences between proportions were tested by using the chi-square (χ^2). It is obtained as follows:

$$\chi^2 = \Sigma(O_i - E_i)^2/E_i = (O_1 - E_1)^2/E_1 + (O_1 - E_1)^2/E_1 + \ldots + (O_n - E_n)^2/E_n$$

where O_i and E_i are the observed and expected frequencies of the i-th character in each class.

The value obtained is then compared with that given in the Table of Chi-square distribution with (N – 1) degree of freedom (d.f.). In the case of 2 × C contingency Table, the number of d.f. is (Row –1)(Column – 1). The expected frequency is calculated as (Row

Total)(Column Total)/(Grand Total) OR (Column Total)/(Grand Total) multiplied by Row Total.

Analysis of Variance (ANOVA): One way analysis of variance was used for testing the differences between the means of more than two samples (Snedecor and Cochran, 1967). The basic procedure consists in examining the amount of variance "Within Samples" in relation to the amount of variance "Between Samples". Following are the steps followed for computing this test:

1. Correction factor (C) = $(\Sigma X_i)^2/N$, where X_i is the total number of ith item in all the samples, and N is the total number of items in all the samples.
2. Total sum of squares (TSS) = ΣX_i^2 - C, where X_i^2 is the square of each ith item in all the samples.
3. Sum of squares for variance between samples (SSB) = $n_1(\bar{X}_1 - \bar{X}) + n_2(\bar{X}_2 - \bar{X}) + \ldots + n_k(\bar{X}_k - \bar{X})$,

where $\bar{X}$ = Overall mean for all items in all samples

$\bar{X}_1, \bar{X}_2, \ldots, \bar{X}_k$ = Sample means 1, 2, . . . , k

$n_1, n_2, \ldots, n_k$ = Number of items in samples 1, 2, . . . , k.

4. Sum of squares for variance within samples (SSW) = (TSS – SSB)
5. Mean squares for variance between samples (MSB) = SSB/(K- 1), where (K – 1) is the degree of freedom between samples, i.e., K = Number of samples compared.
6. Mean square for variance within samples (MSW) = SSW/(N- K), where (N – K) is the degree of freedom for all individual items for all samples, i.e., N = Number of individual items for all samples.
7. F- ratio = MSB/MSW

The value obtained is then compared with that in the Table of F-distribution with (K – 1) as larger variance and (N – K) as smaller variance, taking 95% confidence interval.

Regression Analysis: Regression analysis has many applications. The main purpose is the regression analysis is to know if Y (dependent variable) does depend on X (independent variable), or to make a prediction of Y from X. In the present study, we are also concerned with the error in Y-variable after adjustments were made for the effects of X-variable. The regression coefficient (b) of Y on X is worked out as follows:

$$b = \Sigma xy / \Sigma x^2$$

where $\Sigma xy = \Sigma XY - (\Sigma X)(\Sigma Y)/N$

$$\Sigma x^2 = \Sigma X^2 - (\Sigma X)^2/N$$

The regression of Y on X is expressed as

$\bar{Y} = a + bX$, where $a = \bar{Y} - \bar{X}b$, and $\bar{Y}$ = Estimated value.

CHAPTER IV

DEMOGRAPHIC CHARACTERISTICS

In this chapter, we shall describe the demographic characteristics of the three religious groups of the Khynriam Khasi, namely, Christians, Muslims and Khasis.

Age and Sex Structure

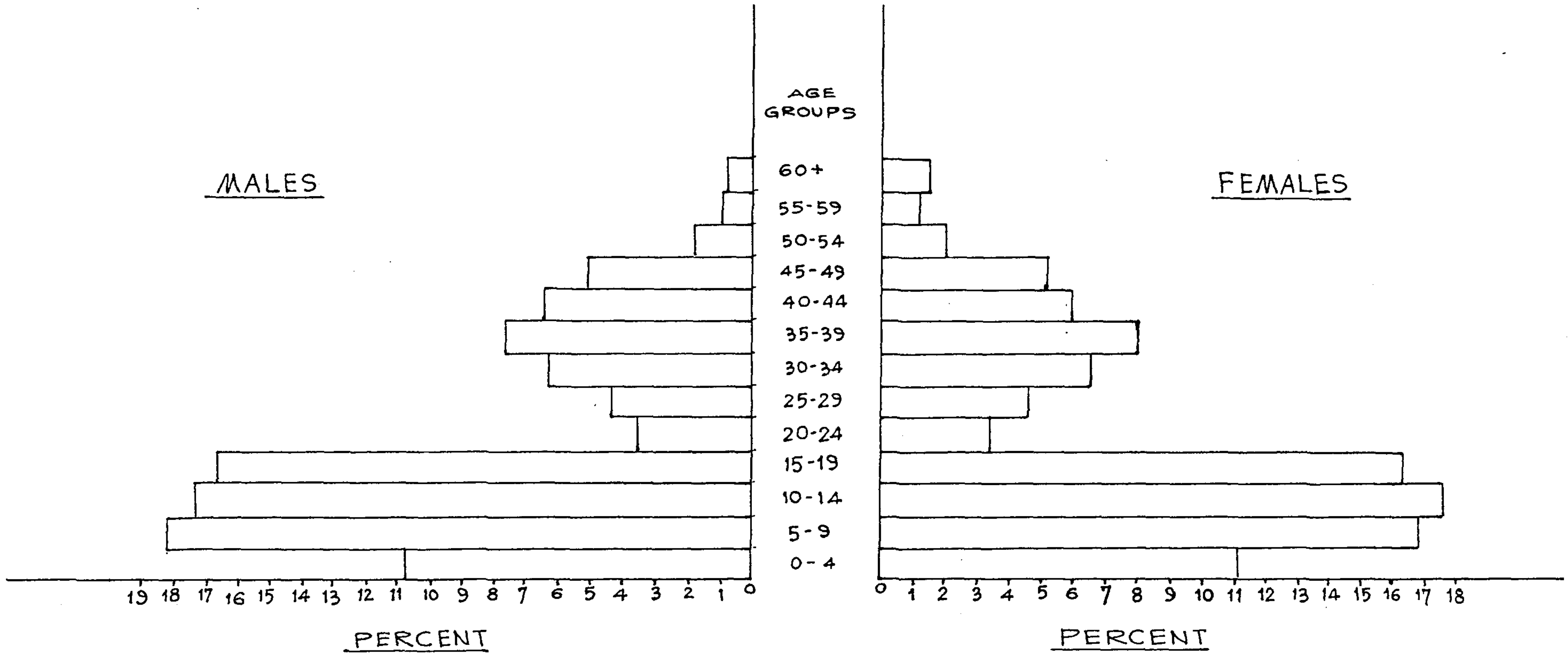
Table 4.1 shows the total population of the three religious groups by age and sex. About 46%, 50% and 4% of the total population in the Christians belongs to the age groups 0-14, 15-49 and 50 + years, respectively, which are more or less similar to the Khasis, i.e., 47, 49 and 4 per cent, respectively, and the Muslims (44, 51 and 5 per cent, respectively). Figures 3.1, 3.2 and 3.3 also show that the base of each population pyramid tends to be constricted, thereby indicating the tendency to decline in fertility rate, provided the infant and child mortality rates are low in all the three religious groups. According to Sundbarg's classification of population, a population is said to be *progressive* when the number of persons in relation to the total population are 40.0%, 50.00% and 10.00% in the age groups 0-14, 15-49 and 50 + years, respectively. The population is referred to as *stationary* if these frequencies are 33.00%, 50.00% and 17.00%, respectively; while the frequencies of 20.00%, 50.00% and 30.00%, respectively, are the characteristics of *regressive* population (Khongsdier 2001). Thus, the three religious groups of the Khasi population may be categorized as *progressive type*.

Table 4.1 also shows that the over all sex ratio, i.e., number of males per 100 females, is low in all the religious groups, especially among the Muslims (95.14) and Christians (96.54), which is much below the ideal sex ratio of 1:1. However, the chi-square vale indicates that the deviation from the ideal sex ratio of 1:1 is not statistically significant in all the religious groups (χ^2 -value for: Christians = 0.51, $P > 0.05$; Muslims = 0.75, $P > 0.05$; and Khasis = 0.16, $P > 0.05$).

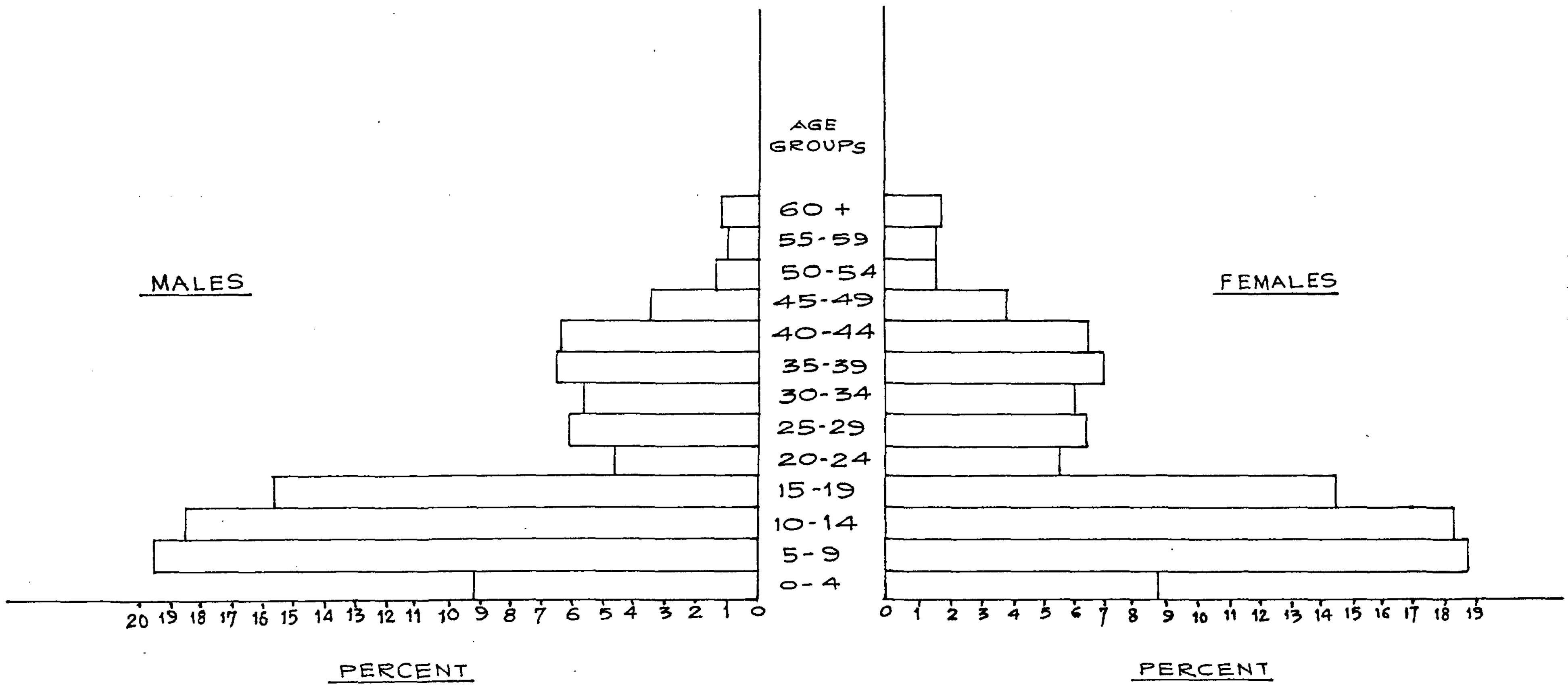
Table 4.1. Total population of the three religious groups by age and sex

Age groups (years)	Christians		Muslims		Niam Khasis	
	Male	Female	Male	Female	Male	Female
0 - 4	88	93	54	54	76	79
5 - 9	148	142	115	116	141	140
10 -14	141	148	109	112	126	131
0-14	760 (46.09)		560 (46.51)		693 (44.03)	
Sex ratio	98.43		98.58		98.00	
15 - 19	135	136	92	90	140	142
20 - 24	28	27	28	34	42	41
25 - 29	36	39	36	39	40	42
30 - 34	51	55	34	37	49	52
35 - 39	62	67	39	43	59	60
40 - 44	52	50	38	40	43	42
45 - 49	41	44	21	24	26	27
15 - 49	823 (49.91)		595 (49.42)		805 (51.14)	
Sex ratio	96.89		93.81		98.28	
50 - 54	15	17	8	9	15	16
55 - 59	7	9	6	9	13	11
60 +	6	12	7	10	9	12
50 +	66 (4.00)		49 (4.07)		76 (4.83)	
Sex ratio	113.16		75.00		94.87	
Total	810	839	587	617	779	795
Persons	1649 (100.00)		1204 (100.00)		1574 (100.00)	
Sex ratio	96.54		95.14		97.99	

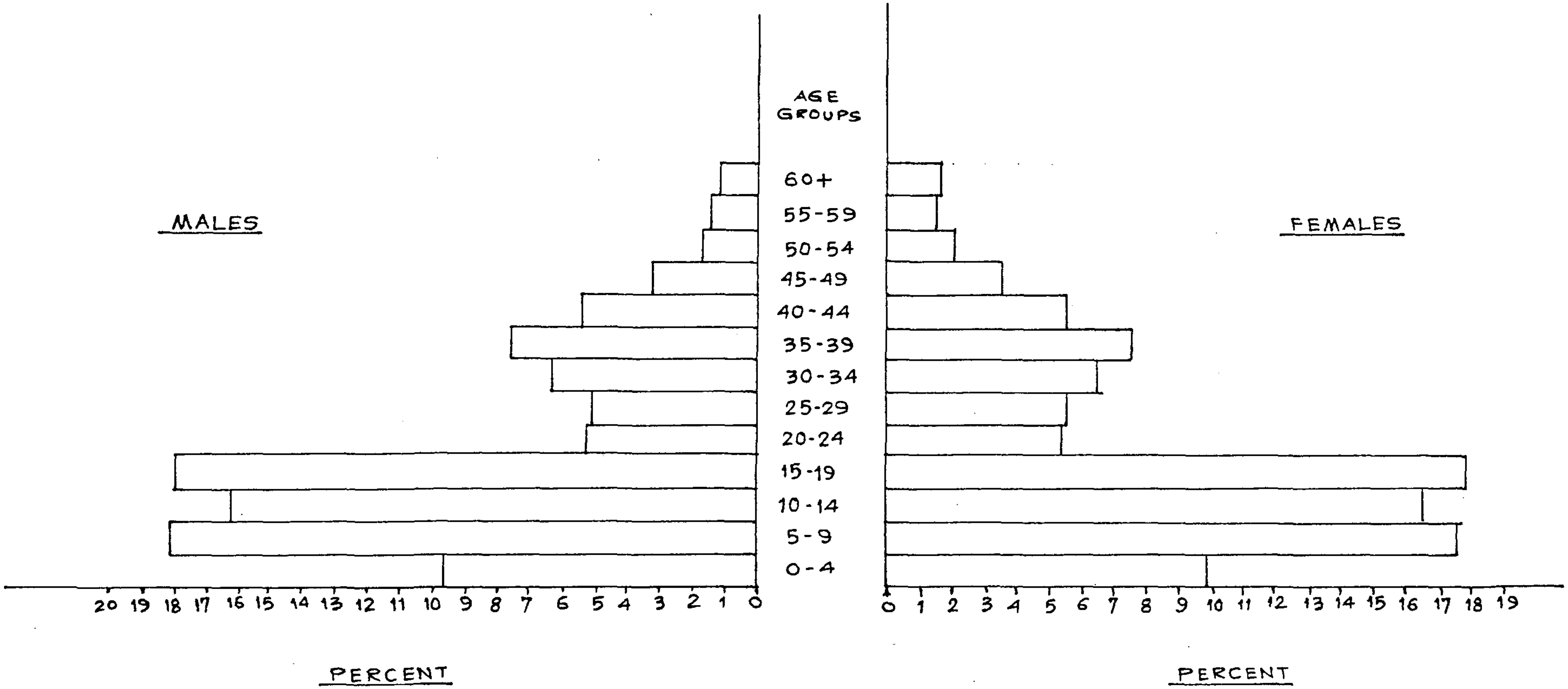
Figures within parentheses indicate percentage



POPULATION PYRAMID (CHRISTIAN)



POPULATION PYRAMID (MUSLIM)



POPULATION PYRAMID (NIAM KHASI)

In the age group 0-14, the sex ratios are 98.43, 98.58, and 98.00 respectively in the Christians, Muslims and Khasis, which are low in comparison with the ideal sex ratio of 1:1. However, the goodness of fit indicates that the deviation from the ideal sex ratio in this age group is not statistically significant for all the religious groups (χ^2-value for: Christians = 0.05, P > 0.05; Muslims = 0.03, P > 0.05; and Khasis = 0.07, P > 0.05). In the age group 15-49 years, the sex ratios are 96.89, 93.81 and 98.28 in the Christians, Muslims and Niam Khasis. Thus, in this age group also the sex ratio is low in all the religious groups, despite the absence of significant difference (χ^2-value for: Christians = 0.21, P > 0.05; Muslims = 0.61, P > 0.05; and Khasis = 0.06, P > 0.05). This low number of males in relation to per 100 females is also found in the last age group, i.e., 50 + years, in which the sex ratios are 96.54, 95.14 and 97.99 respectively for the Christians, Muslims and Niam Khasis. Like in the case of other age groups, the test of goodness of fit however indicates that the low sex ratios in all the religious groups are not statistically significant (χ^2-value for: Christians = 0.21, P > 0.05; Muslims = 0.61, P > 0.05; and Khasis = 0.06, P > 0.05).

Table 4.2. Marital status of individuals by present age groups

Marital status by age groups	Christians		Muslims		Niam Khasis	
	Male	Female	Male	Female	Male	Female
≤24 years						
Married	3 (1.55)	8 (3.02)	4 (2.84)	10(5.52)	2 (0.84)	19 (7.98)
Unmarried	537	535	394	396	523	512
DSW	0	3	0	0	0	2
25-29 years						
Married	17 (8.81)	33 (12.45)	12 (8.51)	26 (14.36)	21 (9.68)	34 (14.29)
Unmarried	19	3	24	12	18	5
DSW	0	3	0	1	1	3
30-34 years						
Married	23 (11.92)	51 (19.25)	20 (14.18)	32 (17.68)	42 (19.35)	42 (17.65)
Unmarried	28	2	14	4	6	3
DSW	0	2	0	1	.1	7
≥35 years						
Married	150 (77.72)	173(65.28)	105 (74.47)	113 (62.43)	152(70.05)	143 (60.08)
Unmarried	23	8	10	3	10	3
DSW	10	18	4	19	3	22
Total	810	839	587	617	779	795
Married	193	265	141	181	217	238
Unmarried	617	548	442	415	557	523
DSW	0	26	4	21	5	34

DSW = Divorced, widowed and separated.
Figures within parentheses indicate percentage

Marital Status

Table 4.2 shows the marital status of both males and females in all the three religious groups. Of the married males, 1.55%, 2.84% and 0.84% belong to the age group 24 years and below in the Christians, Muslims and Khasis, respectively, while in the case of females these frequencies are 3.02%, 5.52% and 7.98%, respectively. It indicates that the Muslim males get married earlier than their Christian and Khasi counterparts, though it is not statistically significant ($P > 0.05$). With respect to married females, Table 4.2 shows that about 3.02%, 5.52% and 7.98% in the Christians, Muslims and Niam Khasis, respectively, get married at the age of 24 years and below. Here it shows that the females in the Niam Khasi get married earlier than the Muslim and Christian females, and the differences are statistically significant ($\chi^2 = 6.05$, DF =2, $P < 0.05$). However, the over all differences in women's mean age at marriage between the three religious groups (Table 4.3) are not statistically significant ($F = 02$, $P > 0.05$). As regards the sex differences, it shows that the marriage is more delayed in males than in females as generally observed in other populations (Khongsdier and Ghosh, 1996).

Table 4.3. Mean age at marriage

Religious groups	Male			Female		
	Number	Mean	SE	Number	Mean	SE
Christians	203	25.48	0.19	291	20.32	0.21
Muslims	225	25.45	0.17	275	20.30	0.19
Niam Khasis	145	25.94	0.21	202	20.35	0.25

Table 4.4. Mean age at first child birth.

Religious groups	Male			Female		
	Number	Mean	SE	Number	Mean	SE
Christians	203	26.92	0.22	291	22.24	0.23
Muslims	225	26.78	0.17	275	21.63	0.21
Niam Khasis	145	27.05	0.21	202	21.64	0.24
F-ratio	1.82, P > 0.05			0.02, P > 0.05		

Table 4.3 shows the mean age at marriage for both males and females in all the three religious groups. It can be observed that there is not much difference in mean age at marriage across religious groups. It holds good for both males and females. However, Table 4.4 indicates that the mean age at first child birth is slightly higher in the Christian women (22.24 years) than in the Niam Khasis (21.64 years) and Muslim (21.63 years) women. Like in the case of age at marriage, the one-way analysis of variance shows that the differences in mean age at first child birth between the religious groups are not statistically significant for both males and females (Table 4.4).

Fertility

It is seen that the mean number of live births per woman, living in wedlock, increases with the rise in age groups in all three religious group of population (Table 4.5). Among the Christians, the mean numbers of live births per mother are 3.34 ± 0.23, 4.20 ± 0.20, 5.03 ± 0.20, 5.21± 0.30 in the age groups below 29, 30 – 34, 35 – 39 and 40 – 44 years, respectively. In the Muslims these mean values for different age groups of mothers are found to be 3.31 ± 0.21, 4.31± 0.24, 5.32 ± 0.34, 6.57 ± 0.39, respectively, while among the Niam Khasis they are 3.62 ± 0.23, 4.38 ± 0.27, 5.73 ± 0.27, 5.64 ± 0.36, respectively. The one way analysis of variance (ANOVA) indicates that there are significant differences between age groups of mothers in respect of live births for all the religious groups (Table 4.5). Considering the differences between religious groups, it is found that the mean number of live births per married woman (of all ages) living in wedlock is higher in the Muslims (4.89 ±0.18 than in the Christians (4.50 ± 0.13) and Niam Khasis (4.52 ± 0.15). However, the ANOVA test indicates that the differences among all three religious groups are not statistically significant ($F = 1.90$, $P > 0.05$).

Table 4.6 shows the mean number of surviving children per woman living in wedlock. Like in the case of live births, the mean number of surviving children also increases with the rise in age group of the mothers. It is found that the mean number of surviving children per woman living in wedlock are 3.07± 0.19, 3.98 ± 0.18, 4.74 ±0.17, 4.90± 0.26 among the Christians, and 3.03 ± 0.19, 4.00± 0.22, 4.84 ± 0.29, 6.00± 0.32 among the Muslims in the age groups $\leq$ 29, 30 –34, 35 –39 and 40 – 44 years, respectively. In the Niam Khasis these mean values are found to be 3.21 ± 0.20, 4.00 ±

0.23, 5.29 ± 0.25, 5.13 ± 0.32, respectively. The ONOVA test indicates that these differences between age groups in respect of surviving children are statistically significant in all the religious groups. Thus, the age of mother is very important in regulating the live births and mean number of surviving children. However, the differences between religious groups in respect of surviving children are not statistically significant (F = 0.84, P > 0.05), although it is slightly higher among the Muslims.

Table 4.5. Live births by age groups of women living continuously in wedlock.

Age group (years)	Number of mothers	Number of Live births	Mean number of Live births	Standard error
Christians				
≤ 29	41	137	3.34	0.23
30-34	51	214	4.20	0.20
35-39	62	312	5.03	0.20
40-44	42	219	5.21	0.30
Total	196	882	4.50	0.13
One-way analysis of variance: F-ratio = 12.48, P < 0.001				
Muslims				
≤ 29	36	119	3.31	0.21
30-34	32	138	4.31	0.24
35-39	38	202	5.32	0.34
40-44	35	230	6.57	0.39
Total	141	689	4.89	0.18
One-way analysis of variance: F-ratio = 20.94, P < 0.001				
Niam Khasis				
≤ 29	53	192	3.62	0.23
30-34	42	184	4.38	0.27
35-39	55	315	5.73	0.27
40-44	39	220	5.64	0.36
Total	189	911	4.82	0.15
One-way analysis of variance: F-ratio = 14.11, P < 0.001				

F- ratio = 1.90, P > 0.05.

Table 4.6. Surviving children by age groups of women living continuously in wedlock.

Age group (years)	Number of mothers	Number of Surviving children	Mean number of Surviving children	Standard error
Christians				
≤ 29	41	126	3.07	0.19
30-34	51	203	3.98	0.18
35-39	62	294	4.74	0.17
40-44	42	206	4.90	0.26
Total	196	829	4.23	0.10
One-way analysis of variance: F-ratio = 16.82, P < 0.0001				
Muslims				
≤ 29	36	109	3.03	0.19
30-34	32	128	4.00	0.22
35-39	38	184	4.84	0.29
40-44	35	210	6.00	0.32
Total	141	631	4.48	0.16
One-way analysis of variance: F-ratio = 20.85, P < 0.0001				
Niam Khasis				
≤ 29	53	170	3.21	0.20
30-34	42	168	4.00	0.23
35-39	55	291	5.29	0.25
40-44	39	200	5.13	0.32
Total	189	829	4.39	0.14
One-way analysis of variance: F-ratio = 17.02, P < 0.0001				

F- ratio = 0.84, P < 0.05

Table 4.7. Live births by age groups of all married women

Age group (years)	Number of mothers	Number of Live births	Mean number of Live births	Standard error
Christians				
≤ 29	47	161	3.43	0.22
30-34	53	222	4.19	0.19
35-39	65	324	4.98	0.20
40-44	46	245	5.33	0.26
45 +	80	484	6.05	0.36
Total	291	1436	4.93	0.14
One-way analysis of variance: F-ratio = 13.07, P < 0.0001				
Muslims				
≤ 29	37	124	3.35	0.21
30-34	33	144	4.36	0.24
35-39	41	224	5.46	0.33
40-44	39	256	6.56	0.37
45 +	52	324	6.23	0.36
Total	202	1072	5.31	0.17
One-way analysis of variance: F-ratio = 16.12, P < 0.0001				
Niam Khasis				
≤ 29	58	201	3.47	0.24
30-34	51	232	4.55	0.25
35-39	58	328	5.66	0.27
40-44	41	231	5.63	0.35
45 +	66	427	6.47	0.36
Total	274	1419	5.18	0.15
One-way analysis of variance: F-ratio = 16.12, P < 0.0001				

F-ratio = 1.57, P > 0.05.

Table 4.8. Surviving children by age groups of all married women

Age group (years)	Number of mothers	Number of Surviving children	Mean number of Surviving children	Standard error
Christians				
≤ 29	47	148	3.15	0.18
30-34	53	209	3.94	0.17
35-39	65	304	4.68	0.16
40-44	46	227	4.93	0.22
45 +	80	425	5.31	0.29
Total	291	1313	4.51	0.11
One-way analysis of variance: F-ratio = 13.27, P < 0.0001				
Muslims				
≤ 29	37	113	3.05	0.19
30-34	33	131	3.97	0.23
35-39	41	201	4.90	0.30
40-44	39	233	5.97	0.31
45 +	52	286	5.50	0.30
Total	202	964	4.77	0.14
One-way analysis of variance: F-ratio = 16.75, P < 0.0001				
Niam Khasis				
≤ 29	58	171	2.95	0.20
30-34	51	213	4.18	0.22
35-39	58	301	5.19	0.23
40-44	41	209	5.10	0.31
45 +	66	370	5.61	0.28
Total	274	1264	4.61	0.13
One-way analysis of variance: F-ratio = 19.19, P < 0.0001				

F-ratio = 1.01, P ≥ 0.05.

Table 4.7 shows the number of live births to all married women by age groups. It is found that the mean live births per married woman are 4.93 ± 0.14, 5.31 ± 0.17 and 5.18 ± 0.15 in the Christians, Muslims and Niam Khasis, respectively. Although the mean live births are higher in the Muslims and Niam Khasis when compared with the Christians, the ANOVA test indicates that these differences between religious groups of the Khasi populations are not statistically significant ($F = 1.57$, $P > 0.05$). Like in the case of married women living in wedlock, the mean number of live births to all married women in all the three religious groups of the population increases as age advances. In the Christians, it increases from 3.43 ±0.22 for the women in the age group ≤ 29 years to 6.05 ±0.36 for the women aged 45 years and above. Among the Muslims, it increases from 3.35 ±0.21 in the age group ≤ 29 years to 6.56 ±0.37 for the women aged 40-44 years but it decreases again to 6.23 ± 0.36 in the age group 45 years and above. Among the Niam Khasis, it increases from 3.47 ± 0.24 for those women in the age group ≤ 29 years to 6.47±0.36 for the women aged 45 years and above. These differences in mean number of live births between age groups of mothers are statistically significant in all the religious groups (Table 4.7).

Table 4.8 shows the number of surviving children by age groups of all married women. Like in the case of live births, it is seen that the mean number of surviving children increases with the rise in the age group of mothers, although among the Muslims, it increases till 40 –44 years and lower in the age group 45 years and above. Nevertheless, the overall differences between age groups in respect of surviving children are found to be highly significant for all the religious groups. With respect to religious differences, Table 8 shows that the mean number of surviving children is 4.51 ±0.11, 4.77 ± 0.14 and 4.61 ± 0.13 in the Christians, Muslims and Niam Khasis, respectively. The ANOVA test indicates that the mean number of surviving children is more or less similar in all religious groups ($F = 1.01$, $P > 0.05$).

Table 4.9 shows the age specific fertility rate among the three religious groups. It is found that the total fertility rate (TER) is slightly lower among the Christian (5.38) than the other two religious group (5.85). It is also seen that the age specific fertility rate (ASFR) reaches it peak, when the mothers are in the age group 25-29 years, then it starts decreasing with the rise in age of the mothers (Fig. 4. 4). This holds good for all the three religious groups.

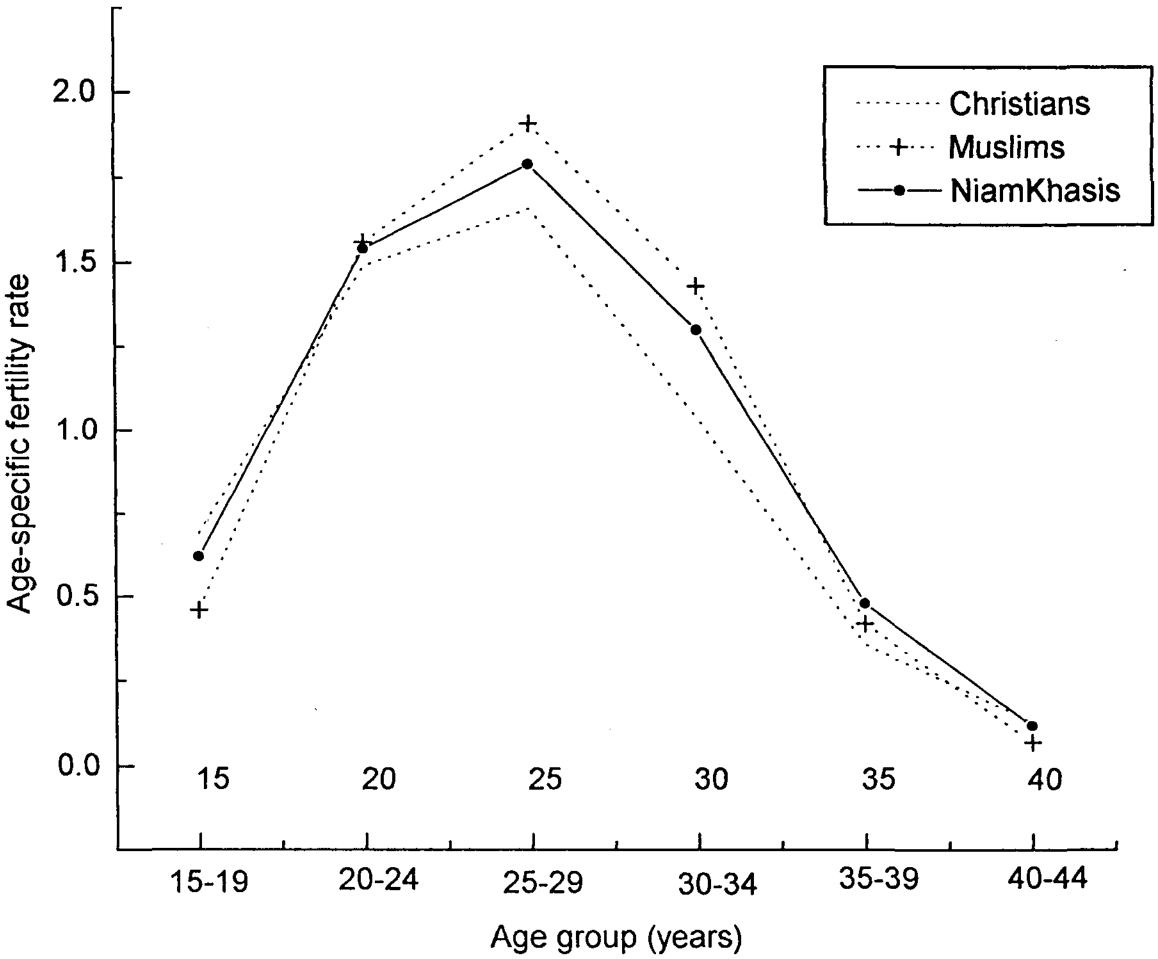


Fig.4.4. Age-specific fertility rates

Table 4. 9. Age-specific fertility rate (ASFR) by religious groups

Age group (in years)	Number of married women			Number of live births			Age-specific fertility rate		
	Christians	Muslims	Niam Khasis	Christians	Muslims	Niam Khasis	Christians	Muslims	Niam Khasis
15 - 19	291	202	274	202	94	169	0.69	0.46	0.62
20 - 24	289	201	270	430	314	417	1.49	1.56	1.54
25 - 29	280	192	257	466	366	459	1.66	1.91	1.79
30 - 34	244	165	216	253	236	280	1.04	1.43	1.30
35 - 39	191	132	165	68	56	181	0.36	0.42	0.48
40 - 44	126	91	107	16	6	13	0.13	0.07	0.12
45 +	80	52	66	1	0	0	0.01	0	0
Total fertility rate (TFR)							5.38	5.85	5.85

Table 4.10. Infant and juvenile mortality rates

Sex/religious groups	Number of live births	Infant mortality[a]		Juvenile mortality[b]	
		Number	Per cent	Number	Per cent
Christians					
Male	789	61	7.73	13	1.65
Female	647	37	5.72	12	1.85
Total	1436	98	6.82	25	1.74
Muslims					
Male	604	53	8.77	8	1.32
Female	468	37	7.91	10	2.13
Total	1072	90	8.39	18	1.68
Niam Khasis					
Male	722	63	8.73	18	2.49
Female	697	59	8.46	15	2.15
Total	1419	122	8.60	33	2.33

[a]Death before 1 year of life
[b]Death between 1 and 14 years of life

Mortality

The frequency of infant and juvenile mortality is given in Table 4.10. It is seen that the infant mortality rates (i.e., number of deaths before 1 year of life per 100 live births) are 6.82%, 8.39% and 8.60% in the Christians, Muslims and Niam Khasis, respectively. Thus the infant mortality rate is lower in the Christians than in the Muslims and Niam Khasis, despite the absence of statistical difference ($\chi^2 = 3.60$, DF = 2, $P > 0.05$). With respect to juvenile mortality, the frequency is more or less same in the Christians (1.74%) and Muslims (1.68%), but it is higher in the Niam Khasis (2.33%). However, the Chi-square value indicates that the differences in juvenile mortality rate between the religious groups are not statistically significant ($\chi^2 = 1.79$, DF = 2, $P > 0.05$).

Table 4.11. Reproductive wastage

Parameters	Christians	Muslims	Niam Khasis
Total number of mothers	291	202	274
Total number of pregnancies	1552	1163	1545
Total number of abortions	67	54	71
Total number of still-births	49	37	55
Abortion rate (%)	4.32	4.64	4.59
Still-birth rate (%)	3.16	3.18	3.56
Rate of reproductive wastage (%), i.e. abortions and still-births	7.47	7.82	8.15

Reproductive Wastage

The prevalence of reproductive wastage for all the religious groups is shown in Table 4.11. It is found that the still birth rates (i.e., number of still-births per 100 pregnancies) are 3.16%, 3.18% and 3.56% in the Christians, Muslims and Niam Khasis respectively, and the abortion rates to these three religious groups (i.e., number of abortions per 100 pregnancies) are 4.32%, 4.64% and 4.59%, respectively. Thus, the rates of reproductive wastage (i.e., number of abortions and still-births per 100 pregnancies) are 7.47%, 7.82% and 8.15% in the Christians, Muslims and Niam Khasis respectively. It appears that the Christians and Muslims are more or less similar in the frequency of reproductive wastage, and it is slightly higher in the Niam Khasis. However, the Chi-square value indicates that there is no significant difference between the religious groups in respect of reproductive wastage ($\chi^2 = 0.42$, DF = 2, $P > 0.05$).

SOCIOECONOMIC CORRELATES

In this section, we shall deal with the relationship between the demographic parameters and socio-economic factors like age of mothers, age at marriage, education of mothers, and income of household for all the three religious groups.

Age at Marriage

The mean number of live births to married women by age at marriage are given in Table 4.12. It is found that the mean number of live births per married woman decreases with the rise in age at marriage. It holds true for the Christians, Muslims and Niam Khasis. Table 4.13 shows the results of the multiple regression analysis on the effect of age at marriage on the number of live births after controlling for other factors like age, educational level, and income. It is found that the coefficient of regression (b± SE) on the effect of age at marriage (independent variable) on the number of live births (dependent variable) is negatively significant for all the religious groups (Christians: b = -0.220 ± 0.033, t = 6.74, $P < 0.0001$, Muslims: b = -0.218 ± 0.041, t = 5.43, $P < 0.0001$, and Niam Khasis: b = -0.186 ± 0.044, t = 4.27, $P < 0.0001$). Thus, the present findings indicate that the age at marriage is a very important factor in controlling the fertility rates in the present population, irrespective of religious groups.

Table 4.12.. *Mean number of live births to married women by age at marriage*

Age at marriage	Number of mothers	Live births	
		Mean	Standard error
Christians:			
≤19 years	146	6.05	0.12
20-24 years	99	4.17	0.14
≥25 years	46	3.02	0.15
ANOVA-F statistics		50.59, P < 0.0000	
Muslims:			
≤19 years	61	6.49	0.35
20-24 years	101	5.16	0.20
≥25 years	40	3.88	0.25
ANOVA-F statistics		17.66, P < 0.001	
Niam Khasis			
≤19 years	135	6.19	0.23
20-24 years	104	4.43	0.16
≥25 years	35	3.54	0.38
ANOVA-F statistics		28.85, P < 0.001	

Table 4.13. Results of multiple regression analysis of live births on age at marriage after allowing for other factors.

Source of variation	d.f.	Sum of squares	Mean squares	F-value	Probability
Christians:					
1. Age, age at marriage, education and income	4	678.997	169.749	54.26	0.0000
2. Age, income and education	3	536.710	178.903	49.51	0.0000
3. Age at marriage after age, income and education	1	142.287	142.287	45.47	0.0000
4. Residual	286	894.763	3.129		
Coefficient of regression (b ±SE) = -0.220 ± 0.033, t = 6.74, P < 0.0001					
Muslims:					
1. Age, age at marriage, education and income	4	433.572	108.393	30.97	0.0000
2. Age, income and education	3	330.375	110.125	27.51	0.0000
3. Age at marriage after age, income and education	1	103.197	103.197	29.49	0.0000
4. Residual	197	689.398	3.499		
Coefficient of regression (b ±SE) = -0.218 ± 0.041, t = 5.43, P < 0.0001					
Niam Khasis:					
1. Age, age at marriage, education and income	4	716.231	179.058	50.71	0.0000
2. Age, income and education	3	651.792	217.264	57.83	0.0000
3. Age at marriage after age, income and education	1	64.439	64.439	18.25	0.001
4. Residual	269	950.006	3.532		
Coefficient of regression (b ± SE) = -0.186 ± 0.044, t = 4.27, P < 0.0001					

Educational Level

The mean number of live births per married woman according to educational levels is summarized in Table 4.14. Among the Niam Khasis, the mean number of live births tends to decrease significantly with the increasing level of education of the mothers, ranging from 6.82 ± 0.31 for the illiterates to 3.89 ± 0.26 for the mothers with higher level of education. In the case of Christians, the mean number of live births varies from 5.56 ± 0.36 for the illiterates to 4.04 ± 0.17 for the mothers with higher level of education, whereas in the case of Muslims it varies between 5.73 ± 0.32 to 4.58 ± 0.28 for the mothers with illiteracy and higher level of education, respectively. These differences in live births between educational groups of mothers are statistically significant for all the religious groups (Table 4.14).

Table 4.15 shows the results of the multiple regression analysis on the effect of educational level on the number of live births after controlling for other factors like age, age at marriage, and income. It is found that the coefficient of regression (b± SE) on the effect of education on the number of live births is negative but not significant in the Christians (b =-0.136 ± 0.098, t = 1.39, P > 0.05) and Muslims(-0.002 ± 0.124, t = 0.02, P > 0.05), although it is negatively significant in the Niam Khasis (-0.448 ± 0.127, t = 3.52, P < 0.0001). Thus, the present findings indicate that the education is not as important as expected in controlling the fertility rates among the Muslim and Christian Khasis, but it is certainly important in the Niam Khasi.

Table 4.14. *Mean number of live births and surviving children to married women by educational level*

Educational level	Number of mothers	Live births	
		Mean	Standard error
Christians			
Illiterate	62	5.56	0.36
Primary	64	5.61	0.29
Secondary	66	5.03	0.29
Higher	99	4.04	0.17
ANOVA-F statistics		8.87, P < 0.0001	
Muslims			
Illiterate	59	5.73	0.32
Primary	48	5.85	0.41
Secondary	52	4.94	0.28
Higher	43	4.58	0.28
ANOVA-F statistics		3.35, P < 0.02	
Niam Khasis			
Illiterate	68	6.82	0.31
Primary	74	5.35	0.26
Secondary	69	4.57	0.25
Higher	63	3.89	0.26
ANOVA-F statistics		21.16, P < 0.0001	

Table 4.15. Results of multiple regression analysis of live births on education after allowing for other factors.

Source of variation	DF	Sum of squares	Mean squares	F-value	Probability
Christians:					
1. Age, age at marriage, education and income	4	678.997	169.749	54.26	0.0000
4. Age, age at marriage and income	3	672.961	224.321	71.47	0.0000
5. Education after age, age at marriage and income	1	6.036	6.036	1.93	NS
4. Residual	286	894.763	3.129		
Coefficient of regression (b ± SE) = -0.136 ± 0.098, t = 1.39, P > 0.05					
Muslims:					
1. Age, age at marriage, education and income	4	433.572	108.393	30.97	0.0000
2. Age, age at marriage and income	3	433.570	144.524	41.51	0.0000
3. Education after age, age at marriage and income	1	0.002	0.002	0.00	NS
4. Residual	197	689.398	3.499		
Coefficient of regression (b ± SE) = -0.002 ± 0.124, t = 0.02, P > 0.05					
Niam Khasis:					
1. Age, age at marriage, education and income	4	716.231	179.058	50.71	0.0000
2. Age, age at marriage and income	3	672.488	224.163	60.90	0.0000
3. Education after age, age at marriage and income	1	43.743	43.743	12.39	0.001
4. Residual	269	950.006	3.532		
Coefficient of regression (b ± SE) = -0.448 ± 0.127, t = 3.52, P < 0.0001					

NS = Not significant

Table 4.16. Mean number of live births to married women by income group

Income group	Number of mothers	Live births	
		Mean	Standard error
Christians:			
LIG	86	6.27	0.25
MIG	118	5.03	0.21
HIG	86	3.47	0.16
ANOVA-F statistics	39.64, P < 0.00001		
Muslims:			
LIG	81	6.40	0.29
MIG	83	4.82	0.22
HIG	38	4.05	0.22
ANOVA-F statistics	18.42, P < 0.0001		
Niam Khasis			
LIG	101	6.41	0.26
MIG	121	4.73	0.19
HIG	52	3.85	0.29
ANOVA-F statistics	39.63, P < 0.0001		

Table 4.17. Results of multiple regression analysis of live births on income level after allowing for other factors.

Source of variation	DF	Sum of squares	Mean squares	F-value	Probability
Christians:					
1. Age, age at marriage, education and income	4	678.997	169.749	54.26	0.0000
2. Age, age at marriage and education	3	583.797	194.599	56.42	0.0000
3. Income after age, age at marriage and education	1	95.200	95.200	30.43	0.0000
4. Residual	286	894.763	3.129		
Coefficient of regression (b ± SE) = -0.832 ± 0.151, t = 5.52, P< 0.0001					
Muslims:					
1. Age, age at marriage, education and income	4	433.572	108.393	30.97	0.0000
2. Age, age at marriage and education	3	379.902	126.634	33.74	0.0000
3. Income after age, age at marriage and education	1	53.67	53.67	15.34	0.001
4. Residual	197	689.398	3.499		
Coefficient of regression (b ± SE) = -0.739 ± 0.189, t = 3.92, P <0.001					
Niam Khasis:					
1. Age, age at marriage, education and income	4	716.231	179.058	50.71	0.0000
4. Age, age at marriage and education	3	583.899	194.633	48.55	0.0000
5. Income after age, age at marriage and education	1	132	132.332	37.47	0.0000
4. Residual	269	950.006	3.532		
Coefficient of regression (b ± SE) = -0.987 ± 0.161, t = 6.12, P < 0.0001					

Income Level

The mean live births per married woman according to income levels are given in Table 4.16. It is seen that the mean number of live births tends to decrease significantly with the increasing level of the income of household for all the religious groups. Among the Christians, the mean number of live births per mother varies from 6.27 ± 0.25 for the LIG to 3.47 ± 0.16 for HIG, while in the case of Muslims it varies from 6.40 ± 0.29 to 4.05 ± 0.22 in the LIG and MIG respectively. Among the Niam Khasis, on the other hand, it varies between 6.41 ± 0.26 and 3.85 ± 0.29 for the mothers belonging to the LIG and HIG, respectively. These differences in live births between income groups of households are found to be statistically significant for all the religious groups (Table 4.16).

Table 4.17 shows the results of the multiple regression analysis on the effect of income level on the number of live births after controlling for other factors like age, age at marriage, and educational level. It is found that the coefficient of regression on the effect of income on the number of live births is negatively significant for all the religious groups (Christians: $b = -0.832 \pm 0.151$, $t = 5.52$, $P < 0.0001$, Muslims: $b = -0.739 \pm 0.189$, $t = 3.92$, $P < 0.001$, and Niam Khasis: $b = -0.987 \pm 0.161$, $t = 6.12$, $P < 0.0001$). Thus, the present findings indicate that income of the household is a very important factor in controlling the fertility rates in the present population, irrespective of religious groups.

In view of all the socio-economic factors, it is observed that the fertility rate in the present population is negatively associated with the age at marriage and income levels of mothers. The effect of education, on the other hand, is not clearly perceptible in the present study, except among the Niam Khasi mothers, which indicates that educational level of the mothers is also very important in regulating the fertility rate. The effect of religion on fertility rate is also perceptible. It is observed that the total fertility rate is more or less same among the Muslims and Niam Khasis, but it is lower in the Christians.

Infant Mortality and Socio-economic conditions

Table 4.18 shows the summary of logistic regression analysis on the effects of maternal age, education, religion and income on infant mortality. It is found that the regression coefficient ($\beta \pm$ standard error) of infant mortality (dependent variable) on maternal age was positively significant (0.021 ± 0.008, $P < 0.011$), and it was negatively significant with respect to educational level (-0.150 ± 0.074, $P < 0.043$) and income level (-1.283 ± 0.125, $P < 0.000$). As has been shown in Table 4.18, the effect of religion on infant mortality is not statistically significant (0.051 ± 0.101, $P > 0.05$). Thus, it indicates that maternal age, education and income are very important in influencing infant mortality in the present population. It is obvious that infant mortality rate increases with the increasing age of the mothers. This may be due to the fact that mothers of higher age groups have higher fertility rate, which is theoretically correlated with higher infant mortality rate. The inverse relationship between infant mortality and educational as well as income level is according to the general observation in other populations, which indicate that mothers belonging to the higher educational and income levels are more conscious of the health of their children, and they have more access to modern medical aids, etc.

Table 4.18. Summary of logistic regression analysis on the effects of maternal age, education, religion and income on infant mortality

Parameters	Coefficient (β)	Standard error	Wald test	Probability level
Age (in absolute number of maternal age)	0.021	0.008	6.402	0.011
Educational level (Illiterate=0, Primary =1, Secondary=2, Higher level = 3)	-0.150	0.074	4.109	0.043
Income level (LIG = 1, MIG = 2, HIG = 3)	-1.283	0.125	106.000	0.000
Religion (Muslims =1, Christians =2, Niam Khasis = 3)	0.051	0.101	0.254	0.614
Constant	1.167	0.505	5.345	0.021

Deviance (likelihood ratio) = 172.394, DF = 4, P < 0.000.

CHAPTER V

GROWTH PATTERN

In this chapter, we shall describe the growth pattern of the Khasi both boys and girls taking into consideration the body weight, height, sitting height, biacromial diameter, bi-iliac diameter, head circumference, arm circumference and chest circumference.

Weight

Table 5.1 shows the mean and standard deviation of the body weight for both boys and girls. The mean values are plotted against age in Figure 5.1. The distance curve shows that there is a gradual increase in average weight for both boys and girls from 3 years onwards, although there is a decrease in weight for girls from 17 to 18 years of age. It is further observed that the girls are slightly heavier than boys at 3, 6, 7 and 10 years of age. Both boys and girls are more or less same in weight at the age of 11, but girls are significantly heavier than boys at 12 years of age ($t = 3.80$, $P < 0.000$), and thereafter the latter are heavier than the former. This may be associated with the adolescent growth spurt in girls at 12 years of age. In fact, the t-test indicates that the boys are significantly heavier than the girls from 12 to 13 and 17 to 18 years, while the girls are significantly taller than the boys from 11 to 12 years of age (Table 5.1).

The annual increment or growth rate in weight is plotted against age in Figure 5.2. It is seen that the velocity is higher in boys than in girls in many age groups, although it is higher in girls from 5 to 6, 9 to10, 11 to 12, 13 to 14 and 15 to16 years. The maximum gain (4.19 kg) in girls occurs at 14 years of age, though the distance curve shows that they are lighter than boys at that age. In the case of boys, the maximum velocity of 5.14 kg takes place at 13 years, which may be associated with their adolescent growth spurt. From 17 to 18 years of age, there is a decline to below zero in weight for girls, while the annual increment in boys is about 1.25 kg.

Table 5.1. Statistical constants of weight (kg) for boys and girls

Age (yrs)	Boys Mean	Boys SD	Boys Increment	Girls Mean	Girls SD	Girls Increment	t-value
3	11.93	1.81	-	12.13	1.87	-	0.73
4	13.95	2.07	2.02	13.88	2.04	1.75	0.22
5	16.13	1.85	2.18	15.70	1.84	1.82	1.53
6	17.10	2.17	0.97	17.74	2.41	2.04	1.86
7	18.11	2.25	1.01	18.69	2.36	0.86	1.69
8	20.65	2.78	2.54	20.41	2.46	1.72	0.59
9	23.04	2.85	2.39	22.68	3.23	2.27	0.79
10	24.59	2.47	1.55	24.72	3.57	2.04	0.24
11	26.98	3.71	2.39	26.99	2.96	2.27	0.02
12	28.86	3.24	1.88	30.87	3.65	3.88	3.80**
13	34.00	3.10	5.14	33.08	2.63	2.21	2.11*
14	37.30	3.99	3.30	37.27	5.08	4.19	0.04
15	41.67	4.33	4.37	41.12	3.97	3.85	0.87
16	43.29	4.68	1.62	43.17	3.85	2.05	0.26
17	47.63	3.66	4.34	44.67	4.34	1.30	4.78**
18	48.88	4.05	1.25	44.38	5.06	-0.09	6.14**

*P < 0.05, *P < 0.000

Height

Table 5.2 shows the statistical constants for the height of both boys and girls. The smooth curve (Fig. 5.1A and 5.1B) in the figure indicates the fitting of the present data according to fourth degree polynomial model by which the height is equal to $64.19 + 8.59(\text{Age}) - 0.47(\text{Age})^2 + 0.03(\text{Age})^3 - 5.46\,(\text{Age})^4$ cm for boys and to $65.53 + 7.79(\text{Age}) - 0.43(\text{Age})^2 + 0.04(\text{Age})^3 - 0.001(\text{Age})^4$ cm for girls. The estimated values for adult height is found to be 154.20 cm for males and 146.83 cm for females. This indicates that the girls have reached their adult height by the age of 18, while the boys still continue to grow. The present observation seems to confirm that observed among the girls of Assamese Muslims in Assam, though it is not so in the case of boys (Begum and Choudhury, 1999).

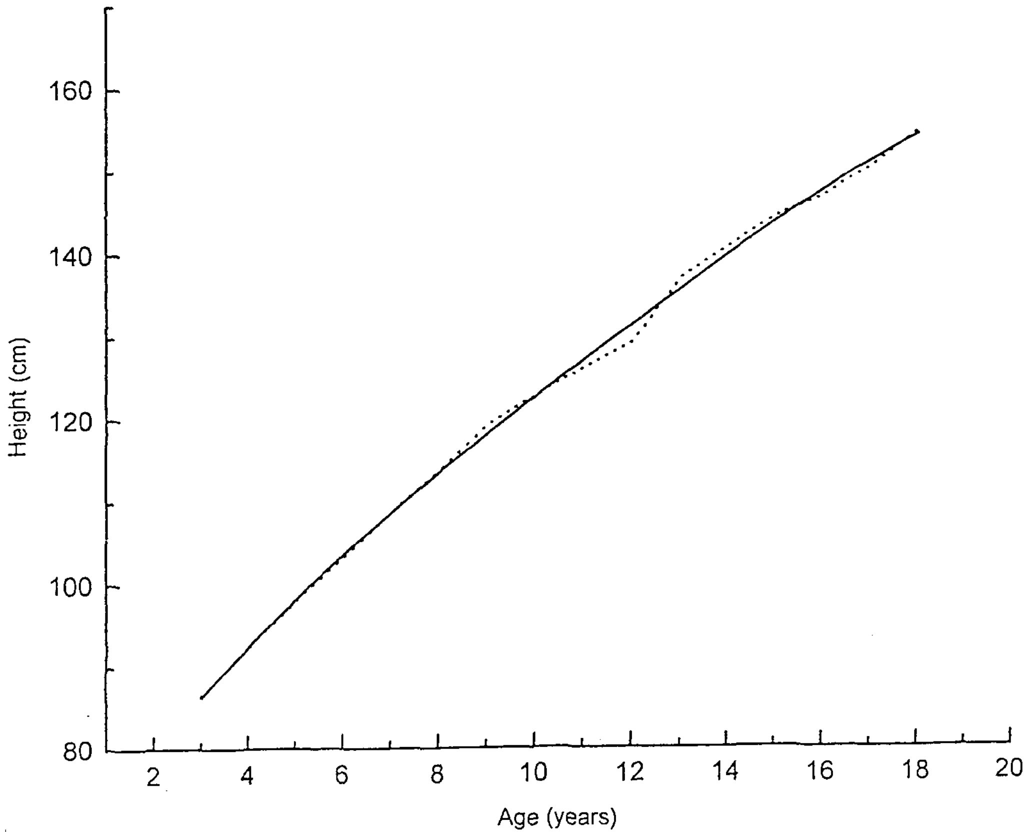


Figure 5.1A. Distance curve for height of boys (smooth curve is 4th degree polynomial model)

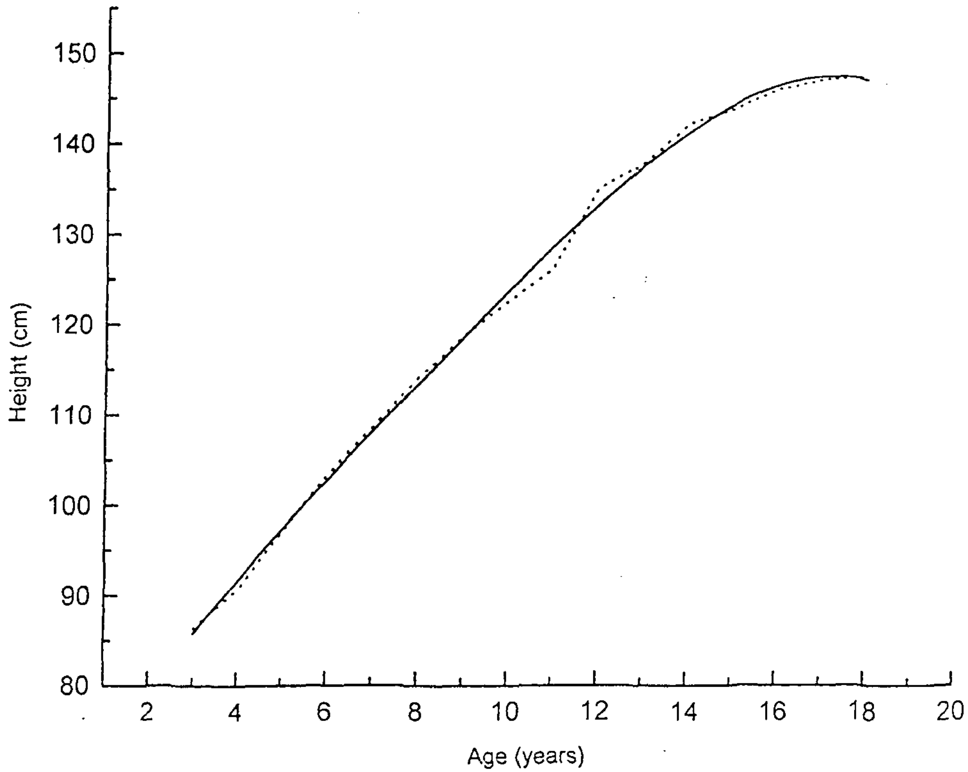


Figure 5.1B. Distance curve for height fo girls (smooth curve is 4th degree polynomial model)

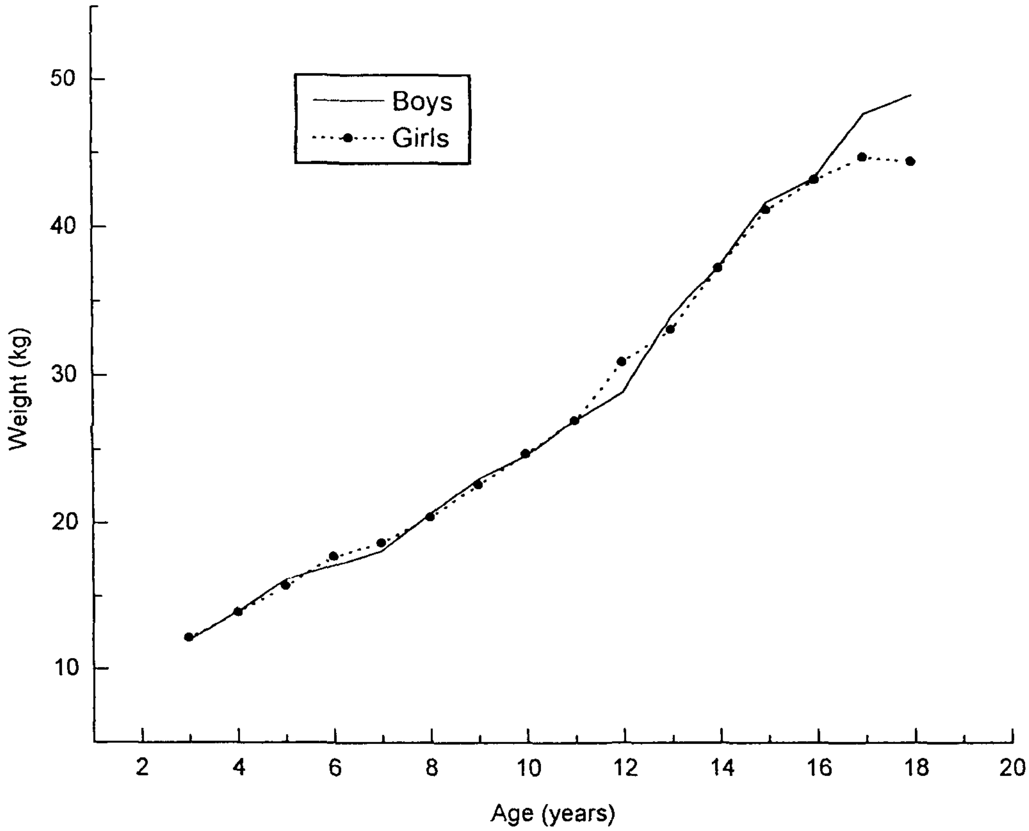


Fig.5.1. Distance curve for weight of boys and girls

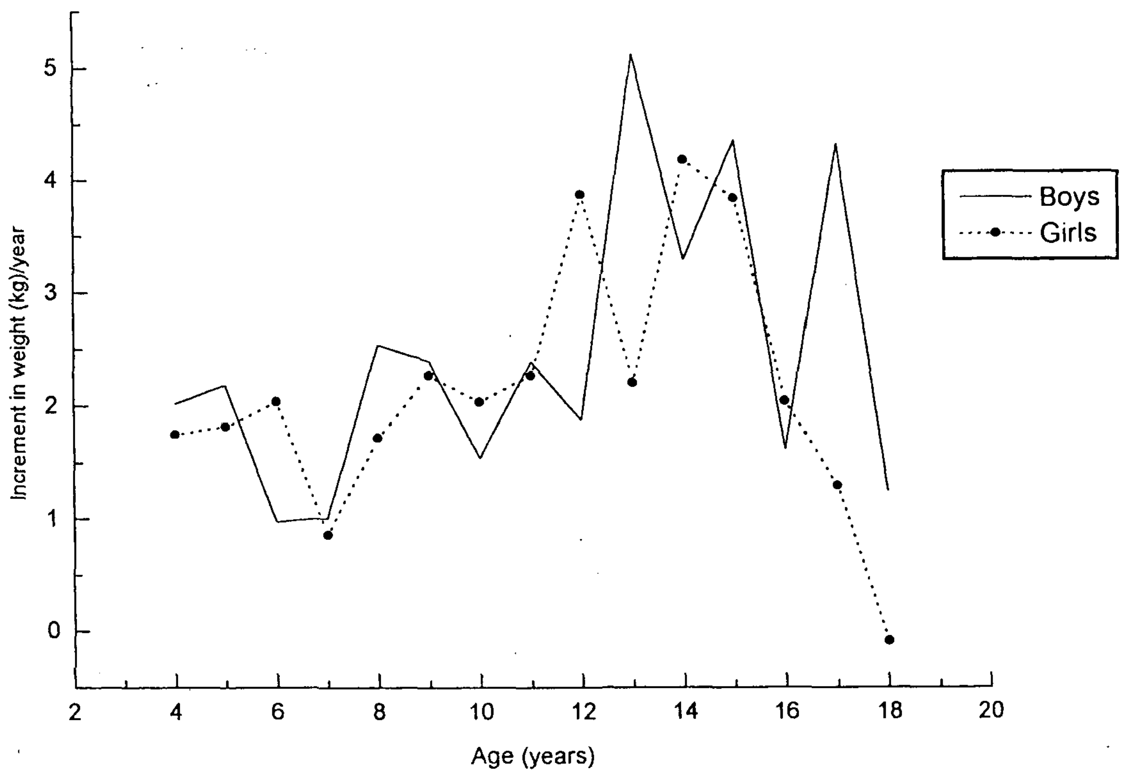


Fig.5.2. Velocity curve for weight of boys and girls

The distance curve (Figure 5.3) shows that boys are taller than girls at ages 3 to 5, 8 to 9 and 15 years onwards, whereas the latter are taller than the former from 12 to 14 years. From 6 to 7 and 10 to 11 years of age, the distance curve shows a similar pattern for both boys and girls. The differences between boys and girls in height are found to be statistically significant at the age of 4, 12, 14, 17 and 18 years. It is seen that the boys are significantly taller than the girls at about 4, 17 and 18 years of age, while the girls are taller than the boys at about 12 and 14 years of age (Table 5.2).

The velocity curve (figure 5.4), which indicates the growth rate per year, shows that both the sexes gained their height from 3 to 18 years in a moderate and continuous manner. It is observed that the velocity rate is higher in boys than in girls in many age groups, although it is higher in the latter than in the former at 5, 6, 8, 12, and 14 years of age. On the other hand, the growth rate is more or less similar for both boys and girls at 9, 10 and 11 years of age. It is found that the maximum increase in height occurs between 12 and 13 years for boys (7.72 cm) and 11 and 12 years for girls (8.85 cm). Thus, like in the case of weight, it indicates that the adolescent growth spurt occurs earlier in girls (12 years) than in boys (13 years).

Table 5.2. Statistical constants of height (cm) for boys and girls

Age	Boys			Girls			t-value
(yrs)	Mean	SD	Increment	Mean	SD	Increment	
3	86.50	5.33	-	86.41	4.70	-	0.12
4	92.47	5.07	5.97	90.97	5.53	4.35	2.11*
5	98.07	6.28	5.60	97.08	5.78	6.32	1.08
6	103.21	7.37	5.14	103.43	6.21	6.35	0.21
7	108.69	6.38	5.48	108.65	6.96	5.22	0.04
8	113.61	7.35	4.92	114.19	5.94	5.54	0.56
9	119.20	6.46	5.59	118.87	6.91	4.68	0.33
10	122.76	7.22	3.56	122.63	7.00	3.76	0.12
11	126.13	6.34	3.37	126.24	5.95	3.61	0.12
12	129.22	6.36	3.09	135.09	4.41	8.85	6.99**
13	136.94	5.09	7.72	137.80	4.79	2.71	1.14
14	140.64	5.64	3.70	142.22	4.22	4.42	2.08*
15	144.25	6.54	3.61	143.72	3.55	1.50	0.67
16	146.78	6.43	2.53	145.84	3.33	2.12	1.19
17	150.27	5.74	3.49	146.89	4.04	1.05	4.16**
18	154.65	5.98	4.38	147.20	3.57	0.31	9.65**

*P < 0.05; **P < 0.000

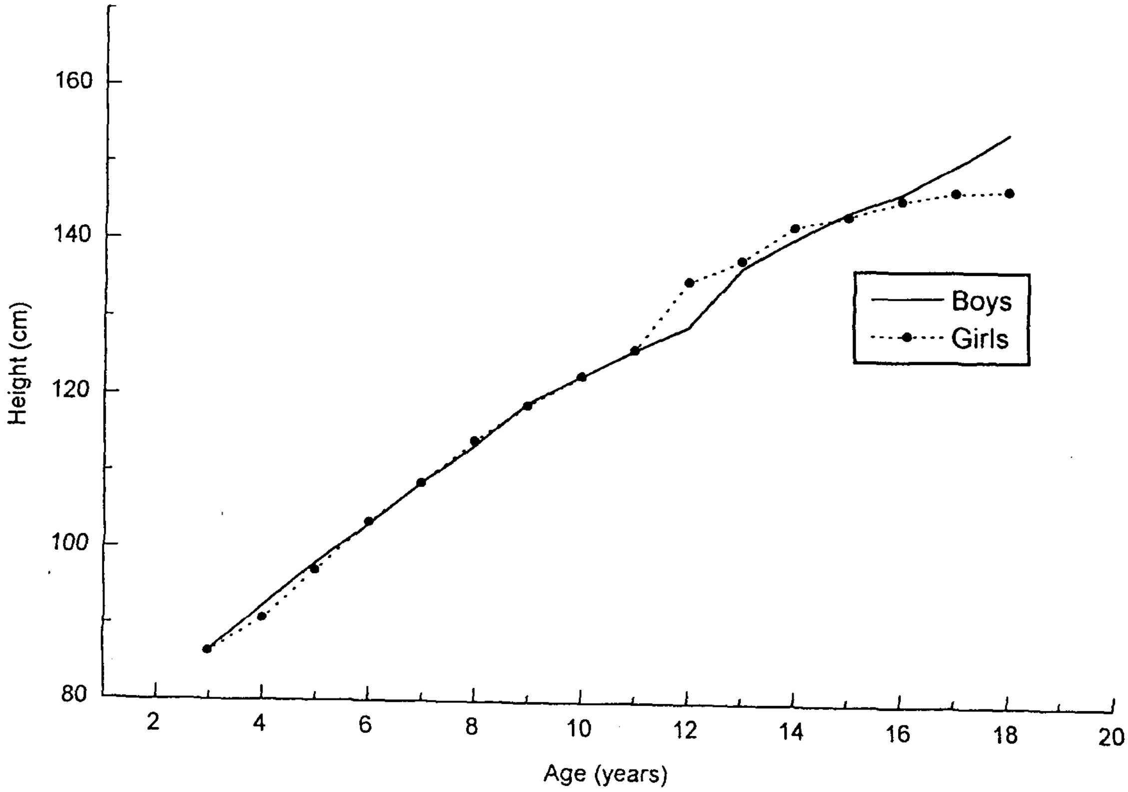


Fig. 5.3. Distance curve for height of boys and girls

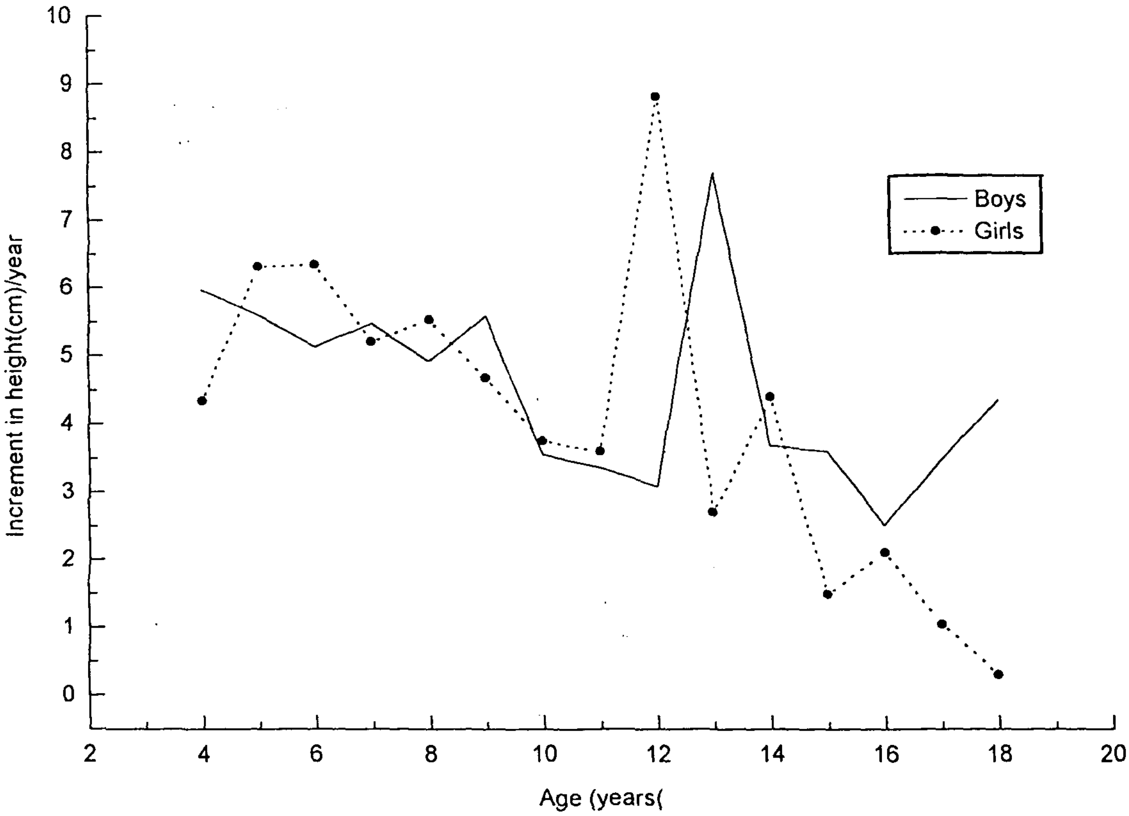


Fig.5.4. Velocity curve for height of boys and girls

Sitting Height

The statistical constants for sitting height of both boys and girls are given in Table 5.3. The distance curve (Figure 5.5) shows that both boys and girls have a similar growth pattern at 6, 10, 13 and 16 years of age, but the sitting height is higher in girls for many age groups, and it is statistically significant at 3, 5,7 and 12 years of age. The higher mean value of sitting height in boys is perceptible at 4, 8 and 17 to 18 years, but it is significant only at age 18.

The velocity curve (Figure 5.6) shows that both the sexes gained their sitting height continuously from 3 to 18 years of age. It is observed that the velocity rate is higher in boys than in girls in many age groups, although it is higher in the latter than in the former at 5, 7, 9, 12, and 14 years of age. On the other hand, the growth rate is more or less similar for both boys and girls at 10, 11 and 16 years of age. It is found that the maximum increase in sitting height occurs between 12 and 13 years for boys (4.40 cm) and between 11 and 12 years for girls (4.57 cm). Thus, like in the case of weight and height, it indicates that the adolescent growth spurt occurs at about 12 and 13 years in girls and boys, respectively.

Biacromial Diameter

The means and standard deviations of biacromial diameter are presented in Table 5.4. The mean values are plotted against age as shown in Figure 5.7. It indicates that there is a gradual increase in biacromial diameter as age advances. It is true for both boys and girls. However, the distance curve shows that both boys and girls have a similar growth pattern from 7 to 15 years of age, although the girls are significantly broader in shoulder at about 12 years of age, which is associated with their adolescent growth spurt. On the other hand, the boys have a broader shoulder from 3 to 6 and 16 years onwards, although the difference is statistically significant only at the age of 18.

Table 5.3. Statistical constants of sitting height (cm) for boys and girls

Age	Boys			Girls			
(yrs)	Mean	SD	Increment	Mean	SD	Increment	t-value
3	45.76	3.92	-	46.83	3.04	-	2.06*
4	49.01	4.29	3.25	48.81	4.14	1.18	0.28
5	51.28	4.95	2.27	52.79	4.28	3.98	2.15*
6	54.97	5.82	3.69	54.58	5.26	1.79	0.47
7	55.51	4.49	0.54	56.91	4.32	2.33	2.13*
8	59.14	4.41	3.63	58.90	5.02	1.99	0.33
9	61.76	5.09	2.62	62.08	4.01	3.18	0.46
10	63.31	4.35	1.55	63.81	4.91	1.73	0.70
11	64.64	5.18	1.33	65.49	4.67	1.68	1.10
12	66.81	4.77	2.17	70.06	4.41	4.57	4.61**
13	71.21	4.22	4.40	71.21	4.79	1.15	0.00
14	73.37	3.87	2.16	74.22	4.22	3.01	1.38
15	76.13	4.42	2.76	76.34	3.55	2.12	0.35
16	77.12	3.96	0.99	77.18	3.33	0.84	0.11
17	79.31	3.74	2.19	78.36	4.04	1.18	1.48
18	80.53	3.93	1.22	78.62	3.57	0.26	3.13**

*P < 0.05; **P < 0.001

The velocity curve (Figure 5.8) for biacromial diameter shows that the growth rate is higher in boys than in girls at 10, 11, 13, and 17 years onwards, and it is higher in the latter than in the former at 5, 6, 7, 9 and 12 years of age. In boys, the maximum gain of 1.93 cm occurs from 12 to 13 years of age, whereas in girls the maximum acceleration rate of 2.27 cm takes place from about 11 to 12 years of age. Thus, like in the case of other measurements, the girls show their adolescent spurt at about 12 years of age, and the boys at about the age of 13. The pre-adolescent spurt is also observed at age 10 in boys, and 9 years in girls during which the growth rates are 1.17 and 1.35 cm, respectively.

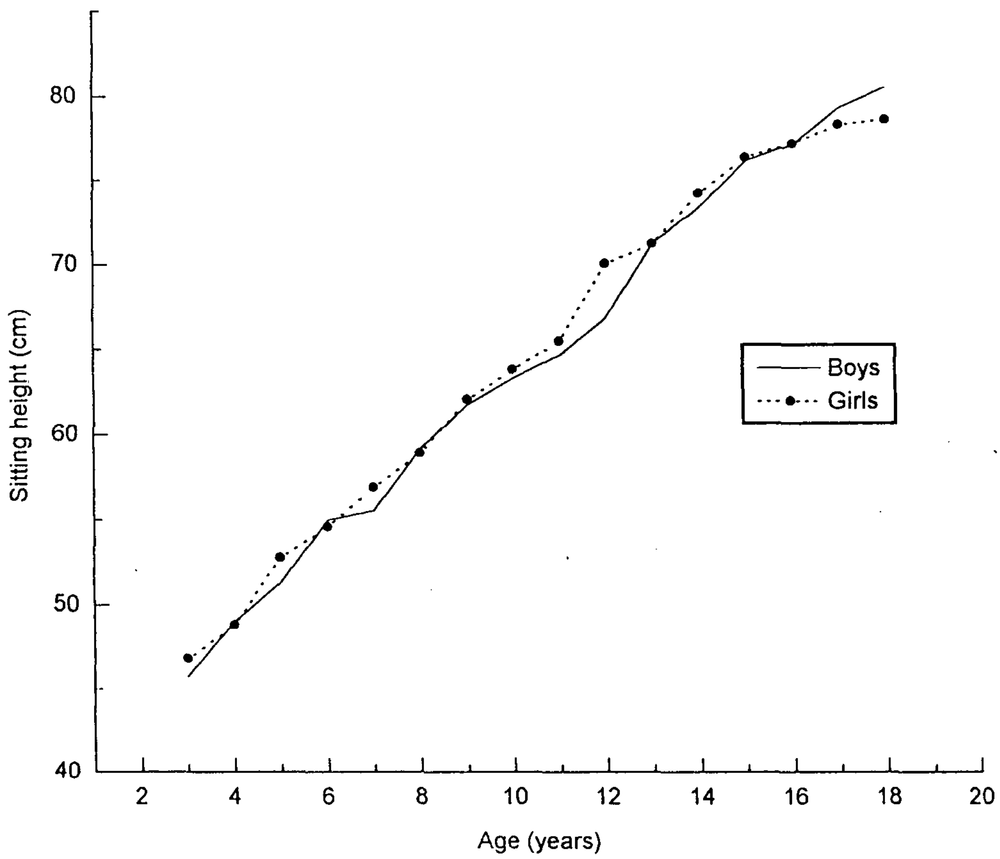


Fig.5.5. Distance curve for sitting height of boys and girls

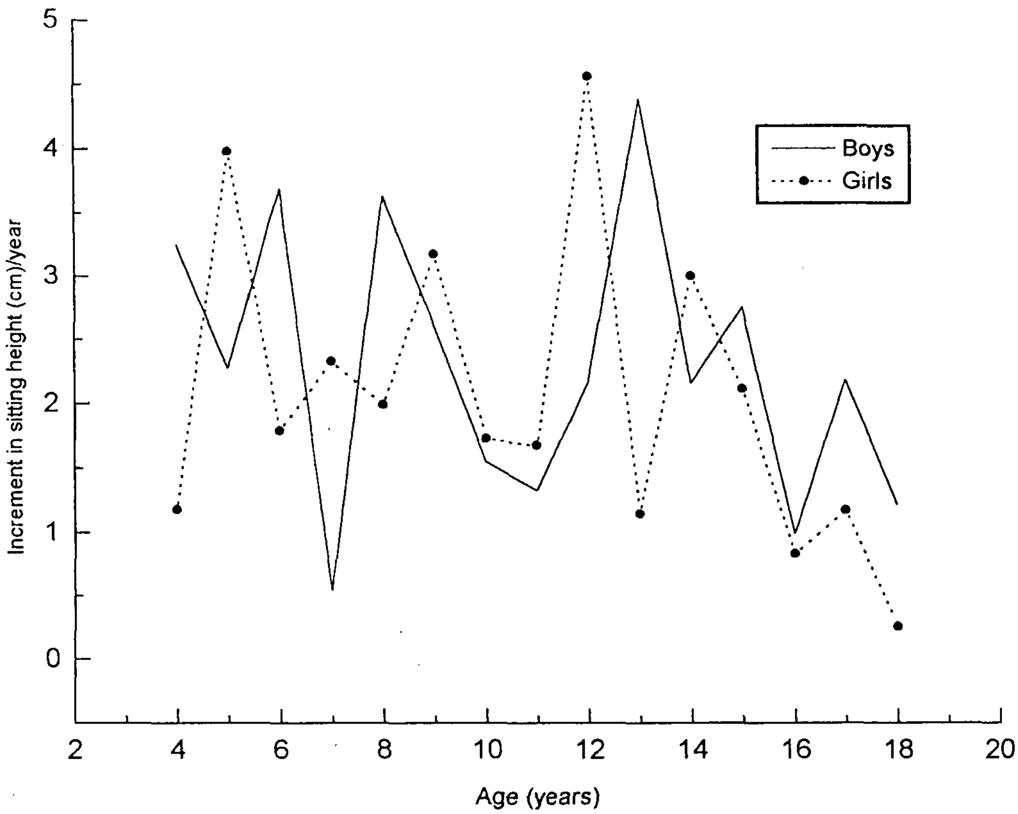


Fig.5.6. Velocity curve for sitting height of boys and girls

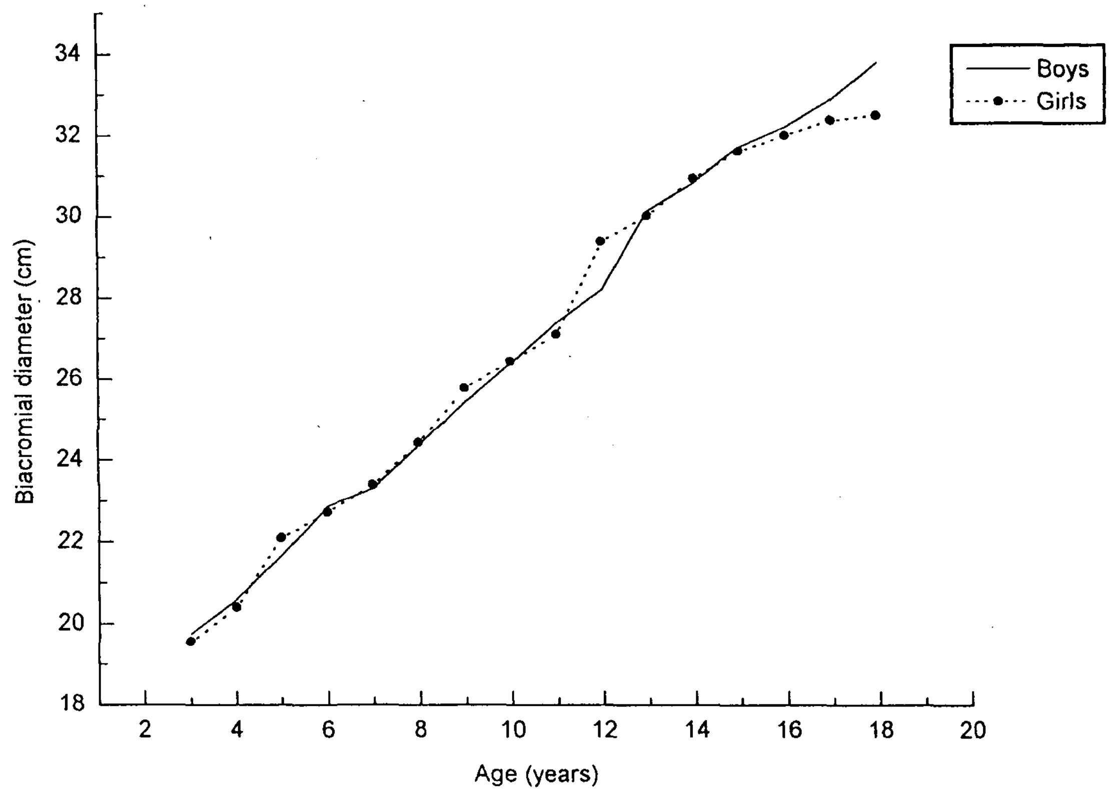


Fig.5.7. Distance curve for biacromial diameter of boys and girls

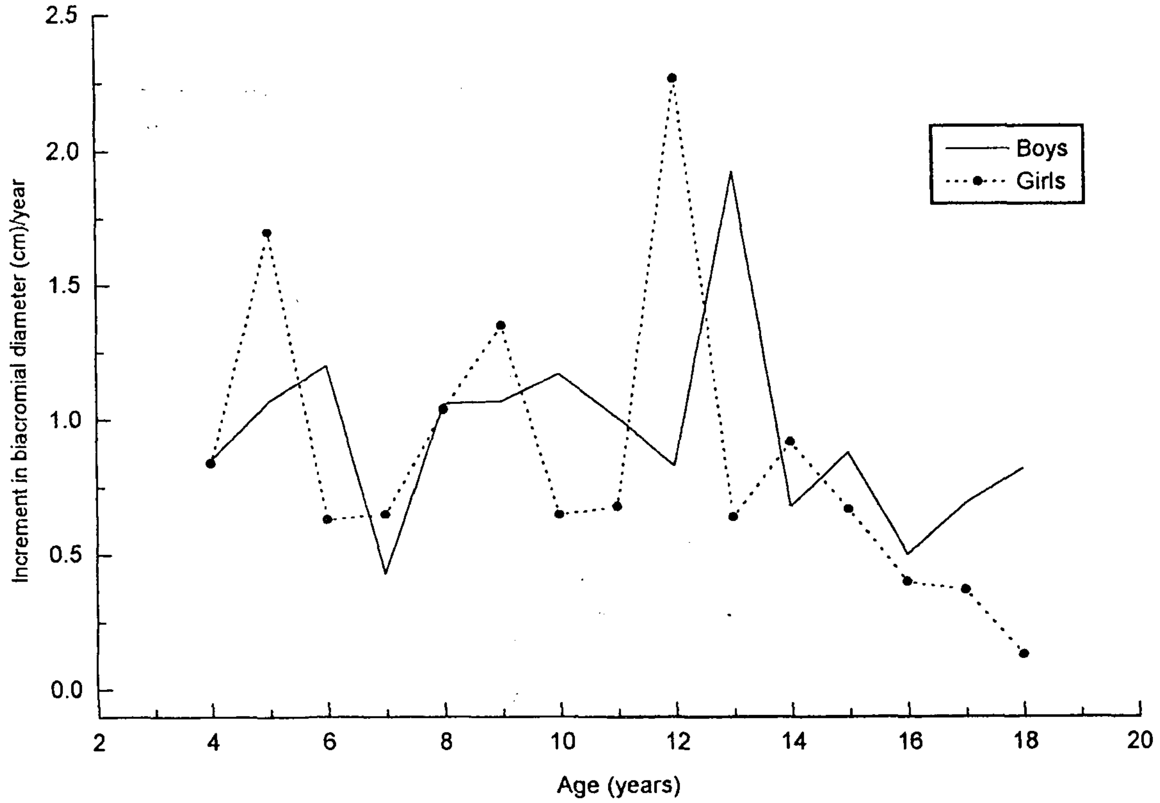


Fig.5.8. Velocity curve for biacromial diameter of boys and girls

In view of the present data on biacromial diameter, it can be concluded that both boys and girls show a similar growth pattern, except during the adolescent period. Like in the case of other measurements, the mean values and growth rates are higher in girls than in boys from 11 to 12 years of age. However, the boys do not show much higher mean values of measurements, although they show a higher growth rate during their adolescent period (i.e., at about 13 years).

Table 5.4 Statistical constants of biacromial diameter (cm) for boys and girls

Age	Boys			Girls			
(yrs)	Mean	SD	Increment	Mean	SD	Increment	t-value
3	19.74	1.20	-	19.56	1.29	-	0.97
4	20.59	1.58	0.85	20.40	1.81	0.84	0.73
5	21.66	1.56	1.07	22.10	1.52	1.70	1.88
6	22.86	1.46	1.20	22.73	1.94	0.63	0.50
7	23.29	1.50	0.43	23.38	1.81	0.65	0.36
8	24.35	1.70	1.06	24.42	1.86	1.04	0.25
9	25.42	1.81	1.07	25.77	1.70	1.35	1.33
10	26.37	2.42	1.17	26.42	2.16	0.65	0.14
11	27.38	2.46	1.01	27.10	1.96	0.68	0.81
12	28.20	1.76	0.83	29.37	2.05	2.27	3.96*
13	30.14	1.93	1.93	30.01	1.83	0.64	0.45
14	30.82	1.56	0.68	30.93	1.91	0.92	0.41
15	31.70	1.73	0.88	31.60	1.39	0.67	0.42
16	32.20	1.58	0.50	32.00	1.48	0.40	0.54
17	32.89	1.69	0.69	32.37	1.63	0.37	1.91
18	33.79	1.85	0.82	32.50	1.33	0.13	4.77**

*P < 0.05; **P < 0.001

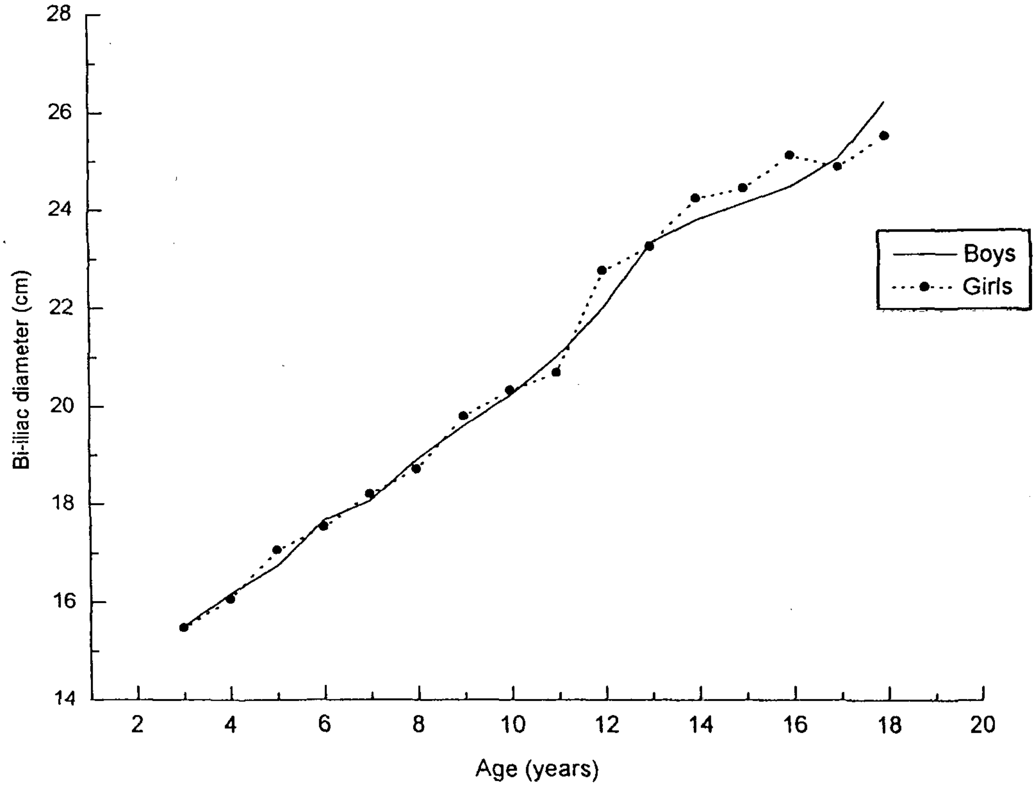


Fig.5.9. Distance curve for bi-iliac diameter of boys and girls

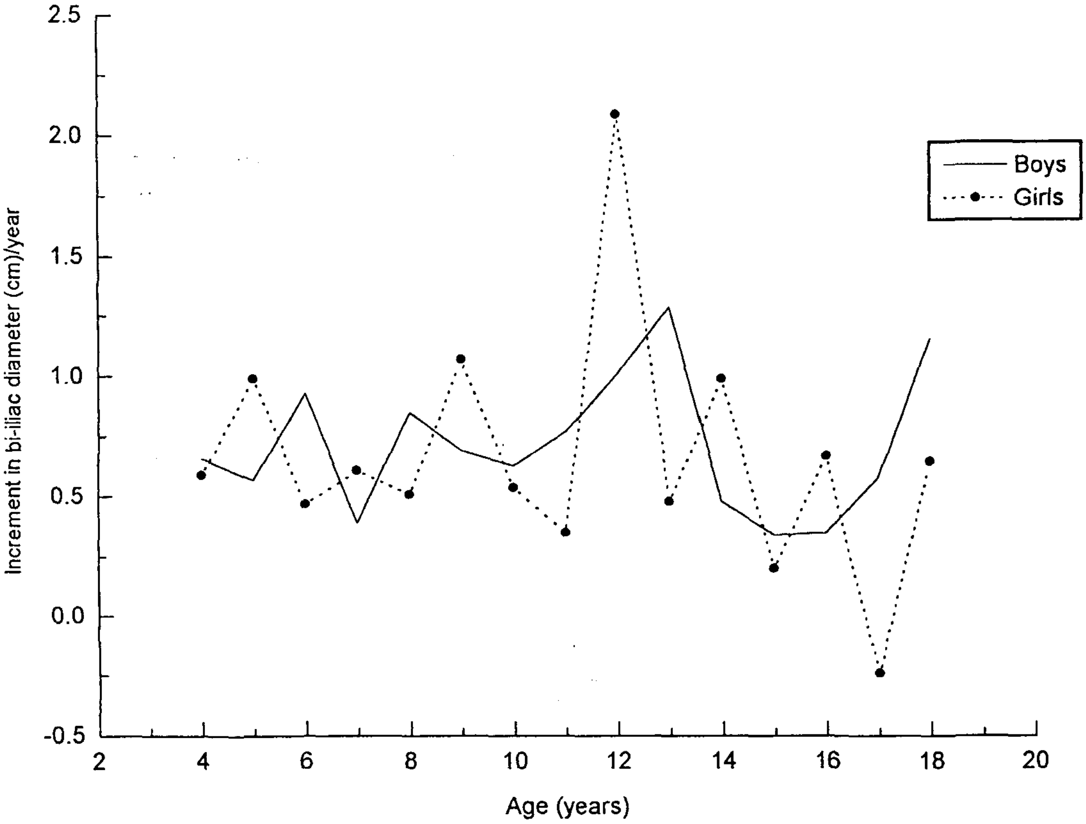


Fig. 5.10. Velocity curve for bi-iliac diameter of boys and girls

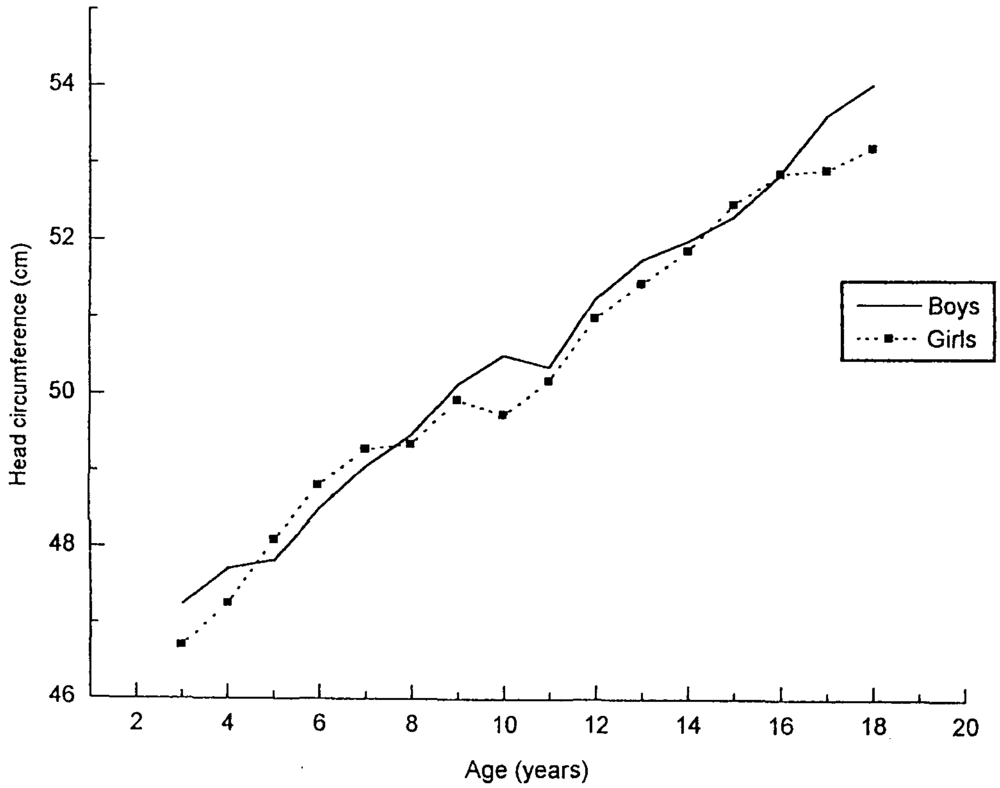


Fig.5.11. Distance curve for head circumference of boys and girls

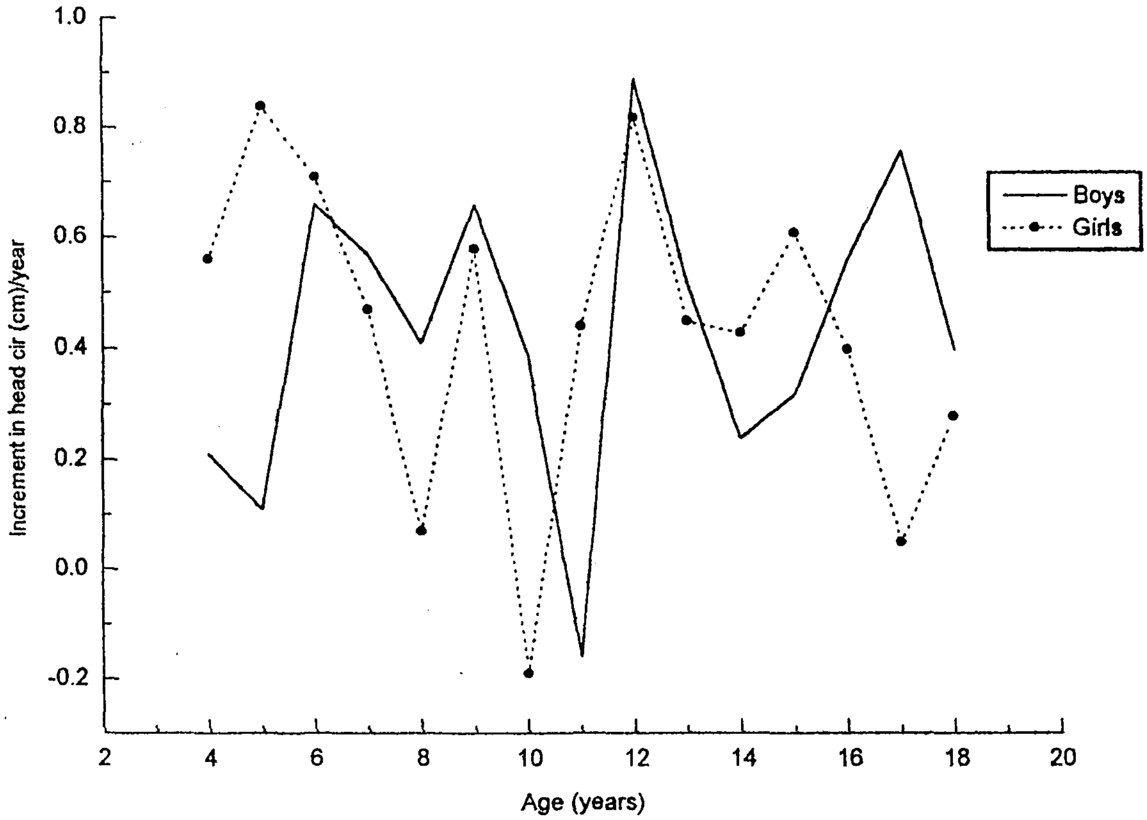


Fig.5.12. Velocity curve for head circumference of boys and girls

Bi-iliac Diameter

Table 5.5 shows the means and standard deviations of bi-iliac diameter for both boys and girls. The distance curve based on the means against age is shown in Figure 5.9. Like in the case of biacromial diameter, both boys and girls by and large show similar mean values of bi-iliac diameter in many age groups. However, the girls have a broader hip than the boys at 5, 12, 14, 15 and 16 years, while the latter have a higher value than the former from 17 years to the last terminal age group. The t-values (Table 5.5) indicate that the differences between the sexes are significant at 5, 12, 16, and 18 years of age. That is, the bi-iliac diameter is significantly higher in girls than in boys at the age of 5 and 12 and 16, while the boys surpass the girls significantly at the age of 18.

Table 5.5. Statistical constants of biiliac diameter (cm) for boys and girls

Age	Boys			Girls			
(yrs)	Mean	SD	Increment	Mean	SD	Increment	t-value
3	15.50	1.11	-	15.48	0.93	-	0.13
4	16.16	1.23	0.66	16.07	1.22	0.59	0.46
5	16.73	1.07	0.57	17.06	1.15	0.99	1.96*
6	17.66	1.20	0.93	17.53	1.51	0.47	0.63
7	18.05	1.34	0.39	18.20	1.47	0.61	0.71
8	18.90	1.26	0.85	18.71	1.63	0.51	0.83
9	19.59	1.51	0.69	19.78	1.48	1.07	0.85
10	20.22	1.85	0.63	20.32	1.64	0.54	0.37
11	20.99	1.85	0.77	20.67	1.58	0.35	1.19
12	22.00	1.90	1.01	22.76	2.18	2.09	2.42*
13	23.29	2.26	1.29	23.24	1.17	0.48	0.15
14	23.77	2.16	0.48	24.23	2.21	0.99	1.38
15	24.11	2.01	0.34	24.43	1.98	0.20	1.05
16	24.46	1.82	0.35	25.10	1.99	0.67	2.16*
17	25.04	1.63	0.58	24.86	1.82	-0.24	0.63
18	26.20	1.75	1.16	25.51	1.90	0.65	2.37*

*$P < 0.05$

The growth rate per annum is plotted against age in Figure 5.10. It is seen that the velocity rate is different between sexes, although it is similar at 4, 10 and 15 years of age. The boys accelerate more than the girls from 5 to 6, 7 to 8, 10 to 11, 12 to 13 and 17 years onwards, while the latter grow faster at 5, 7, 9, 12, 14 and 16 years of age. The acceleration or velocity in boys reaches its peak of 1.29 cm at about 13 years, while the peak velocity of 2.09 cm in girls is observed at the age of about 12 years. In the case of girls, there is also a deceleration of growth in bi-iliac diameter from 16 to 17 years, which is followed by a caught-up at 18 years of age. Nevertheless, data on bi-iliac diameter also show that adolescent growth spurt occurs at 12 and 13 years in girls and boys, respectively.

Head Circumference

The statistical constants of the head circumference for both boys and girls are given in Table 5.6, and the means plotted against age is shown in Figure 5.11. It is observed that the boys are higher in head circumference than the girls from 3 to 4, 8 to 14 and 17 to 18 years, while the girls surpass the boys from 5 to 8 years of age. Both boys and girls are more or less similar in growth pattern from 14 to 16 years of age. However, the t-values given in Table 5.6 show that the differences between the sexes are significant only at 10, 17 and 18 years of age.

As far as the velocity curve is concerned (Figure 5.12), it indicates that the acceleration rate is higher in girls than in boys from 3 to 6 and 14 to 15 years of age with the peak velocity (0.82 cm) at the age of 12 as in the case of other measurements. On the other hand, the boys have higher head circumference than the girls from 6 to 9 and 16 years onwards with the peak velocity (0.89 cm) at 12 years of age as in the case of girls. Thus, unlike other measurements mentioned above, both boys and girls experience a high growth spurt at the age of 12, which may be associated with their adolescent growth spurt. Further, it is observed from Figure 5.12 that both boys and girls have a deceleration of growth rate, which occurs at 11 years in boys and 10 years in girls. Thereafter, the growth rate tends to increase with the increasing age of both the sexes.

Upper Arm Circumference

Table 5.7 shows the means and standard deviations of the upper arm circumference for both boys and girls, and the distance and velocity curves are shown in Figures 5.13 and 5.14, respectively. The distance curve shows that mean values of arm circumference are more or less similar for both sexes in all age groups, except at 12, 17, and18 years of age. It is seen that the girls have a higher mean arm circumference than that of boys at 12 years of age. On the other hand, the arm circumference is higher in boys than in girls from 17 to 18 years of age. It is also found that these sex differences in mean arm circumference are statistically significant (Table 5.7).

Table 5.6. Statistical constants of head circumference (cm) for boys and girls

Age	Boys			Girls			
(yrs)	Mean	SD	Increment	Mean	SD	Increment	t-value
3	47.25	1.34	-	46.70	2.17	-	1.92
4	47.72	1.85	0.21	47.26	1.70	0.56	1.69
5	47.83	1.61	0.11	48.10	1.65	0.84	1.09
6	48.49	1.46	0.66	48.81	1.64	0.71	1.37
7	49.06	1.66	0.57	49.28	1.17	0.47	1.03
8	49.47	1.55	0.41	49.35	1.37	0.07	0.53
9	50.13	1.48	0.66	49.93	1.30	0.58	0.96
10	50.52	1.42	0.39	49.74	1.55	-0.19	3.39*
11	50.36	1.76	-0.16	50.18	1.39	0.44	0.73
12	51.25	1.67	0.89	51.00	1.91	0.82	0.91
13	51.77	1.48	0.52	51.45	1.11	0.45	1.61
14	52.01	1.34	0.24	51.88	1.37	0.43	0.63
15	52.33	1.38	0.32	52.49	1.28	0.61	0.79
16	52.89	1.51	0.56	52.89	1.34	0.40	0.00
17	53.65	1.38	0.76	52.94	1.70	0.05	2.78*
18	54.05	1.55	0.40	53.22	1.64	0.28	3.27*

*P < 0.01

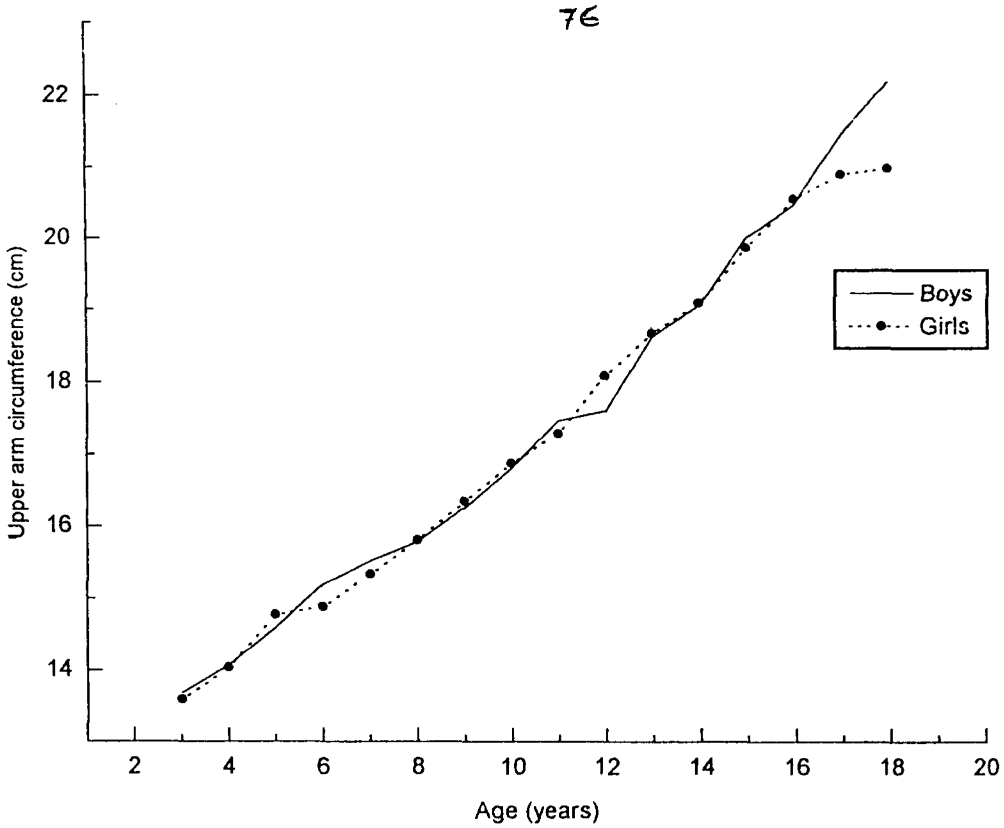


Fig. 5.13. Distance curve for upper arm circumference of boys and girls

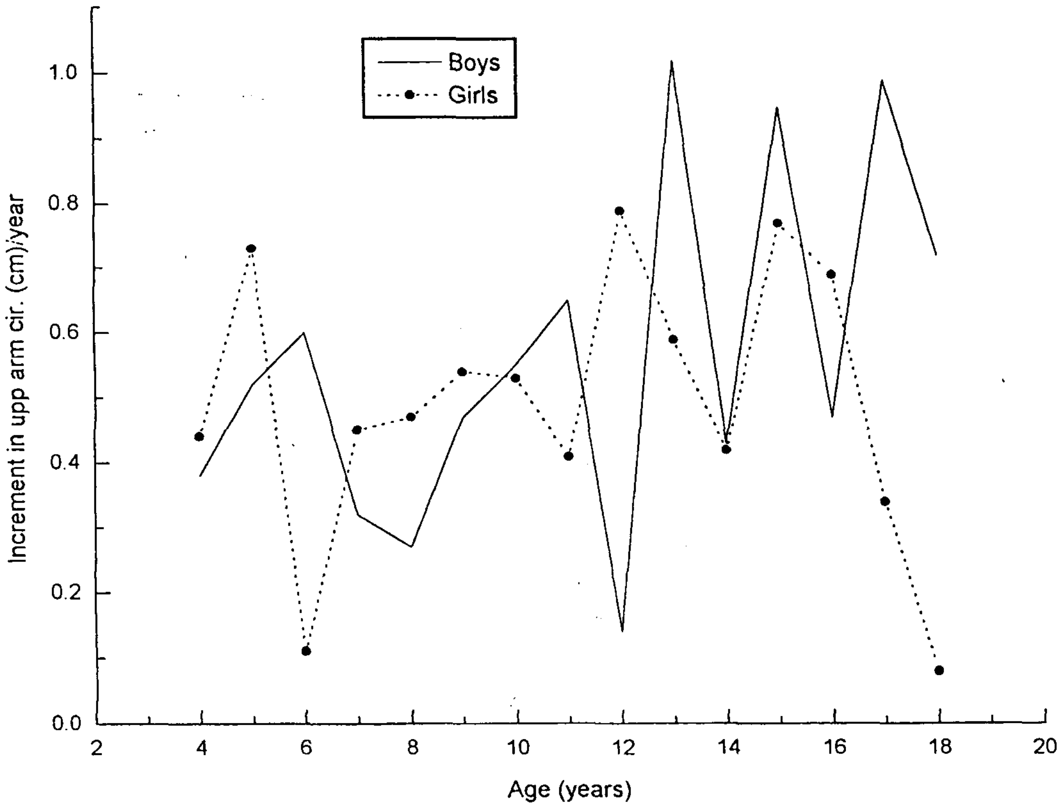


Fig. 5.14. Velocity curve for upper arm circumference of boys and girls

Table 5.7. Statistical constants of upper arm circumference (cm) for boys and girls

Age	Boys			Girls			
(yrs)	Mean	SD	Increment	Mean	SD	Increment	t-value
3	13.69	1.09	-	13.60	0.94	-	0.60
4	14.07	1.02	0.38	14.04	1.20	0.44	0.18
5	14.59	1.26	0.52	14.77	1.07	0.73	1.01
6	15.19	1.22	0.60	14.88	1.23	0.11	1.68
7	15.51	1.11	0.32	15.33	1.28	045	1.00
8	15.78	1.20	0.27	15.80	1.14	0.47	0.11
9	16.25	1.21	0.47	16.34	1.36	0.54	0.47
10	16.80	1.39	0.55	16.87	1.24	0.53	0.34
11	17.45	1.36	0.65	17.28	1,42	0.41	0.80
12	17.59	1.11	0.14	18.07	1.33	0.79	2.55*
13	18.61	1.25	1.02	18.66	1.26	0.59	0.31
14	19.04	1.27	0.43	19.08	1.51	0.42	0.19
15	19.99	1.35	0.95	19.85	1.48	0.77	0.65
16	20.46	1.47	0.47	20.54	1.42	0.69	0.36
17	21.45	1.62	0.99	20.88	1.60	0.34	2,15*
18	22.17	1.38	0.72	20.96	1.32	0.08	5.74**

*P < 0.05, **P < 0.000

As for the annual growth rate, Figure 5.14 shows that the velocity rate is more or less similar in both boys and girls from 3 to 4, 8 to 10, and 12 to 14 years of age. The boys have a higher growth rate than the girls at 6, 11, 15 and 17 years onwards, while the latter are higher in velocity rate at the age of 5, 7, 8, 12 and 16. The total gain in arm circumference is more in boys (8.48 cm) than in girls (7.36 cm). In boys, the maximum gain occurs at 13 years, while in girls it takes place at the age of 12 years, accounting to about 12% and 11% of the total gain from 3 to 18 years for boys and girls, respectively. Thus, it is obvious that adolescent spurt occurs at 12 and 13 years in girls and boys, respectively. The pre-adolescent growth spurt in boys takes place at the age of 11 with the annual increment of 0.65 cm, while in girls it occurs during the period between 9 and 10 years of age.

Table 5.8. Statistical constants of chest circumference (cm) for boys and girls

Age	Boys			Girls			
(yrs)	Mean	SD	Increment	Mean	SD	Increment	t-value
3	51.61	4.09	-	51.23	4.51	-	0.59
4	54.54	4.66	2.93	53.38	4.40	2.51	1.67
5	55.33	3.70	0.79	55.18	4.21	1.80	0.25
6	56.75	4.58	1.42	57.94	5.10	2.76	1.63
7	58.65	4.80	1.90	59.01	4.78	1.07	0.50
8	60.59	5.29	1.94	59.37	5.67	0.36	1.43
9	62.48	4.43	1.89	62.83	5.69	3.46	0.46
10	64.34	5.96	1.86	64.13	5.50	2.00	0.24
11	67.17	4.99	1.83	65.90	5.33	1.77	1.58
12	68.53	4.99	1.36	69.76	5.87	3.86	1.47
13	73.43	5.63	4.90	71.20	4.78	1.44	2.81*
14	75.52	5.57	2.09	74.37	5.22	3.17	1.40
15	78.00	4.59	2.48	76.30	5.15	1.93	2.29*
16	79.50	4.93	1.50	78.40	4.76	2.10	1.46
17	83.43	4.90	3.93	79.55	4.20	1.15	5.18**
18	85.94	5.67	2.51	79.98	4.90	0.43	7.11**

*P < 0.05, **P < 0.000

Chest Circumference

The statistical constants for chest girth of both boys and girls are given in Table 5.8. The mean values are plotted against age as shown in Figure 5.15. It is observed that there is a gradual increase in chest girth from 3 to 18 years of age for both boys and girls. The distance curve shows that the chest girth is higher in boys than in girls from 3 to 5, 7 to 8,and 10 to 11 years of age. On the other hand, the girls are higher in mean values from 6 to 7, 10 to 11 and after 12 years of age. However, these differences between boys and girls in respect of chest girth are significant only at 13, 15, 17 and 18 years. Nevertheless, it indicates that the boys have higher chest girth in many age groups, except in some age groups like adolescent period when the girls surpass the boys.

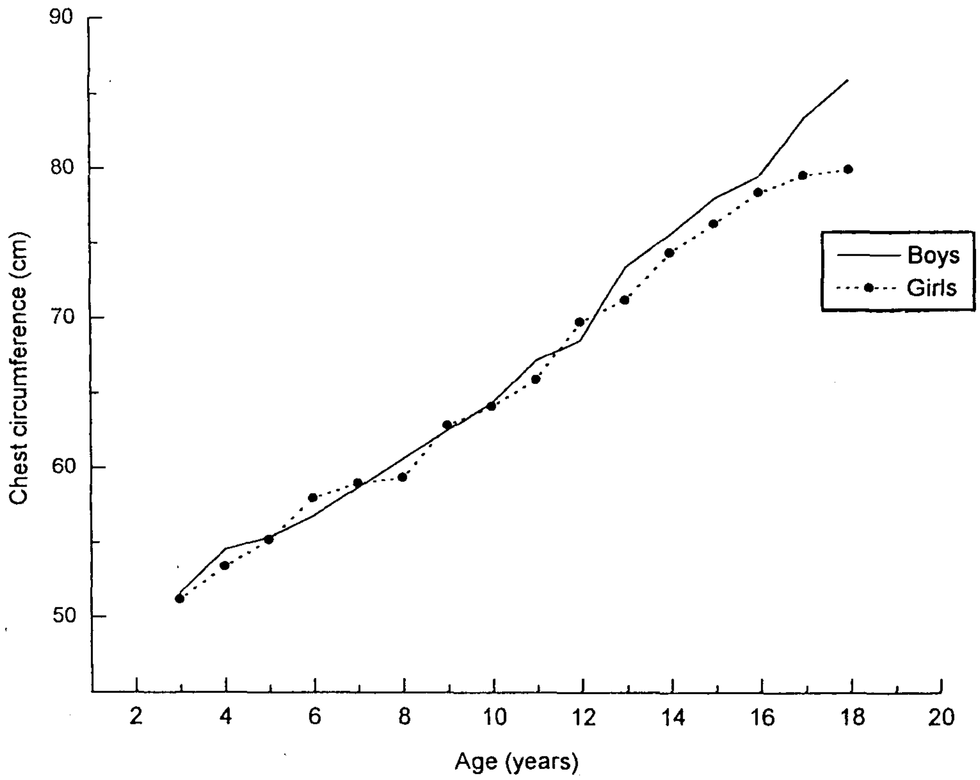


Fig.5.15. Distance curve for chest circumference of boys and girls

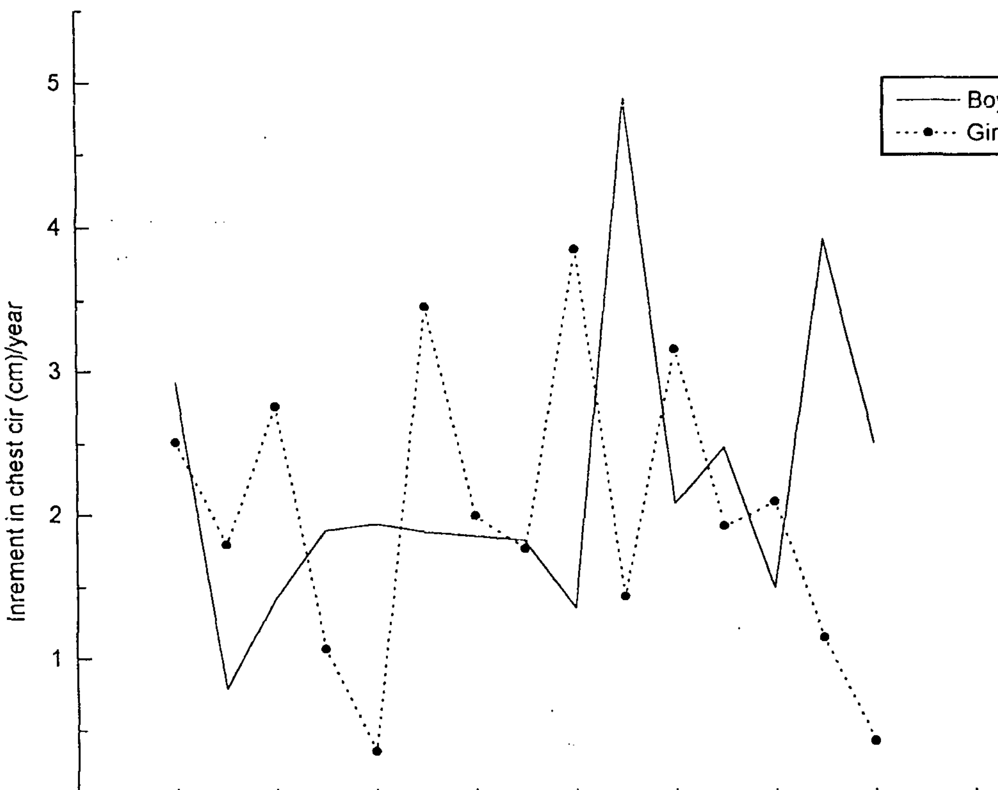


Fig.5.16. Velocity curve for chest circumference of boys and girls

Figure 5.16 shows that the velocity rates vary between sexes. It is observed that the growth rate is higher in girls than in boys at 5,6,9,10,12,14 and 16 years of age. On the other hand, the acceleration rate is higher in boys than in girls at the age of 4,7,8,11,13,1517 and 18 years. It is found that the total gain from 3 to 18 years is 34.33 cm in boys and 28.55 cm in girls. The maximum gain or peak velocity of 4.90 cm in boys occurs at the age of 13 (i.e., 14.27% of the total gain) while it is 3.86 cm, (i.e., 13.52% of the total gain) in girls at the age of 12 years.

GROWTH BY SOCIOECONOMIC CONDITION

In this section, we shall deal with the relationship between growth of children and the socio-economic condition of the households. In this connection, we shall take into consideration the income of household and religion as described in Chapter III.

INCOME OF HOUSEHOLD

Weight

The means and standard deviations of weight according to income groups for boys and girls are given in Tables 5.9 and 5.10, respectively. It is observed that both boys and girls in the HIG are heavier than those belonging to the LIG and MIG, although the MIG boys are heavier than the HIG boys from 3 to 4 years of age. The one way analysis of covariance (ANCOVA) indicates that the differences between income groups after adjusting for the effect of religion are highly significant for many age groups of boys and girls. This clearly shows that the income of household is very important in controlling the growth in weight for the children of the present population.

Table 5.9. Mean weight of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	11.33	1.95	12.68	1.27	12.14	1.88	5.19	0.007*
4	13.50	2.17	14.54	1.82	14.14	2.09	1.84	0.170
5	15.43	1.70	16.46	1.86	17.07	1.67	5.84	0.004*
6	16.51	2.31	17.61	1.95	17.73	1.87	3.83	0.003*
7	17.97	2.00	18.03	2.21	18.56	2.79	2.13	0.130
8	19.92	2.63	20.41	2.67	22.37	2.64	7.92	0.001*
9	21.93	2.75	23.29	3.04	24.23	2.28	8.00	0.001*
10	23.40	3.77	25.19	2.84	25.98	3.04	4.40	0.020*
11	25.33	4.08	27.23	2.53	29.13	3.11	9.37	0.000*
12	27.69	3.42	29.92	2.62	30.83	2.00	6.91	0.002*
13	32.35	3.66	35.09	3.91	34.98	4.29	4.43	0.020*
14	35.24	3.60	37.95	3.41	39.74	3.99	11.41	0.000*
15	40.04	4.41	42.52	3.64	43.87	4.22	5.72	0.005*
16	41.46	3.70	44.44	4.98	44.96	4.80	5.30	0.007*
17	46.80	2.58	47.90	3.84	48.09	4.65	1.06	0.350
18	48.04	4.57	48.90	4.01	50.13	3.11	1.17	0.320

* Significant

Table 5.10. Mean weight of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	11.27	1.53	12.24	1.73	13.25	1.99	10.59	0.000*
4	13.10	2.47	14.05	1.47	14.64	1.82	5.60	0.005*
5	15.07	1.79	15.94	1.57	16.71	2.14	5.21	0.007*
6	17.15	2.07	17.78	2.81	18.66	2.35	4.87	0.010*
7	18.18	2.20	18.78	2.05	19.38	2.79	3.19	0.050*
8	20.54	2.46	19.74	2.35	21.55	2.33	5.20	0.010*
9	21.74	3.31	22.74	2.86	24.39	3.15	5.01	0.010*
10	23.46	3.61	24.57	3.11	26.53	3.68	4.70	0.010*
11	26.72	2.97	27.04	2.82	27.58	3.40	1.02	0.370
12	30.31	3.72	30.64	3.49	31.69	3.80	0.77	0.380
13	32.28	3.26	33.36	4.82	33.72	5.87	1.11	0.340
14	35.84	4.64	38.08	5.54	38.40	4.60	2.16	0.120
15	39.17	3.48	41.78	4.26	42.76	2.61	5.78	0.004*
16	42.27	3.68	42.80	4.12	45.08	2.85	3.30	0.040*
17	43.27	4.01	44.51	4.56	46.92	3.50	3.02	0.050*
18	42.72	4.50	45.31	5.43	47.55	3.55	5.12	0.010*

* Significant

Table 5.11. Mean height of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	84.71	4.33	87.66	4.94	89.54	7.05	7.24	0.001*
4	91.26	5.11	93.96	5.22	93.15	3.84	2.08	0.070
5	95.00	5.91	98.37	5.85	102.47	6.09	6.41	0.003*
6	99.88	6.79	104.57	6.00	108.68	6.50	3.53	0.030*
7	107.62	5.85	107.74	5.75	112.54	7.34	7.46	0.001*
8	110.22	7.74	114.03	5.40	119.43	5.05	15.16	0.000*
9	116 39	6.39	118.21	6.38	123.81	3.69	19.30	0.000*
10	119.83	8.01	123.11	5.29	127.55	5.01	9.17	0.000*
11	123.53	6.81	126.17	5.11	129.88	4.98	9.70	0.000*
12	127.82	5.94	130.87	5.72	130.23	9.26	2.31	0.020*
13	135.12	5.59	137.18	4.33	139.06	4.44	4.47	0.010*
14	138.13	5.52	140.81	4.64	144.69	5.18	9.37	0.000*
15	142.62	5.42	145.04	6.58	146.58	8.25	2.29	0.110
16	144.38	5.76	147.57	5.86	150.97	7.32	6.88	0.002*
17	148.79	5.17	149.52	4.19	155.76	8.54	6.38	0.003*
18	153.08	6.11	154.41	5.90	157.57	5.18	2.60	0.080

*Significant

Table 5.12. Mean height of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	85.16	5.03	86.13	3.89	88.76	4.82	4.17	0.020*
4	89.30	5.34	90.84	5.61	92.46	5.38	2.54	0.090
5	95.41	5.29	98.41	6.20	97.95	5.13	3.30	0.040*
6	102.43	5.69	102.77	6.05	105.68	6.85	2.91	0.060
7	106.53	7.10	108.82	7.52	111.74	4.77	5.57	0.050*
8	113.47	6.21	113.04	5.64	117.15	5.45	4.74	0.010*
9	117,06	7.59	118.33	6.35	123.37	4.33	5.71	0.010*
10	121.59	6.88	121.32	7.38	126.15	5.46	3.67	0.030*
11	124.44	6.90	126.26	4.81	130.91	2.74	8.05	0.001*
12	132.76	5.61	134.28	7.11	138.35	6.34	5.10	0.010*
13	136.89	5.89	138.05	5.92	138.65	5.35	0.92	0.400
14	139.68	5.64	143.28	5.54	144.87	7.46	5.41	0.010*
15	141.29	5.58	144.06	5.13	147.02	2.95	6.83	0.002*
16	145.19	5.28	144.29	5.04	150.00	3.50	9.00	0.000*
17	144.35	5.85	146.75	6.10	152.83	5.75	8.20	0.001*
18	145.46	5.96	147.16	6.38	154.10	5.56	7.96	0.001*

*Significant

Table 5.13. Mean sitting height of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	45.47	3.80	46.20	2.92	45.69	5.96	0.31	0.740
4	48.66	4.34	49.57	3.92	48.95	4.99	0.27	0.070
5	50.62	4.61	51.65	4.94	52.05	5.91	0.51	0.600
6	53.78	6.00	54.75	4.55	57.80	3.47	4.54	0.001*
7	55.18	4.65	55.79	4.54	55.51	4.33	1.96	0.150
8	58.18	4.19	58.39	3.78	61.27	5.16	5.41	0.010*
9	59.66	5.65	62.16	4.89	64.07	3.24	9.85	0.000*
10	62.29	4.41	63.18	3.76	65.28	4.42	3.07	0.050*
11	62.63	5.93	65.32	4.16	66.85	3.90	6.59	0.002*
12	66.17	4.70	67.42	3.90	67.80	7.56	0.78	0.460
13	69.71	3.74	70.46	4.72	74.04	2.71	9.74	0.000*
14	71.87	4.43	73.74	2.89	75.31	3.45	5.94	0.004*
15	74.64	4.12	76.70	4.81	78.59	2.83	5.26	0.007*
16	75.47	4.11	78.14	3.02	78.71	4.44	6.95	0.002*
17	77.84	4.15	79.12	3.29	82.67	2.51	7.41	0.001*
18	78.92	4.42	80.80	3.58	82.37	3.02	4.72	0.010*

*Significant

Table 5.14. Mean sitting height of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	46.52	2.54	46.49	3.67	47.88	2.28	1.73	0.25
4	47.41	4.35	48.35	3.80	48.33	4.36	1.42	0.25
5	52.60	3.79	52.40	5.12	54.27	2.73	1.39	0.26
6	54.62	4.03	51.97	6.34	56.91	5.01	7.43	0.01*
7	55.93	4.90	57.31	3.84	57.96	4.61	2.51	0.09
8	59.02	4.80	58.53	5.20	59.49	5.07	0.34	0.71
9	62.18	3.56	61.19	4.37	63.51	3.94	1.51	0.23
10	63.76	5.10	63.21	4.97	64.91	4.61	0.58	0.56
11	64.84	5.65	64.77	3.45	69.00	2.84	6.36	0.00*
12	69.63	3.88	69.21	4.66	71.58	4.28	1.83	0.17
13	69.98	5.16	71.97	4.58	71.68	4.48	2.55	0.08
14	72.90	5.06	75.07	3.39	75.05	3.42	2.57	0.08
15	74.76	3.70	76.69	3.37	78.18	2.63	5.53	0.01*
16	76.90	3.18	76.64	3.46	78.72	2.89	2.40	0.10
17	77.44	3.96	78.21	4.20	80.81	2.81	2.99	0.06
18	77.24	3.42	79.43	3.38	81.19	2.60	7.69	0.00*

*Significant

Height and Sitting Height

Like in the case of weight, Tables 5.11 and 5.12 show that boys and girls belonging to the HIG are taller than their counterparts in the LIG and MIG. The ANCOVA test indicates that the differences between income groups are highly significant in many age groups for both boys and girls. Likewise, the mean sitting height in boys varies significantly between income groups except in the lower age groups (, i.e., from 3 to 5 years of age). and at ages 7 and 12 (Table 5.13). On the other hand, Table 5.14 shows that sitting height does not vary significantly in most of the age groups for girls, except at 6, 11, 15 and 18 years of age. Nevertheless, it indicates that income of the household is important in controlling height and sitting height in the present population especially in the case of boys.

Biacromial and Biiliac Diameters

Tables 5.15 and 5.16 show the means and standard deviations of biacromial diameter according to income groups for boys and girls, respectively. With the exception of few cases, the mean biacromial diameter in boys is higher in HIG when compared with the LIG and MIG, and it is statistically significant in many age groups. On the other hand, the ANCOVA test indicates that the differences between income groups for girls after adjusting for the effect of religion are significant only at 3, 5, 6, 14 and 16 years of age. This indicates that income of the household does not play significant role in patterning the growth of biacromial diameter in girls, although it is to a certain extent important in the case of boys. A similar trend is observed with respect to biiliac diameter (Tables 5.17 and 5.18). The Tables show that there is not much difference between income groups for girls, but the differences are significant in many age groups for boys.

Table 5.15. Biaromial diameter of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	19.48	1.27	19.97	0.96	20.06	1.36	2.52	0.090
4	20.60	1.47	20.49	1.56	20.75	1.98	0.19	0.830
5	21.13	0.95	21.94	2.02	22.29	1.11	4.15	0.002*
6	22.20	1.37	23.19	1.22	23.86	1.24	12.03	0.000*
7	23.01	1.32	23.46	1.65	23.41	1.49	1.89	0.160
8	24.07	1.30	24.34	1.76	24.89	2.19	1.30	0.280
9	24.41	1.65	25.16	1.49	26.97	1.17	25.19	0.000*
10	25.68	2.46	26.35	2.26	27.62	2.12	4.43	0.020*
11	26.48	2.36	27.31	2.28	28.78	2.21	7.31	0.001*
12	27.95	1.55	28.24	1.94	29.37	1.76	1.97	0.150
13	29.31	2.07	30.51	1.79	30.82	1.52	5.74	0.005*
14	30.29	1.89	31.18	1.11	31.11	1.40	5.15	0.008*
15	31.37	1.65	31.68	1.36	32.61	2.33	2.19	0.120
16	31.75	1.22	32.22	1.37	33.28	2.49	4.87	0.010*
17	32.71	1.83	32.93	1.55	33.09	2.04	0.66	0.520
18	33.45	1.66	33.48	1.95	34.62	1.70	2.21	0.120

*Significant

Table 5.16. Biaromial diameter of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	19.41	1.15	19.67	1.67	19.60	1.66	0.53	0.05*
4	20.34	1.76	20.10	1.78	20.86	1.90	1.18	0.31
5	21.64	1.11	22.31	1.72	22.72	1.65	3.35	0.04*
6	22.66	1.85	21.96	1.65	23.55	2.07	4.35	0.02*
7	23.20	1.84	23.47	1.65	23.56	1.99	0.36	0.70
8	23.97	1.73	24.43	1.76	24.88	2.15	1.38	0.26
9	25.76	1.61	25.47	1.86	26.34	1.50	1.21	0.31
10	26.16	2.02	26.03	2.43	27.13	1.60	2.29	0.11
11	26.87	1.91	27.02	1.91	27.68	2.22	1.23	0.30
12	29.44	2.24	29.08	1.91	29.69	2.08	0.30	0.74
13	29.96	1.74	30.31	1.62	29.56	2.23	1.24	0.30
14	30.05	2.03	31.30	1.48	31.85	1.81	7.23	0.00*
15	31.30	1.61	31.77	1.29	31.66	1.21	0.92	0.40
16	31.83	1.25	31.71	1.55	32.82	1.33	3.86	0.03*
17	32.40	1.75	32.10	1.65	33.17	1.00	1.64	0.21
18	32.38	1.30	32.42	1.33	33.23	1.34	1:74	0.18

*Significant

Table 5.17. Biiliac diameter of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	15.25	1.23	15.57	0.94	16.11	0.89	3.40	0.040*
4	16.00	1.06	16.15	1.23	16.68	1.58	1.67	0.190
5	16.54	0.94	16.75	1.22	17.10	0.93	1.44	0.240
6	17.36	1.23	17.58	1.08	18.42	0.99	5.98	0.004*
7	17.93	1.23	18.00	1.54	18.39	1.08	2.49	0.090
8	18.71	1.01	18.95	1.20	19.17	1.61	0.98	0.410
9	18.75	1.19	19.56	1.54	20.68	1.16	17.38	0.000*
10	19.67	2.13	20.31	1.33	21.07	1.57	4.12	0.020*
11	20.40	1.62	20.75	1.52	22.10	2.06	7.26	0.000*
12	21.90	1.63	21.76	1.97	23.36	2.48	2.30	0.190
13	22.85	2.25	23.28	1.99	23.89	2.51	1.62	0.200
14	23.40	2.22	23.63	2.01	24.65	2.17	1.77	0.180
15	23.91	2.01	24.16	2.18	24.49	1.66	0.33	0.720
16	24.11	1.74	24.36	1.58	25.65	2.26	3.51	0.040*
17	25.04	1.63	24.90	1.64	25.63	1.58	0.46	0.630
18	26.35	1.71	25.71	1.55	27.04	1.95	2.97	0.050*

*Significant

Table 5.18. Biiliac diameter of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	15.25	0.96	15.57	0.95	15.68	0.84	1.99	0.08
4	15.85	1.05	16.05	1.50	16.38	1.01	1.35	0.27
5	16.98	1.18	17.09	1,22	17.20	0.92	0.26	0.77
6	17.47	1.15	17.05	1.32	18.06	2.01	2.82	0.07
7	18.21	1.62	18.07	1.07	18.32	1..67	0.15	0.86
8	18.74	1.33	18.32	1.58	19.44	181	3.61	0.03*
9	19.86	1.55	19.37	1.42	20.38	1.31	2.23	0.11
10	20.12	1.80	20.11	1.55	20.91	1.54	1.68	0.19
11	20.72	1.91	20.57	1.89	20.81	1.59	0.30	0.75
12	22.97	2.52	22.42	2.23	23.03	1.73	0.32	0.73
13	23.35	2.35	23.14	1.87	23.25	2.46	0.24	0.78
14	23.54	2.31	24.54	1.98	24.93	2.22	3.03	0.05*
15	24.17	2.08	24.57	1.94	24.54	1.98	0.34	0.72
16	24.68	1.83	24.76	1.67	26.35	2.35	5.44	0.01*
17	24.59	1.92	24.62	1.64	26.23	1.66	4.17	0.02*
18	25.62	1.75	25.17	2.19	26.29	1.07	1.40	0.25

*Significant

Head, Arm and Chest Circumferences

Tables 5.19 and 5.20 show the means and standard deviations of head circumference according to income groups for boys and girls, respectively. The ANCOVA test indicates that the differences between income groups are significant only at the ages of 3, 5, 9, 10 and 16 years of age in boys and at 6, 10, 14 and 17 in girls.

The means and standard deviations of mid upper arm circumference according to income groups for boys and girls are shown in Tables 5.21 and 5.22, respectively. It is observed that the mean upper arm circumferences are higher in the HIG when compared with the LIG and HIG, and the differences are significant in many age groups for boys. In the case of girls, the ANCOVA test indicates that the differences are significant only at the age of 10,12 and 14 years of age. Nevertheless, it indicates that income of the household is an important factor influencing the arm circumferences of children in this population, especially in boys.

With respect to chest circumference, Tables 5.23 and 5.24 show that the differences between income groups are significant in many age groups for boys. In the case of girls, the differences are found to be significant only in six age groups, i.e., at 6, 8,10,14, 16 and 17 years of age. Like in the case of mid upper arm circumference, the influence of income seems to be more important in boys as compared to girls.

Table 5.19. Head circumference of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	46.88	1.74	47.88	1.13	47.01	1.95	3.44	0.040*
4	47.53	1.78	47.65	2.06	48.44	1.51	1.63	0.200
5	47.33	1.58	48.16	1.70	48.16	1.13	3.19	0.040*
6	48.20	1.60	48.67	1.28	48.67	1.25	2.20	0.120
7	48.97	1.69	49.06	1.68	49.24	1.64	0.67	0.510
8	49.27	1.72	49.63	1.49	49.61	1.28	0.62	0.540
9	49.88	1.59	49.88	1.57	50.69	1.06	3.12	0.050*
10	49.91	1.39	50.96	1.13	51.05	1.43	6.79	0.002*
11	50.03	2.04	50.20	1.43	51.00	1.53	2.49	0.090
12	51.03	1.37	51.50	2.16	51.08	0.61	1.12	0.330
13	51.57	1.48	51.88	1.47	51.92	1.54	0.46	0.630
14	51.69	1.44	52.09	1.15	52.45	1.40	2.01	0.140
15	51.97	1.35	52.57	1.27	52.73	1.54	2.41	0.100
16	52.26	1.62	53.18	1.25	53.76	1.20	6.84	0.002*
17	53.54	1.47	53.52	1.28	54.36	1.53	1.43	0.250
18	53.63	1.61	54.16	1.51	54.44	1.39	1.45	0.240

*Significant

Table 5.20. Head circumference of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	46.79	1.57	46.25	2.89	47.31	1.23	1.72	0.29
4	47.32	1.76	47.13	1.55	47.37	1.85	0.11	0.90
5	47.87	1.75	48.37	1.59	48.01	1.51	1.16	0.32
6	48.78	1.31	48.23	2.21	49.42	1.34	3.40	0.04*
7	49.20	1.22	49.40	1.16	49.28	1.21	0.31	0.73
8	49.47	1.26	49.11	1.46	49.69	1.26	1.37	0.26
9	49.82	1.22	49.91	1.44	50.16	1.21	0.39	0.68
10	49.54	1.64	49.44	1.58	50.53	1.13	3.53	0.03*
11	49.93	1.45	50.32	1.36	50.46	1.32	1.10	0.34
12	51.49	2.46	50.47	1.59	51.27	1.58	1.95	0.15
13	51.22	0.93	51.46	1.14	51.80	1.24	2.07	0.13
14	51.44	1.49	52.02	1.23	52.44	1.17	3.76	0.03*
15	52.31	1.28	52.64	1.17	52.59	1.57	0.60	0.55
16	52.81	1.29	52.84	1.48	53.00	1.07	0.27	0.76
17	52.40	1.56	52.98	1.79	53.93	1.27	3.63	0.03*
18	52.87	1.46	53.46	1.46	53.72	1.92	1.56	0.22

*Significant

Table 5.21. Upper arm circumference of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	13.39	1.06	13.96	0.93	14.04	1.29	3.11	0.050*
4	14.05	0.96	14.07	1.02	14.13	1.26	0.22	0.800
5	14.20	1.24	14.80	1.30	15.07	0.92	3.46	0.040*
6	14.96	1.35	15.34	1.08	15.49	1.03	1.94	0.150
7	15.54	1.22	15.40	1.00	15.66	1.14	1.83	0.170
8	15.70	1.35	15.87	1.06	15.79	1.12	0.15	0.860
9	15.86	1.01	16.24	1.25	16.78	1.23	5.44	0.006*
10	16.38	1.50	17.06	1.06	17.23	1.41	2.92	0.050*
11	16.71	1.39	17.64	0.87	18.31	1.21	14.68	0.000*
12	17.10	1.20	17.60	1.01	18.03	0.50	3.50	0.040*
13	18.27	1.15	18.66	1.31	19.00	1.22	2.28	0.110
14	18.66	1.25	19.22	1.26	19.38	1.21	4.03	0.020*
15	19.65	1.39	20.20	1.34	20.40	1.11	2.42	0.100
16	20.05	1.53	20.61	1.40	21.11	1.27	3.51	0.040*
17	21.24	1.24	21.36	1.67	22.18	1.96	1.09	0.340
18	21.80	1.58	22.16	1.14	22.76	1.44	2.23	0.120

*Significant

Table 5.22. Upper arm circumference of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	13.38	0.96	13.70	0.85	13.76	1.02	1.68	0.23
4	14.15	1.32	13.86	0.97	14.10	1.31	1.66	0.20
5	14.50	1.09	14.82	1.02	15.31	0.95	1.20	0.31
6	14.94	1.28	14.79	1.18	14.85	1.24	0.01	0.99
7	15.41	1.38	15.19	1.19	15.37	1.26	0.30	0.74
8	15.99	1.28	15.66	1.03	15.88	1.21	0.47	0.58
9	16.34	1.27	16.18	1.31	16.62	1.63	0.37	0.69
10	16.37	1.11	17.00	1.08	17.29	1.48	4.36	0.02*
11	16.97	1.59	17.45	1.35	17.66	0.95	2.01	0.14
12	16.53	1.01	17.55	1.59	18.32	0.97	3.94	0.02*
13	18.52	1.35	18.63	1.35	18.85	1.00	0.72	0.49
14	18.35	1.39	19.70	1.50	19.28	1.21	7.89	0.01*
15	19.43	1.57	19.99	1.44	20.18	1.35	1.50	0.23
16	20.56	1.18	20.27	1.57	21.07	1.26	1.41	0.25
17	20.66	1.81	20.85	1.51	21.47	1.33	1.04	0.36
18	20.70	1.31	21.11	1.23	21.48	1.51	1.87	0.16

*Significant

Table 5.23. Chest circumference of boys according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	51.00	4.40	51.94	3.26	52.78	4.66	0.86	0.430
4	54.16	4.20	55.95	5.30	56.88	4.15	1.61	0.190
5	54.57	3.25	55.48	4.16	56.87	3.30	2.12	0.130
6	56.36	4.75	57.52	5.24	56.62	3.20	0.62	0.540
7	58.71	4.69	59.10	4.43	57.62	5.74	0.27	0.770
8	59.16	4.51	61.29	5.03	62.29	6.46	3.64	0.030*
9	60.40	3.98	63.09	4.71	64.56	3.98	8.86	0.000*
10	62.57	5.57	64.31	5.36	67.53	6.26	4.85	0.010*
11	65.42	5.33	67.23	2.97	69.68	5.29	6.70	0.002*
12	67.34	4.35	68.78	4.92	73.47	5.51	5.44	0.006*
13	71.73	5.14	72.98	6.50	76.19	4.17	4.77	0.010*
14	74.94	5.92	74.76	4.80	77.85	5.12	1.28	0.280
15	76.39	4.25	78.98	5.05	79.89	3.02	4.71	0.010*
16	77.56	4.26	80.20	4.60	82.66	5.56	6.58	0.002*
17	82.93	5.09	83.67	4.83	83.40	5.21	0.41	0.670
18	84.95	6.00	85.34	5.38	88.74	5.18	2.21	0.120

*Significant

Table 5.24. Chest circumference of girls according to income groups

Age (yrs)	Low Income Group (LIG)		Middle Income Group (MIG)		High Income Group (HIG)		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	50.53	4.55	51.06	4.85	52.58	3.71	1.68	0.32
4	53.35	4.80	52.24	3.92	54.60	4.24	1.66	0.32
5	54.49	4.01	55.50	4.46	56.14	4.06	1.20	0.31
6	56.70	3.94	57.46	5.80	60.40	5.44	4.87	0.01*
7	57.90	4.09	59.37	5.00	60.32	5.28	2.70	0.07
8	58.97	3.94	58.07	6.23	62.28	5.31	4.57	0.01*
9	63.56	6.22	61.48	5.74	63.86	4.10	1.01	0.37
10	62.04	5.00	64.22	5.41	66.58	5.44	4.42	0.02*
11	65.42	5.90	65.48	4.71	68.21	5.00	2.20	0.12
12	70.33	6.79	69.36	5.95	69.77	4.96	0.08	0.92
13	70.14	3.64	71.73	5.68	71.81	4.49	1.30	0.27
14	72.04	5.08	75.38	4.98	76.74	4.38	6.53	0.01*
15	75.19	5.67	76.03	4.80	78.86	4.44	2.55	0.08
16	78.65	4.03	77.07	4.88	80.97	4.48	3.80	0.03*
17	78.07	3.58	79.48	4.24	83.00	3.50	6.48	0.01*
18	78.83	4.17	80.80	5.45	81.57	4.95	2.44	0.09

*Significant

RELIGION

The effect of religion on growth pattern of the children in the present study may be briefly described as follows:

Weight: Tables 5.25 and 5.26 shows the means and standard deviations of body weight for boys and girls, respectively. The Tables show that with the exception of few cases, the Muslim boys and girls are heavier than their counterparts belonging to the other religious groups, viz., the Niam Khasis and Christians. The ANCOVA test also indicates that the differences between religious groups after adjusting for income of the household are significant in many age groups.

Height and Sitting Height: Like in the case of body weight, the Khasi Muslim children are taller than the Christian and Niam Khasi children (Tables 5.27 and 5.28). The ANCOVA test indicates that the differences between religious groups are significant in many age groups. Thus, it indicates that religion also plays and important role in influencing body weight and height of the children in the present study. With respect to sitting height, Tables 5.29 and 5.30 show that, like in the case of height, the Muslim boys and girls are also higher in mean values of sitting height as compared with the Christian and Niam Khasi boys and girls across ages. It is found that the differences between religious groups after allowing for income are significant for many age groups.

Table 5.25. Mean weight of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	12.12	1.89	12.35	1.64	11.38	1.85	2.02	0.140
4	14.58	1.93	13.98	2.36	13.56	1.84	1.69	0.190
5	17.13	1.57	16.11	2.10	15.50	1.56	7.18	0.001*
6	17.87	0.92	16.73	2.60	16.92	1.26	3.52	0.030*
7	19.17	2.12	17.92	2.03	17.53	2.33	6.22	0.003*
8	22.28	3.33	20.55	2.54	19.89	2.37	8.02	0.001*
9	25.39	3.21	22.47	2.25	22.10	2.27	19.65	0.000*
10	26.79	3.24	25.02	2.58	22.66	3.33	12.47	0.000*
11	28.57	3.57	26.63	3.70	26.17	3.62	5.78	0.008*
12	30.43	2.83	28.17	3.20	28.51	3.27	3.07	0.050*
13	35.38	4.49	33.45	3.18	33.66	4.45	1.78	0.180
14	39.32	3.31	37.05	3.72	36.23	4.22	4.88	0.010*
15	44.33	3.92	40.74	4.09	40.81	4.19	7.51	0.001*
16	44.41	4.34	43.04	3.65	42.76	5.48	1.39	0.260
17	49.56	2.24	46.69	3.35	47.36	4.15	3.33	0.040*
18	50.21	2.92	48.36	3.32	48.63	5.02	1.32	0.270

* Significant

Table 5.26. Mean weight of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	11.96	1.74	12.89	2.20	11.50	1.38	3.81	0.030*
4	14.13	2.16	14.12	2.08	13.51	1.93	1.56	0.220
5	16.04	1.96	15.38	1.91	15.76	1.68	1.73	0.180
6	19.17	2.40	17.45	2.30	16.84	2.03	11.00	0.000*
7	19.68	2.25	18.69	2.46	18.01	1.15	5.46	0.006*
8	22.34	2.58	19.47	2.02	19.95	2.04	14.85	0.000*
9	25.06	2.89	21.18	2.90	22.12	2.67	18.20	0.000*
10	26.05	3.21	24.14	3.45	24.32	3.80	3.72	0.030*
11	29.11	2.39	27.22	2.61	25.42	2.77	12.21	0.000*
12	32.48	2.73	30.97	3.64	29.71	3.28	4.41	0.020*
13	34.38	4.31	33.96	4.66	31.66	4.38	3.96	0.020*
14	38.12	5.34	37.53	4.32	36.47	5.45	0.67	0.510
15	42.40	4.03	40.93	2.82	40.29	4.56	2.10	0.130
16	44.80	3.18	42.77	2.86	42.44	4.66	4.01	0.020*
17	44.32	5.13	44.88	3.16	44.21	4.80	0.04	0.960
18	44.20	4.70	44.81	4.25	44.17	5.86	0.08	0.920

* Significant

Table 5.27. Mean height of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	84.72	3.52	86.65	5.80	87.44	5.62	2.57	0.080
4	92.72	6.28	91.70	5.00	92.99	4.37	1.14	0.330
5	99.96	5.20	96.47	7.02	98.11	6.13	4.12	0.002*
6	105.20	6.29	101.00	7.47	103.97	7.62	8.43	0.000*
7	110.30	6.91	108.49	6.37	107.71	5.95	3.85	0.030*
8	116.44	7.07	113.31	7.51	112.40	7.17	5.54	0.006*
9	122.74	4.25	119.02	6.42	117.26	6.83	9.99	0.000*
10	125.57	6.71	124.13	5.66	119.58	7.75	5.63	0.005*
11	129.02	5.07	126.85	5.48	123.38	6.94	7.35	0.001*
12	130.00	7.70	130.03	4.50	128.04	6.85	0.85	0.430
13	137.12	5.51	137.41	4.82	136.39	5.17	0.50	0.950
14	142.74	5.72	139.97	5.15	139.85	5.77	2.47	0.090
15	148.69	8.70	142.21	4.97	143.25	4.86	8.99	0.000*
16	149.99	7.10	145.00	7.22	146.05	4.60	6.45	0.003*
17	154.44	6.39	149.40	6.58	148.84	3.44	7.21	0.000*
18	157.48	6.32	154.05	6.73	153.64	4.66	2.76	0.070

* Significant

Table 5.28. Mean height of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	86.18	4.89	86.43	4.96	86.56	4.84	0.33	0.720
4	91.84	4.71	89.62	6.46	90.99	5.18	2.27	0.110
5	99.61	4.55	95.27	7.14	96.96	4.54	5.18	0.008*
6	106.19	7.04	102.61	5.35	101.98	5.74	5.26	0.007*
7	110.66	8.64	108.07	5.31	107.77	6.84	3.24	0.040*
8	117.23	6.93	112.62	5.73	113.53	7.72	6.47	0.002*
9	121.56	6.32	117.82	5.47	117.58	8.15	3.88	0.030*
10	126.09	6.39	122.99	6.30	119.86	7.09	6.23	0.003*
11	128.37	3.63	126.97	6.18	124.14	6.36	4.66	0.010*
12	137.10	6.53	136.47	6.94	132.51	6.17	4.34	0.020*
13	139.81	5.87	137.86	5.04	136.46	6.12	2.62	0.080
14	144.50	5.87	141.24	6.63	141.35	6.19	2.60	0.080
15	145.79	4.72	142.71	4.54	143.00	5.98	3.63	0.030*
16	146.99	3.41	145.24	5.09	145.59	6.35	1.69	0.190
17	147.96	6.99	146.76	6.44	146.44	6.48	1.02	0.370
18	148.19	5.72	146.82	7.61	146.87	6.42	0.75	0.480

*Significant

Table 5.29. Mean sitting height of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	45.51	3.45	46.08	5.37	45.60	2.16	0.15	0.860
4	50.54	3.47	47.87	4.94	49.12	3.90	2.79	0.070
5	53.77	5.09	49.84	5.36	50.31	3.98	5.25	0.007*
6	58.75	6.86	54.33	4.15	52.96	5.30	10.98	0.000*
7	58.66	3.91	54.92	4.34	53.75	3.89	13.95	0.000*
8	61.99	4.09	59.04	3.86	57.76	4.42	8.17	0.001*
9	65.24	3.76	62.12	3.72	59.44	5.51	15.39	0.000*
10	65.29	3.68	64.18	3.53	61.14	4.70	7.79	0.001*
11	66.90	3.60	66.21	4.31	61.56	5.48	11.52	0.000*
12	68.58	5.76	67.58	3.20	65.04	4.81	4.23	0.020*
13	70.77	4.55	72.06	3.53	70.70	4.58	0.51	0.610
14	75.13	2.94	73.35	3.52	72.27	4.31	3.88	0.030*
15	78.92	4.73	76.52	2.90	74.06	4.35	9.54	0.000*
16	78.83	4.17	77.01	3.79	76.13	3.67	4.34	0.020*
17	81.51	2.19	79.82	3.50	77.83	3.96	7.57	0.001*
18	83.17	2.67	80.99	3.47	78.69	4.02	9.22	0.000*

* Significant

Table 5.30. Mean sitting height of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	46.68	2.68	47.03	3.82	46.77	2.45	0.03	0.970
4	49.91	3.80	47.40	4.47	47.27	3.77	1.09	0.340
5	55.57	3.00	51.56	4.88	51.96	3.62	8.85	0.000*
6	58.67	4.64	53.52	4.78	52.28	4.28	17.84	0.000*
7	58.51	4.30	56.46	3.83	56.21	4.55	3.79	0.030*
8	61.14	6.03	57.72	3.84	58.46	4.86	3.56	0.030*
9	64.18	3.27	61.69	3.27	60.65	4.59	6.42	0.003*
10	66.67	2.94	64.48	3.74	61.19	5.69	9.95	0.000*
11	65.79	3.42	67.75	4.62	62.97	4.24	9.87	0.000*
12	72.53	3.29	70.45	4.19	68.05	4.42	8.32	0.001*
13	73.02	4.26	72.41	3.83	68.86	5.14	7.54	0.001*
14	74.98	3.91	75.04	3.14	73.06	4.94	2.00	0.140
15	77.38	3.15	77.41	2.06	74.64	4.14	6.13	0.003*
16	78.98	2.69	77.71	2.65	75.59	3.55	9.27	0.000*
17	78.59	4.62	79.21	3.67	77.56	4.29	0.95	0.390
18	78.78	3.38	79.21	3.74	78.10	3.57	0.85	0.430

* Significant

Biacromial and bi-iliac diameter: The means and standard deviations of biacromial diameter according to religious groups are given in Tables 5.31 and 5.32 for boys and girls, respectively, while those for bi-iliac diameter are presented in Tables 5.33 and 5.34, respectively. It is seen from Table 5.31 the Muslim boys have broader shoulder than the Christian and Niam Khasi boys, especially from 14 years onwards. In the case of girls, Table 5.32 also shows the higher mean values in the Muslims, although they are surpassed by the Christian girls especially from 7 to 8 and 12 to 13 years of age.

With respect to bi-iliac diameter, Tables 5.33 and 5.34 show that, like in the case of other measurements, the Muslim children have a significant broader hip when compared to the Christian and Niam Khasi children.

Table 5.31. Biacromial diameter of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	19.38	1.31	19.88	1.21	19.82	1.10	1.32	0.270
4	20.72	1.29	20.63	1.72	20.47	1.63	0.16	0.850
5	21.70	1.74	21.94	1.34	21.41	1.58	0.47	0.630
6	22.67	1.33	22.97	1.39	22.88	1.63	0.15	0.870
7	23.61	1.69	23.49	1.09	22.87	1.63	3.16	0.050*
8	23.67	2.08	24.85	1.43	24.29	1.61	2.13	0.130
9	25.28	1.19	25.96	1.84	25.09	2.02	1.06	0.350
10	26.69	2.79	27.12	1.91	25.48	2.32	3.52	0.030*
11	27.83	1.79	27.68	2.46	26.78	2.80	1.47	0.240
12	28.93	1.70	28.12	1.63	27.83	1.81	2.30	0.110
13	29.86	1.82	30.53	1.56	29.96	2.27	0.65	0.520
14	31.32	1.35	31.10	1.33	30.27	1.71	3.65	0.030*
15	33.00	1.89	31.41	1.44	31.14	1.46	10.48	0.000*
16	32.82	1.98	32.10	1.24	31.87	1.44	3.51	0.040*
17	34.31	2.05	32.43	1.41	32.53	1.30	8.83	0.000*
18	34.57	1.73	33.28	1.37	33.62	2.15	3.08	0.050*

* Significant

Table 5.32. Biacromial diameter of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	19.44	1.24	19.88	0.95	19.35	1.54	1.42	0.250
4	20.76	1.85	20.18	2.03	20.35	1.61	1.09	0.340
5	22.08	1.35	22.15	1.74	22.06	1.48	0.06	0.940
6	22.78	1.68	22.91	1.61	22.51	2.41	0.31	0.740
7	22.96	1.86	24.07	1.94	23.09	1.53	3.25	0.040*
8	24.14	2.06	24.88	1.49	24.20	2.00	1.26	0.290
9	26.23	1.28	26.02	1.67	25.12	1.89	3.66	0.030*
10	26.84	1.99	26.17	2.01	26.35	2.42	1.06	0.350
11	27.72	1.88	27.30	2.16	26.41	1.62	3.29	0.040*
12	29.77	1.45	30.01	1.90	28.53	2.27	4.96	0.009*
13	30.23	1.22	30.46	1.69	29.42	2.14	3.22	0.050*
14	30.97	1.81	31.21	1.94	30.68	1.99	0.31	0.740
15	31.90	1.35	31.64	1.29	31.34	1.49	1.08	0.340
16	32.07	1.55	32.28	0.97	31.72	1.74	0.86	0.430
17	33.04	1.92	32.50	1.12	31.93	1.72	2.94	0.060
18	32.31	1.08	32.85	1.38	32.36	1.42	1.16	0.320

* Significant

Table 5.33. Biiliac diameter of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	15.23	1.42	15.84	0.88	15.32	1.07	2.15	0.120
4	16.21	1.03	16.25	1.35	16.06	1.25	1.11	0.890
5	16.90	1.21	16.64	0.76	16.68	1.19	0.65	0.520
6	17.74	0.81	17.65	1.23	17.62	1.41	0.54	0.590
7	18.63	1.54	17.90	1.24	17.78	1.18	5.47	0.006*
8	18.69	1.35	19.20	1.24	18.75	1.23	1.02	0.370
9	19.71	1.44	19.64	1.39	19.48	1.67	0.84	0.440
10	20.22	1.96	20.66	1.76	19.82	1.81	1.21	0.300
11	21.09	1.65	21.19	1.75	20.72	2.08	0.33	0.720
12	22.49	2.14	21.78	1.69	21.89	1.93	0.78	0.460
13	23.21	2.07	23.16	2.08	23.46	2.57	0.40	0.670
14	24.30	2.09	23.73	2.17	23.46	2.19	0.93	0.400
15	25.07	2.03	23.76	1.77	23.81	2.05	3.47	0.040*
16	25.41	1.95	23.42	2.16	24.60	1.73	12.00	0.000*
17	25.97	2.04	24.78	1.16	24.78	1.58	3.53	0.040*
18	27.15	1.55	25.75	1.79	26.07	1.66	3.89	0.030*

* Significant

Table 5.34. Biiliac diameter of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	15.37	1.00	15.73	0.85	15.33	1.07	1.18	0.310
4	16.14	1.17	16.03	1.21	16.07	1.30	0.29	0.750
5	17.43	1.05	16.72	1.34	17.11	0.94	2.88	0.060
6	17.76	1.45	17.52	1.45	17.35	1.64	0.69	0.510
7	17.84	1.45	18.56	1.66	18.14	1.29	1.73	0.180
8	18.17	1.98	18.95	1.50	18.47	1.48	0.87	0.430
9	20.75	1.24	19.69	1.28	19.04	1.45	11.85	0.000*
10	21.00	1.50	19.93	1.50	20.20	1.77	3.77	0.030*
11	21.42	1.54	20.63	1.40	20.19	1.63	3.79	0.030*
12	23.23	1.60	23.31	2.20	21.96	2.29	3.89	0.020*
13	23.89	2.31	23.49	2.06	22.57	2.07	2.80	0.070
14	24.12	2.02	24.36	2.38	24.21	2.27	0.05	0.950
15	24.91	2.01	24.05	2.08	24.39	1.85	1.38	0.260
16	25.00	2.08	25.22	2.02	25.06	1.95	0.01	0.990
17	25.27	2.37	24.93	1.65	24.60	1.64	1.01	0.370
18	25.68	1.92	25.40	1.81	25.49	2.00	0.15	0.860

- Significant

Head, Arm and Chest circumferences: The means and standard deviations of head circumference according to religious groups for boys and girls are shown in Tables 5.35 and 5.36, respectively. It is seen that in the case of boys there is no significant difference between religious groups in respect of head circumference, except at the ages of 6 and 10 years, which is significantly higher in the Muslim and Christian boys, respectively. In the case of girls, the Christians are significantly higher than the other two religious groups at 6, 7, 13, 17 and 18 years of age. Thus, unlike in the case of other measurements, the Christian girls seem to be higher in head circumference when compared with the Muslim and Niam Khasi girls.

With respect to mid upper arm circumference, Table 5.37 shows that with the exception of few cases, the Muslim boys are significantly higher than the Christian and Niam Khasi boys in many age groups. The same is true in the case of girls (Table 5.38). Thus, it indicates that there are significant differences between religious groups in respect of mid upper arm circumference. However, it may be noted that such differences are mainly due to the differences between the Muslim and other religious groups.

The same trend is observed with respect to chest circumference, which indicates that the Muslim boys and girls are significantly higher in mean values for many age groups (Tables 5.39 and 5.40).

Table 5.35. Head circumference of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	47.29	1.64	47.80	1.27	46.68	1.81	3.78	0.130
4	47.99	1.54	48.04	2.05	47.29	1.78	1.37	0.260
5	48.13	0.96	47.80	1.90	47.66	1.70	0.82	0.440
6	49.10	0.99	48.47	1.49	48.08	1.58	4.24	0.001*
7	49.42	1.16	49.11	1.97	48.76	1.64	1.64	0.200
8	49.47	1.54	49.91	1.56	49.10	1.48	2.08	0.130
9	49.93	1.26	50.46	1.57	49.98	1.52	0.69	0.500
10	50.59	1.28	51.06	1.21	50.05	1.54	3.75	0.030*
11	50.62	1.40	50.70	1.42	49.85	2.17	1.84	0.170
12	51.31	1.02	51.30	1.40	51.17	2.18	0.44	0.960
13	51.65	1.64	52.09	1.71	51.56	1.11	0.94	0.390
14	51.97	1.08	52.30	1.33	51.81	1.49	0.78	0.460
15	52.67	1.27	52.51	1.51	51.97	1.29	1.61	0.210
16	52.93	0.90	53.30	1.60	52.58	1.69	1.18	0.310
17	53.73	1.29	54.02	1.52	53.34	1.29	1.74	0.180
18	53.94	1.40	54.49	1.48	53.72	1.64	1.55	0.220

*Significant

Table 5.36. Head circumference of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	46.36	2.57	47.25	1.65	46.44	2.24	1.41	0.250
4	47.86	1.45	47.37	1.80	46.78	1.66	2.08	0.050*
5	48.57	1.86	48.10	1.68	47.77	1.41	1.83	0.170
6	48.93	1.15	49.35	1.44	48.20	1.97	4.07	0.020*
7	49.41	1.07	49.67	0.96	48.87	1.28	4.34	0.020*
8	49.48	1.22	49.56	1.52	49.09	1.31	1.09	0.340
9	49.85	0.84	50.31	1.32	49.61	1.53	2.24	0.120
10	50.20	1.16	49.67	1.88	49.49	1.43	1.90	0.160
11	50.59	1.21	50.10	1.56	49.99	1.29	1.46	0.240
12	51.34	2.44	51.24	1.73	50.56	1.61	1.49	0.230
13	51.54	1.24	51.78	1.18	51.08	0.83	3.11	0.050*
14	51.66	1.29	52.34	1.32	51.69	1.41	1.96	0.150
15	52.31	1.23	52.71	1.22	52.43	1.38	0.67	0.520
16	52.75	1.08	53.36	1.40	52.60	1.37	2.52	0.090
17	51.93	1.57	53.74	1.39	52.82	1.71	5.51	0.006*
18	52.30	1.38	54.10	1.54	53.15	1.56	7.90	0.001*

*Significant

Table 5.37. Upper arm circumference of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	13.77	0.87	14.13	0.98	13.20	1.14	6.04	0.004*
4	14.35	1.11	14.37	0.94	13.65	0.92	5.28	0.007*
5	15.07	1.48	14.53	0.95	14.34	1.26	3.09	0.050*
6	15.73	0.10	15.11	1.25	14.89	1.34	4.38	0.002*
7	16.18	1.12	15.31	1.00	15.20	1.00	8.97	0.000*
8	15.67	1.75	16.00	0.85	15.65	1.11	0.69	0.510
9	16.42	1.41	16.48	1.15	15.99	1.09	1.52	0.220
10	17.48	1.24	16.86	1.13	16.26	1.50	5.42	0.006*
11	17.94	1.04	17.74	1.21	16.82	1.49	7.00	0.002*
12	18.08	0.73	17.22	1.19	17.10	1.08	5.57	0.005*
13	18.86	1.04	18.66	1.13	18.40	1.45	0.64	0.530
14	19.62	0.73	19.20	1.06	18.55	1.50	5.38	0.006*
15	20.60	1.29	20.08	1.06	19.55	1.47	4.02	0.020*
16	21.03	1.12	20.82	0.95	19.84	1.74	6.31	0.003*
17	22.41	1.29	21.28	1.36	21.09	1.78	1.74	0.180
18	22.73	1.28	22.03	1.10	21.99	1.60	1.98	0.150

* Significant

Table 5.38. Upper arm circumference of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	13.89	0.78	13.90	0.78	13.12	0.99	9.54	0.000*
4	14.57	1.30	14.14	1.04	13.60	1.11	5.05	0.009*
5	14.95	0.78	14.94	1.05	14.48	1.21	2.42	0.090
6	15.49	1.55	14.88	0.61	14.37	1.18	6.59	0.002*
7	15.59	1.55	15.38	112	15.11	1.20	1.04	0.360
8	16.65	1.22	15.62	1.06	15.39	0.85	10.45	0.000*
9	16.89	1.38	16.41	1.27	15.78	1.25	5.13	0.008*
10	17.10	1.06	17.21	1.42	15.40	1.05	3.56	0.030*
11	17.75	1.39	17.57	1.35	16.68	1.33	5.09	0.008*
12	18.35	0.99	18.36	1.00	17.60	1.65	3.48	0.040*
13	18.88	1.43	19.01	0.94	18.16	1.30	4.22	0.020*
14	19.14	1.45	19.25	1.35	18.91	1.69	0.23	0.800
15	20.51	1.17	20.03	1.57	19.18	1.69	6.47	0.002*
16	21.20	1.07	20.85	1.13	19.85	1.56	8.28	0.001*
17	20.95	1.64	21.47	0.91	20.38	1.86	3.19	0.050*
18	20.85	1.26	21.43	0.95	20.69	1.50	2.42	0.100

* Significant

Table 5.39. Chest circumference of boys according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	52.02	3.05	53.89	4.22	49.06	3.00	14.93	0.000*
4	54.69	3.83	57.00	5.20	52.29	3.42	10.59	0.000*
5	55.57	2.89	56.38	4.62	54.37	3.17	1.86	0.160
6	57.80	3.47	57.10	5.31	55.67	4.39	1.62	0.200
7	59.74	3.82	60.10	5.00	56.54	4.58	56.52	0.006*
8	62.13	4.95	61.96	5.04	58.66	5.17	4.95	0.009*
9	63.81	4.51	63.53	4.84	60.90	3.87	4.83	0.010*
10	66.50	6.29	66.25	4.55	61.14	5.55	8.66	0.000*
11	69.51	3.54	67.88	5.03	64.84	4.96	7.84	0.001*
12	72.33	4.36	67.86	4.98	66.78	4.15	9.75	0.000*
13	73.35	4.83	74.43	5.27	72.57	6.37	0.39	0.680
14	77.14	4.96	76.68	5.96	73.57	5.16	3.55	0.030*
15	79.41	3.70	78.83	5.00	76.43	4.36	2.96	0.260
16	80.49	5.22	79.68	4.24	78.74	5.20	1.20	0.310
17	84.98	2.91	83.39	5.15	82.68	5.42	1.17	0.320
18	88.44	5.03	85.76	5.38	84.74	5.42	2.45	0.090

- Significant

Table 5.40. Chest circumference of girls according to religious groups

Age (yrs)	Muslims		Christians		Niam Khasis		ANCOVA-Statistics	
	Mean	SD	Mean	SD	Mean	SD	F-ratio	p-level
3	50.47	4.57	53.35	4.66	49.85	3.65	5.18	0.007*
4	54.40	3.20	54.81	4.77	51.53	4.19	5.88	0.004*
5	54.65	1.85	57.30	5.45	53.62	3.31	6.95	0.002*
6	58.06	3.77	59.17	5.39	56.64	5.57	2.24	0.110
7	59.69	4.14	59,91	5.10	57.79	4.76	1.80	0.170
8	60.75	4.55	59.06	5.73	58.72	6.27	1.66	0.200
9	65.24	4.92	62.85	6,16	60.71	5.13	4.73	0.010*
10	64.90	4.73	65.28	5.53	62.52	5.74	1.94	0.150
11	67.58	5.80	67.05	5.31	63.64	4.31	4.95	0.010*
12	70.48	5.27	70.81	6.60	68.32	5.40	1.69	0.190
13	70.69	6.32	72.93	4.30	69.81	3.58	3.34	0.040*
14	75,06	4.60	75.91	4.89	72.69	5.52	2.91	0.060
15	78.03	4.42	76.49	5.11	74.82	5.39	2.65	0.080
16	80.08	4.13	79.13	3.08	76.72	5.76	4.14	0.020*
17	79.48	4.20	80.86	4.03	78.56	4.16	1.57	0.220
18	79.65	4.43	82.28	4.88	78.51	4.68	4.83	0.010*

* Significant

CHAPTER -VI

NUTRITIONAL STATUS

In this chapter, we shall deal with the nutritional status of Khasi children taking into consideration the anthropometric indices like weight for height and body mass index, which are generally used as indicators of nutritional status. We shall also look into the relationship between these anthropometric indices and socioeconomic condition like religion and income of the household.

NUTRITIONAL STATUS

One of the major health problems in many developing countries is the widespread prevalence of undernutrition and infectious diseases (WHO, 1990). It is generally reported that the basic causes of undernutrition and infections in developing countries are poverty, poor hygienic conditions and little access to preventive and health care (Mitra, 1985; WHO, 1990). Hence, assessment of the nutritional status of population has attracted the attention of not only the nutritionists and other biological scientists, but also the economists and other social scientists with a view to understanding the health and socioeconomic status of the population (Osmani, 1992). Nutritional status is defined as the physical expression of the relationship between the nutrient intakes, or bio-availability of nutrients, and the physiological requirements of an individual (Brown, 1984). This physical expression of the relationship between nutrient intakes and physiological requirements of a person can be measured by a number of methods. Of different methods, anthropometry is one that is generally used for measuring the magnitude of undernutrition at both individual and population levels. Anthropometric measurements and indices like weight, height, mid upper arm circumference, skinfold thickness, weight for age, height for age, weight for height, body mass index, indices of upper arm circumference, etc., (Jelliffe, 1966; Frisancho, 1990) are used for assessing the nutritional status of children.

In the present study, we have taken three important anthropometric indices, i.e., weight for age, height for age and body mass index, for assessing the nutritional status of the children in the present study. We shall also take into consideration how these three indices are associated with religion and income of the household. Thus, they may be presented briefly as follows:

Weight for age

Weight for age, expressed as percentage of individual weight to the median or 50th percentile of the international population reference (i.e., NCHS reference or standard) is generally considered as one of the indicators of underweight. The means and standard deviations of the weight for age for the children of the present study are given in Table 6.1. It is seen that the mean weight for age is higher in girls than in boys from 3 to 7 years of age, except at the age of 5 when both boys and girls show a similar mean value.

It is also found that the differences between boys and girls in respect of mean weight for age are not statistically significant from 8 to 14 years of age, although the boys are higher in mean value at the age of 13, that is, during the maximum growth spurt of their adolescent period. On the other hand, the Table shows that the mean weight for age is significantly higher in girls than in boys from 14 to 18 years, which indicates the great sex dimorphism during adolescent period.

Table 6.1. Statistical constants of weight for age (%) for boys and girls

Age	Boys			Girls			
(yrs)	Number	Mean	SD	Number	Mean	SD	t-value
3	89	87.96	13.41	92	93.06	14.34	2.46*
4	84	91.07	13.53	87	93.27	13.73	1.06
5	87	92.78	10.67	86	92.76	10.87	0.01
6	88	87.15	11.08	89	92.57	12.60	3.04**
7	87	82.49	10.25	93	86.64	10.92	2.62
8	82	84.51	11.41	84	84.13	10.15	0.23
9	92	84.84	10.50	86	82.84	11.78	1.20
10	88	81.10	11.50	79	79.62	11.51	0.83
11	85	79.36	10.92	80	76.70	8.40	1.75
12	85	75.36	8.45	85	77.92	9.22	1.89
13	84	78.74	9.50	87	75.23	10.52	2.29*
14	85	76.89	8.24	87	77.91	10.62	0.70
15	84	77.29	8.03	89	80.73	7.78	2.86**
16	82	73.49	7.95	84	81.25	7.25	6.57***
17	72	75.56	5.81	76	81.43	7.95	5.26***
18	75	73.95	6.13	84	79.65	9.08	4.58***

*P < 0.05; **P < 0.01; ***P < 0.000

Table 6.2. Nutritional status according to weight for age (based on NCHS reference)

Nutritional status	Boys (N =1351		Girls (N = 1368)	
	Number	Per cent	Number	Per cent
Normal (≤ 90)	311	23.02	380	27.78
Mild (75-89.9)	604	44.71	661	48.32
Moderate (60-74.9)	411	30.42	309	22.59
Severe (< 60)	25	1.85	18	1.32

$\chi^2 = 24.94$, DF = 3, P < 0.000

Following the cut-off points suggested by Comez *et al.* (1956), Table 6.2 shows the different degrees of the nutritional status according to weight for age of both boys and girls. It can be seen that the frequencies of mild, moderate and severe forms of underweight are 44.71%, 30.42% and 1.85% in boys and 48.32%, 22.59% and 1.32% in girls, respectively. It indicates that most of the underweight children are in the categories of mild and moderate degrees of undernutrition. Overall, it suggests that the prevalence of underweight is higher in boys (76.98%) than in girls (72.24%), and the difference is found to be statistically significant ($\chi^2 = 24.94$, DF = 3, P < 0.000).

Height for age

In the present study, height for age is expressed as percentage of individual weight to the median of the NCHS population reference. It is widely accepted as one of the best indicators of stunting or short stature due to inadequate nutrition or undernutrition. The means and standard deviations for height for age of both boys and girls are given in Table 6.3. The Table shows that, like in the case of weight for age, the differences between boys and girls in height for age are not statistically significant from 3 to 13 years of age, despite the significant difference at the age of 12. But from 14 years onwards, the mean height for age is significantly higher in girls than in boys.

The nutritional status of both boys and girls according to height for age is presented in Table 6.4, following the cut-of points proposed by Visweswara Roa *et al.*(1986). It can be seen that about 95% of boys and girls in the present population are stunting. Whether stunting or short stature of these children should be regarded as growth retardation, thereby indicating of high undernutrition, is a moot question of interest. It has been suggested that the use of national and international population references for assessing the nutritional status of children in terms of height for age may lead to overestimation of undernutrition in children of the short stature population like the Khasis (Khongsdier, 1996). In the present study, an attempt has also been made to show the different levels of growth retardation as per the ICMR reference of height for age in Table 6.5. It shows that about 84.83% of boys and 77.41% of girls have growth retardation, although the frequency is lower than that derived from the NCHS standard. So the present findings seem to confirm those observations made among the War Khasi (Khongsdier, 1996). The same is true in the case weight for age since weight is also correlated with height.

Table 6.3. Statistical constants of height for age (%) for boys and girls

Age (yrs)	Boys			Girls			t-value
	Number	Mean	SD	Number	Mean	SD	
3	89	94.71	5.83	92	95.66	5.21	1.16
4	84	93.40	5.12	87	92.94	5.66	0.56
5	87	92.63	5.93	86	92.94	5.53	0.36
6	88	91.80	6.55	89	92.77	5.58	1.06
7	87	91.75	5.39	93	91.73	5.88	0.02
8	82	90.79	5.88	84	91.42	4.76	0.76
9	92	90.99	4.93	86	91.05	5.29	0.08
10	88	90.05	5.30	79	90.41	5.17	0.44
11	85	89.12	4.48	80	89.51	4.22	0.57
12	85	88.29	4.39	85	91.38	4.60	4.48***
13	84	89.70	3.34	87	89.04	3.72	1.23
14	85	87.71	3.51	87	89.33	3.98	2.83*
15	84	86.14	3.91	89	89.09	3.29	5.38**
16	82	85.26	3.74	84	87.47	3.66	3.85*
17	72	86.05	3.29	76	90.24	4.00	6.94**
18	75	87.95	3.40	84	90.29	4.04	3.93*

*P < 0.01; **P < 0.000

With regard to sex differences in nutritional status, which is to a great extent independent of standard, Table 6.5 shows that like in the case of weight for age, the prevalence of growth retardation, especially those children with moderate and severe forms of undernutrition, is significantly higher in boys than in girls ($\chi^2 = 58.85$, DF = 3, P < 0.000). Whether or not these findings are associated with the matrilineal system of the society is a different question because we do not have data on child care of the society. But the results of the present study indicate that girls are better than boys in nutritional status.

Table 6.4. Nutritional status according to height for age (based on NCHS reference)

Nutritional status	Boys (N =1351		Girls (N = 1368)	
	Number	Per cent	Number	Per cent
Normal (≤ 100)	58	4.29	69	5.04
Mild (95-99.9)	171	12.66	209	15.28
Moderate (90-94.9)	401	29.68	497	36.33
Severe (< 90)	721	53.37	593	43.35

$\chi^2 = 27.38$, DF = 3, $P < 0.000$

Table 6.5. Nutritional status according to height for age(based on ICMR reference)

Nutritional status	Boys (N =1351		Girls (N = 1368)	
	Number	Per cent	Number	Per cent
Normal (≤ 100)	205	15.17	309	22.59
Mild (95-99.9)	428	31.68	514	37.57
Moderate (90-94.9)	475	35.16	397	29.02
Severe (< 90)	243	17.99	148	10.82

$\chi^2 = 58.85$, DF = 3, $P < 0.000$

Table 6.6. Statistical constants of body mass index for boys and girls

Age (yrs)	Boys			Girls			t-value
	Number	Mean	SD	Number	Mean	SD	
3	89	13.80	1.99	92	14.03	1.92	0.79
4	84	15.09	2.12	87	15.31	2.17	0.67
5	87	1645	1.64	86	16.20	1.87	0.94
6	88	16.58	1.95	89	17.13	1.93	1.89
7	87	16.68	1.99	93	17.22	2.03	0.94
8	82	18.14	1.86	84	17.86	1.81	0.98
9	92	19.31	1.95	86	19.04	2.15	0.88
10	88	19.97	2.07	79	20.13	2.47	0.46
11	85	21.37	2.55	80	21.39	2.19	0.05
12	85	22.34	2.35	85	22.83	2.22	1.40
13	84	24.82	2.72	87	23.98	2.97	2.22*
14	85	26.51	2.50	87	26.18	3.10	0.77
15	84	28.85	2.27	89	28.58	2.19	0.79
16	82	29.47	2.75	84	29.57	2.09	0.26
17	72	31.69	2.12	76	30.25	2.34	3.91**
18	75	31.62	2.40	84	30.13	2.99	3.44**

Body mass index

Body mass index (BMI) is generally considered as the best indicator of fatness or thinness and wasting due to chronic energy deficiency (Ferro-Luzi *et al.*, 1992). It is obtained as weight (kg) divided by height (cm^2) of the individual, and it is independent of age. The means and standard deviations of BMI for both boys and girls are shown in Table 6.6. It can be seen that there is not much difference between boys and girls in respect of BMI, although it is significantly higher in boys than in girls at the ages 13, 17 and 18.

The nutritional status of children according to BMI is summarized in Table 6.7. In the case of children aged 3 to 9 years, we have followed the cut-off point of 1.50, which is equivalent to 5th percentile of the NCHS standard (Visweswara Rao et al., 1986), while the cut-off points proposed by Ferro-Luzi *et al.* (1992) has been adopted for assessing the nutritional status of children aged 10 to 18 years. It is observed that the frequencies of mild, moderate and severe forms of chronic energy deficiency in the children aged 3 to 9 years of age are respectively about 12%, 6% and 8% in boys and 18%, 6% and 8% in girls. Thus, the frequency of mild chronic energy deficiency is about 6% higher in girls than in boys, although the difference between sexes is not statistically significant ($\chi^2 = 6.44$, DF = 3, P > 0.05). In the case of children aged 10 to 18 years, it is seen from Table 6.7 that about 95 % of boys and girls are well nourished in the present population.

Table 6.7. Nutritional status according to body mass index

	Boys (N = 609)		Girls (N = 617)	
	Number	Per cent	Number	Per cent
3 - 9 years				
Normal (≤ 15.0)	450	73.89	472	76.50
Mild (14.0-14.9)	70	11.49	108	17.50
Moderate (13.0-13.9)	38	6.24	37	6.00
Severe (< 13.0)	51	8.37	47	7.62
	$\chi^2 = 6.44$, DF = 3, P > 0.05			
10-18 years				
Normal (≤ 18.5)	708	95.42	713	94.94
Mild (17.0-18.4)	22	2.96	26	3.46
Moderate (16.0-16.9)	7	0.93	11	1.46
Severe (< 16.0)	5	0.67	1	0.13
	$\chi^2 = 0.30$, DF = 3, P > 0.05			

In view of these results, it is obvious that the children in the higher age groups are better in nutritional status than those in the lower age groups, i.e., 3 to 9 years of age. Another important point is that the nutritional status of children according to BMI is much better than that observed with respect to weight for age and height for age. This may be due to the fact that weight for age and height for age are derived as percentage of the median of the international population reference, whereas BMI is directly obtained as a proportion of weight to the square of height of an individual, thereby it is independent of the so-called standard weight or height. Thus, as also observed in other populations, BMI seems to be the better indicator of nutritional status than any other indices taken for the present study.

NUTRITIONAL STATUS AND SOCIO-ECONOMIC CONDITION

As mentioned earlier, it is generally reported that the widespread of undernutrition in developing countries is associated with poor hygienic conditions and socio-economic condition of the populations (Mitra, 1985; WHO, 1990). Therefore, assessment of the nutritional status of population has attracted the attention of not only the nutritionists and other biological scientists, but also the economists and other social scientists with a view to understanding the health and socioeconomic status of the population. In the present study, we have also been an attempt to show the prevalence of undernutrition according to religious and income groups of the population. This may be described as follows:

Religion

The means and standard deviations of weight for age, height for age and BMI according to religious groups for both boys and girls are given in Table 6.8. It is seen that the mean values of all these anthropometric indices are higher in the Muslim children than in the Christian and Niam Khasi children. After allowing the effect of economic condition, the one way analysis of covariance (ANCOVA) indicates that the differences in anthropometric indices between religious groups are highly significant for both boys and girls, except BMI in girls. According to Scheffe's multiple range test, the Muslim boys are found to be significantly higher than the Christian boys in weight for age (Difference ± standard error:5.01 ± 0.81, $P < 0.000$) and height for age (1.70 ± 0.39, $P < 0.000$). With respect to BMI, there is an absence of significant difference according to Scheffe's test, but it is significant according to Least Square Significance Difference (0.94 ± 0.44, $P < 0.03$). The differences between the Muslim and Niam Khasi boys are also significant in respect of all indices (Weight for age: 6.88 ± 0.79, $P < 0.000$; Height for age: 2.07 ± 0.38, $P < 0.000$; BMI: 0.96 ± 0.43, $P < 0.03$). On the other hand, the differences between Christian and Niam Khasi boys are found to be significant only in respect of weight for age (1.87 ± 0.72, $P < 0.03$). Nevertheless, it is clear that the Muslim boys are heavier than the Christian and Niam Khasi boys in respect of all anthropometric indices, thereby suggesting that the Muslim boys are better in nutritional status.

Table 6.8. Anthropometric indices according to religious groups

Indices/sex	Muslims		Christians		Niam Khasis		ANCOVA-F statistics
	N	Mean ± SD	N	Mean ± SD	N	Mean ± SD	
Boys							
Weight for age	339	86.10 ±11.61	467	81.09 ± 11.61	545	79.22 ±11.06	44.55**
Height for age	339	91.28 ± 5.11	467	89.58 ± 5.46	545	89.21 ± 5.59	22.25*
BMI	339	22.51 ± 5.96	467	21.51 ± 5.96	545	21.56 ± 6.41	3.84*
Girls							
Weight for age	365	87.29 ± 12.22	470	83.40 ± 12.29	533	81.32 ± 11.65	35.61**
Height for age	365	92.50 ± 5.05	470	90.61 ± 4.97	533	90.31 ± 5.07	35.96**
BMI	365	22.17 ± 5.83	470	21.68 ± 5.68	533	21.50 ± 6.03	1.73

*P < 0.02, **P < 0.000

Among girls the differences between Muslims and Christians according to Scheffe's test are found to be significant in respect of weight for age (3.89 ±0.84, P < 0.000) and height for age (1.86 ± 0.35, P < 0.000), but not in respect of BMI. But the differences between Christian and Niam Khasi girls are not significant in all the indices, except in the case of weight for age (2.08 ± 0.76, P < 0.02). Thus it indicates that the Christian and Niam Khasi children are by and large similar in height for age and BMI, although the former are higher in weight for age than the latter.

In order to have a better understanding of the effect of religion on nutritional status of Khasi children, an attempt has also been made to show the percentage distribution of weight for age according to three religious groups in Table 6.9. It is found that about 62.54%, 79.23% and 84.04% of the boys in Muslims, Christians and Niam Khasis, respectively, are underweight. Among girls, these frequencies of underweight are found to be 61.92%, 75.11% and 76.74%, respectively. The Chi-square values indicate that the differences between religious groups in respect of weight for age are highly significant (Boys: $\chi^2 = 70.82$, DF = 6, P < 0.000; Girls: $\chi^2 = 46.87$, DF = 6, P

< 0.000). Thus, it indicates that the Muslim Khasi boys and girls are better in weight for age when compared to their counterparts belonging to Christianity (Boys: χ^2 = 38.75, DF = 2, P < 0.000; Girls: χ^2 = 20.20, DF = 2, P < 0.000) and Niam Khasi (Boys: χ^2 = 66.58, DF = 2, P < 0.000; Girls: χ^2 = 40.94, DF = 2, P<0.000). On the other hand, the Christian Khasi children appear to be heavier than the Niam Khasi children, although the differences are not statistically significant in the case of boys (Boys: χ^2 = 4.04, DF = 2, P > 0.05; Girls: χ^2 = 8.56, DF = 2, P < 0.01). Thus, the Muslim children are heavier than the Christian and Niam Khasi children, and the differences between the Christian and Niam Khasi children are significant only in the case of girls, i.e., the Christian girls are heavier than the Niam Khasi girls.

Table 6.9. Nutritional status according to weight for age by religious groups

Nutritional status	Boys			Girls		
	Muslims (N=339)	Christians (N = 467)	Niam Khasis (N =545)	Muslims (N=365)	Christians (N = 470)	Niam Khasis (N =533)
Normal (≤ 90)	127	97	87	139	117	124
%	37.46	20.77	15.96	38.08	24.89	23.26
Mild (75-89.9)	149	206	249	173	245	243
%	43.95	44.11	45.69	47.40	52.13	45.59
Moderate (60-74.9)	62	158	191	49	104	156
%	18.29	33.83	35.05	13.42	22.13	29.27
Severe (< 60)	1	6	18	4	4	10
%	0.29	1.28	3.30	1.10	0.85	1.88
	χ^2 = 70.82, DF = 6, P < 0.000			χ^2 = 46.87, DF = 6, P < 0.000		

Like in the case of weight for age, the Muslim Khasi children are taller than the Christian and Niam Khasi children (Table 6.10). It is seen from Table 6.10 that the prevalence of stunting or growth retardation in boys is about 94.69%, 96.57% and 95.60% respectively in the Muslim, Christian and Niam Khasis. In the case of girls, these frequencies are 92.05%, 94.47% and 97.37%, respectively. The Chi-square values indicate that the differences in the percentage distribution of normal, mild, moderate and severe forms of nutritional status in respect of height for age are highly significant for both boys and girls (Boys: χ^2 = 24.89, DF = 6, P < 0.001; Girls: χ^2 = 40.32, DF = 6, P < 0.000).

It indicates that the children of Muslim Khasi are less retarded when compared with the Christian and Niam Khasi children, despite the fact that the prevalence of stunting is high in all the religious groups. With respect to the difference between the Christian and Niam Khasi children, it is seen from Table 6.10 that the frequency of mild and moderate forms of growth retardation is higher in the Christian Khasi boys than in the Niam Khasi boys, but the frequency of severe form is higher in the latter than in the former. However, these differences between the two religious groups are not statistically significant (χ^2 = 1.54, DF =3, P> 0.05). In the case of girls, the situation is reverse, which shows that the prevalence of mild and moderate forms of growth retardation is higher in the Niam Khasis than in the Christian Khasis, but the frequency of severe form of growth retardation is higher in the latter than in the former, although these differences are not statistically significant (χ^2 = 6.94, DF =3, P> 0.05). Thus, the Christian and Niam Khasi children are by and large similar in the prevalence of growth retardation. The significant differences between religious groups as indicated by the overall Chi-square test is mainly due to the differences between the Khasi Muslims children and other religious groups.

Table 6.10. Nutritional status according to height for age by religious groups

Nutritional status	Boys			Girls		
	Muslims (N=339)	Christians (N = 467	Niam Khasis (N =545)	Muslims (N=365)	Christians (N = 470)	Niam Khasis (N =533)
Normal (≤ 100)	18	16	24	29	26	14
%	5.31	3.43	4.40	7.95	5.53	2.63
Mild (95-99.9)	62	54	55	80	54	75
%	18.29	11.56	10.09	21.92	11.49	14.07
Moderate (90-94.9)	113	137	151	135	165	197
%	33.33	29.34	27.71	36.99	35.11	36.96
Severe (< 90)	146	260	315	121	225	247
%	43.07	55.67	57.80	33.15	47.87	46.34
	$\chi^2 = 24.89$, DF = 6, P < 0.001			$\chi^2 = 40.32$, DF = 6, P < 0.000		

Table 6.11. Nutritional status according to body mass index by religious groups

Nutritional status	Boys			Girls		
	Muslims	Christians	Niam Khasis	Muslims	Christians	Niam Khasis
3 - 9 years						
Normal (≤ 15.0)	122 (80.26)	160 (75.12)	168 (71.79)	134 (78.82)	171 (80.66)	166 (70.64)
Mild (14.0-14.9)	18 (11.84)	26 (12.21)	16 (6.84)	16 (9.41)	19 (8.96)	27 (11.49)
Moderate (13.0-13.9)	3 (1.97)	11 (5.16)	24 (10.25)	8 (4.71)	10 (4.72)	19 (8.08)
Severe (< 13.0)	9 (5.92)	16 (7.51)	26 (11.11)	12 (7.06)	12 (5.66)	23 (9.79)
	χ^2 = 18.76, DF= 6, P < 0.01			χ^2 = 7.81, DF= 6, P > 0.05		
10-18 years						
Normal (≤ 18.5)	181 (96.79)	245 (96.46)	292 (93.89)	189 (96.92)	245 (94.96)	279 (93.69)
Mild (17.0-18.4)	5 (2.67)	6 (2.36)	11 (3.65)	5 (2.56)	9 (3.49)	14 (4.70)
Moderate (16.0-16.9)	1 (0.55)	1 (0.39)	5 (1.66)	0 (0.00)	4 (1.55)	5 (1.68)
Severe (< 16.0)	0 (0.00)	2 (0.79)	3 (1.00)	1 (0.51)	0 (0.00)	0 (0.00)
	χ^2 = 3.49, DF= 2, P > 0.05			χ^2 = 2.67, DF= 2, P > 0.05		

Figures within parentheses indicate percentage

The percentage distribution of BMI according to three religious groups is shown in Table 6.11. In the age group 3 to 9 years, about 19.73%, 24.88%% and 28.20% of boys and 21.18%, 19.34% and 29.36% of girls in the Muslims, Christians and Niam Khasis, respectively, have suffered from chronic energy deficiency. Thus it indicates that the prevalence of chronic energy deficiency is lower among the Muslims than that among the Christians and Niam Khasis, though it is lower among the Christians in the case of girls. However, the Chi-square test indicates that the differences between religious groups are significant only in boys (χ^2 = 18.76, DF= 6, P < 0.01) but not in girls (χ^2 = 7.81, DF= 6, P > 0.05). Table 6.11 further shows that in the age group 10-18 years, the differences between religious groups in respect of BMI are not statistically significant for both boys and girls. Thus, it indicates that religion plays little role in influencing the BMI of the children in the present study, although the influence of religion on weight for age and height for age seems to be important. It clearly shows that the Muslim children are heavier and taller than the Christian and Niam Khasi children. One possible explanation of such a trend in the Muslims may be due to intermixture, i.e., the Muslim children are by and large the product of the intermixture between the Khasi females and the Muslim males who migrated to Meghalaya from other parts of India.

Economic Condition

Table 6.12 shows the means and standard deviations of anthropometric indices used as indicators of nutritional status according to three income groups. It is seen that, with the exception of few cases, the mean values of weight for age, height for age and BMI are lower in the LIG when compared to the MIG and HIG. Adjusting for religion, the ANCOVA test also indicates that the differences between income groups are significant in all anthropometric indices for both boys and girls. According to Scheffe's test, the LIG children are significantly lower than those in the MIG and HIG in respect of all the three anthropometric indices, irrespective of the difference between LIG and MIG in BMI for girls (1.20 ± 0.36, P < 0.004). Likewise, the differences between MIG and HIG children are found to be highly significant for weight for age, height for age and BMI.

Table 6.12. Anthropometric indices according to income groups

Indices/sex	LIG		MIG		HIG		ANCOVA-F statistics
	N	Mean ± SD	N	Mean ± SD	N	Mean ± SD	
Boys							
Weight for age	569	78.69 ± 11.80	500	82.71 ± 11.06	282	85.45 ± 11.11	38.51**
Height for age	569	88.38 ± 5.29	500	89.90 ± 5.11	282	92.79 ± 5.37	67.16**
BMI	569	20.79 ± 5.84	500	22.82 ± 6.46	282	22.03 ± 5.93	15.03**
Girls							
Weight for age	503	80.95 ± 11.45	558	83.50 ± 11.65	307	88.25 ± 13.22	40.72**
Height for age	503	89.80 ± 5.53	558	90.73 ± 7.73	307	93.45 ± 4.71	58.41**
BMI	503	21.16 ± 5.86	558	22.36 ± 6.09	307	21.58 ± 5.58	6.30*

*P < 0.002, **P < 0. 000

In order to understand the effect of economic condition on the nutritional status of the children in the present study, we have also made an attempt to show the prevalence of undernutrition in relation to the three levels of the monthly income of households. With respect to weight for age, Table 6.13 shows that about 81.90%, 76.60% and 67.73% of the boys and 79.52%, 72.94% and 58.96% of girls are underweight in the LIG, MIG and HIG, respectively. It indicates that the proportion of underweight children decreases with the rise in income levels of the household. The Chi-square values also indicate that the differences between income groups in respect of the distribution of children according to different degrees of underweight are highly significant for both boys (χ^2 = 107.09, DF = 6, P < 0.000) and girls (χ^2 = 62.08, DF = 6, P < 0.000). Thus, it suggests that the income of household plays a very important role in influencing the nutritional status of children according to weight for age as has been shown in Table 6.12 with regards to ANCOVA test.

Table 6.13. Nutritional status according to weight for age by income groups

Nutritional status	Boys			Girls		
	LIG (N=569)	MIG (N = 500)	HIG (N =282)	LIG (N=503)	MIG (N = 558)	HIG (N =307)
Normal (≤ 90)	103	117	91	103	151	126
%	18.10	23.40	32.27	20.48	27.06	41.04
Mild (75-89.9)	202	258	149	243	271	147
%	35.50	51.60	52.84	48.31	48.57	47.88
Moderate (60-74.9)	246	123	41	149	129	31
%	43.23	24.60	14.54	29.62	23.12	10.10
Severe (< 60)	18	2	5	8	7	3
%	3.16	0.40	1.77	1.59	1.25	0.98
	χ^2 = 107.09, DF = 6, P < 0.000			χ^2 = 62.08, DF = 6, P < 0.000		

The percentage distribution of height for age according to income groups is presented in Table 6.14. It is seen that the prevalence of stunting is very high in all the income groups for both boys and girls, but the percentage is higher in the lower income groups when compared with the HIG. Such a trend can also be observed with respect to the prevalence of severe forms of growth retardation, which is much higher in the LIG and MIG when compared with the HIG. These differences between income groups in respect of height for age are found to be statistically significant for both boys (χ^2 = 102.50, DF = 6, P < 0.000) and girls (χ^2 = 99.15, DF = 6, P < 0.000). This clearly indicates that income of the household plays a very important role in influencing the height for age of the children of the present study.

Table 6.14. Nutritional status according to height for age by income groups

Nutritional status	Boys			Girls		
	LIG (N=569)	MIG (N = 500)	HIG (N =282)	LIG (N=503)	MIG (N = 558)	HIG (N =307)
Normal (≤ 100)	13	20	25	15	25	29
%	2.28	4.00	8.87	2.98	4.48	9.45
Mild (95-99.9)	50	60	61	56	79	74
%	8.79	12.00	21.63	11.13	14.16	24.10
Moderate (90-94.9)	146	140	115	159	198	140
%	25.66	28.00	40.78	31.61	35.48	45.60
Severe (< 90)	360	280	81	273	256	64
%	63.27	56.00	28.72	54.27	45.88	20.85
	χ^2 = 102.50, DF = 6, P < 0.000			χ^2 = 99.15, DF = 6, P < 0.000		

Table 6.15. Nutritional status according to body mass index by income groups

Nutritional status	Boys			Girls		
	LIG	MIG	HIG	LIG	MIG	HIG
3 - 9 years						
Normal (≤ 15.0)	186 (68.89)	163 (77.25)	101 (78.91)	171 (71.85)	180 (78.60)	121 (80.66)
Mild (14.0-14.9)	31 (11.48)	28 (13.27)	11 (8.59)	26 (10.92)	21 (9.17)	14 (9.33)
Moderate (13.0-13.9)	20 (7.41)	11 (5.21)	7 (5.47)	14 (5.88)	15 (6.55)	8 (5.33)
Severe (< 13.0)	33 (12.22)	9 (4.27)	9 (7.03)	27 (11.34)	13 (5.68)	7 (4.66)
	χ^2 = 13.56, DF= 6, P < 0.03			χ^2 = 8.99, DF= 6, P > 0.05		
10-18 years						
Normal (≤ 18.5)	274 (91.64)	286 (98.96)	148 (96.10)	248 (93.58)	315 (98.96)	150 (95.54)
Mild (17.0-18.4)	15 (5.01)	3 (1.04)	4 (2.60)	11 (4.15)	10 (3.04)	5 (3.18)
Moderate (16.0-16.9)	6 (2.00)	0 (0.00)	1 (0.64)	6 (2.26)	3 (0.91)	2 (1.27)
Severe (< 16.0)	4 (1.34)	0 (0.00)	1 (0.64)	0 (0.00)	1 (0.30)	0 (0.00)
	χ^2 = 18.23, DF= 2, P < 0.000			χ^2 = 2.15, DF= 2, P > 0.05		

The percentage distribution of BMI for children aged 3-9 and 10-18 years are shown in Table 6.15. It is seen that the differences between income groups in respect of BMI are not significant in girls for both the age groups 3-9 and 10-18 years. But in the case of boys, the income of the household seems to be important and the differences between income groups are significant for both the age groups. For the age group 3-9 years, the prevalence of chronic energy deficiency in boys is about 31.11%, 22.75% and 21.09% in LIG, MIG and HIG, respectively. These frequencies are about 8.36%, 1.04% and 3.90% respectively in the age group 10-18 years. Thus it is obvious that the prevalence of chronic energy deficiency is higher in the LIG when compared to the MIG and HIG, and the influence of the income of household is clearly significant in BMI of boys, although it is also perceptible in girls.

CHAPTER VII
DISCUSSION

In the present Chapter, we shall briefly discuss our findings by comparing with other populations especially in Northeast India. We shall also look into the implications of the present findings.

Demography

From an evolutionary point of view, human species- *Homo sapiens* – is more successful in adapting and thereby in maintaining and increasing its numbers. It is generally believed that one of the main reasons for the successful adaptation of human species is its ability to change the environments through culture. For example, development of technology and improved organization have aided human being to reduce the intensity of the forces of natural selection. Notwithstanding there are still many problems that we are confronting today through which natural selection is operating to shape the composition and diversity of human species. According to Molnar (1992), "The dimensions and scope of these ongoing processes require careful consideration, especially the increase in numbers of people and the burden these expanded populations place on the environment. Demographic factors of this expansion exert a major influence on gene frequencies. Epidemiology, the types and distribution of disease, is also altered each generation as new diseases gain in population influence while other ones decline as treats to human health."

As hinted above, demographic parameters like fertility and mortality are very important to understand the genetic make up of a population, and thereby the evolutionary processes of human populations. It is theoretically believed that natural selection, one of the major evolutionary forces, is operating on human population through differential fertility and mortality (Crow, 1958; Johnston, 1973). Also, other demographic parameters like population size, mating patterns admixture rate, migration, etc., are very helpful in understanding the biological characteristics of the population (Basu, 1969;

Ghosh, 1976; Khongsdier and Ghosh, 1994). In the meantime, demographic parameters like fertility and mortality are largely influenced by various socioeconomic factors like religion, education, income, occupation, age at marriage, adoption of family planning, etc. (Mosley and Chen, 1984; Mahadevan, 1986; World Bank, 1999; Caldwell *et al.*, 1999; and others). So, it is quite imperative on the part of physical anthropologists to undertake studies on the effect of socioeconomic conditions on demographic parameters, particularly on fertility and mortality.

In the present study, we have observed that the Khasi population is highly *progressive* irrespective of religious groups, thereby indicating a recent higher fertility rate. Although the mean age at marriage among the Muslim, Christian and Niam Khasi women of the present study is higher than those reported for the populations of Assam (Sengupta and Gogoi, 1995), the mean numbers of live births to married women of all ages belonging to these three religious groups are found to be higher than the Christian (4.81) War Khasis (Khongsdier, 2001) and the Kochs of Garo Hills (Kotal, 2001). It is *observed that the total fertility rate in these three religious groups is more or less similar* to the War Khasi, but much higher than that reported for the state of Meghalaya (NCHS, 2000) and the Kochs of Garo hills (Kotal, 2001), although it is not as high as that reported for the Dalus (Patra and Kapoor, 1996). The age specific fertility rate is found to have reached its peak point in the age group 25- 29 years in all the religious groups, and the total fertility rates are 5.38, 5.85 and 5.85 in the Christians, Muslims and Niam Khasis, respectively (Table 4.9). Thus, it indicates that the fertility rates are slightly higher in the Muslims and Niam Khasis when compared with the Christians.

It is observed that the fertility rate in the present population is negatively associated with the age at marriage and income levels of households. The effect of education, on the other hand, is not clearly perceptible in the present study, except among the Niam Khasi mothers, which indicates that educational level of the mothers is also very important in regulating the fertility rate. The effect of religion on fertility rate is not significant, although the total fertility rate is more or less same among the Muslims and Niam Khasis, but it is lower in the Christians. In other words, it is obvious that Family Planning Programme has gained little momentum in the Khasi population, irrespective of religious groups. Moreover, it is also observed that education of the mothers does not play a significant role in regulating the fertility rate among the Muslim and Christian Khasis, although it is important in the Niam Khasi women. This insignificant effect of education on fertility rate in the Muslims and Christians is in contrast to the observation in other populations (Caldwell *et al.*, 1999), and it is difficult to give any clear-cut explanation. It is well known that Islam does not expressly forbid the voluntary restriction of birth, but children are regarded as the richest blessing that Allah bestows and therefore any attempt to prevent fertility is against the wishes of God (Choudhury, 1982). Of course, it is generally reported that Muslims have higher fertility rate followed by the Hindus and Christians (Irudaya Rajan and Rao, 1991). Likewise, the Bible does not specifically prohibit birth control, but certain Christian denominations like the Catholic Church are against the use of artificial means of birth control (Irudaya Rajan and Rao, 1991). Thus, it is likely that even education of the mothers may not become so important in such a situation.

In the present study, the term "Christians" refers to all Christian denominations including the Roman Catholics. Unfortunately, we have not collected data on specific Christian denomination and, therefore, we are not in position either to refute or support the contention that fertility rate is higher in the Catholics than in any other Christian denominations. We hope that further studies will throw much more light in this regard. The effect of other factors like age at marriage and income of the household on fertility rate seems to be very important in the Khasi population, irrespective of religious groups. The effect of age at marriage on fertility is by and large universal since the reproductive period is shorter in the case of those with higher age at marriage. On the other hand, the significant effect of the income of household on fertility rate in this population is likely to be related to the fact that people belonging to the higher economic groups are more conscious of the socio-economic welfare of their children. It is likely that they have higher aspiration for better education and higher economic status, thereby reducing the birth rate with a view to providing their children with such facilities.

The infant mortality rates in the Christians of the present study are similar to Christian War Khasis (6.89%), while the rates in the Muslims and Niam Khasis are similar to the Non-Christian War Khasi (Khongsdier, 2001), and for the state of Meghalaya (NCHS, 1999). However, the religious groups of the present study have lower infant and juvenile mortality rates than the Dalus (Patra and Kapoor, 1996) and Chapra Kochs (Kotal, 2001) of Garo hills.

It is observed that the infant mortality rate increases with the increasing age of the mothers. It is found that the regression coefficient ($\beta \pm$ standard error) of infant mortality (dependent variable) on maternal age is positively significant (0.021 ± 0.008, $P < 0.011$), and it is negatively significant with respect to education (-0.150 ± 0.074, $P < 0.043$) and income (-1.283 ± 0.125, $P < 0.000$) as shown in Table 4.18.. However, the effect of religion on infant mortality is not statistically significant (0.051 ± 0.101, $P > 0.05$). Thus, it indicates that maternal age, education and income are very important in influencing infant mortality in the present population. This may be due to the fact that mothers of higher age groups have higher fertility rate, which is theoretically correlated with higher infant mortality rate. The inverse relationship between infant mortality and educational as well as income level is according to the general observation in other populations (Rustein, 2000; Wagstaff, 2000), which indicate that mothers belonging to the higher educational and income levels are more conscious of the health of their children, and they have more access to modern medical aids, etc. On the other hand, religion does not seem to play very important role in influencing infant mortality rate.

With respect to reproductive wastage, it is found that the still birth rates (i.e., number of still-births per 100 pregnancies) are 3.16%, 3.18% and 3.56% in the Christians, Muslims and Niam Khasis, respectively, and the abortion rates to these three religious groups (i.e., number of abortions per 100 pregnancies) are 4.32%, 4.64% and 4.60%, respectively. Thus, the rates of reproductive wastage (i.e., number of abortions and still-births per 100 pregnancies) are 7.47%, 7.82% and 8.15% in the Christians, Muslims and Niam Khasis, respectively. It appears that the Muslims and Niam Khasis are more or less similar in the frequency of reproductive wastage, and it is slightly higher in the Christians, despite the absence of statistical difference. Like in the case of infant mortality, the frequencies of reproductive wastage in the three religious groups of the present study are similar to those reported for the War Khasis (Khongsdier, 2001), but higher than those reported for the Dalus (4.93%) of Garo hills (Patra and Kapoor, 1996).

Growth Pattern

Besides the demographic aspects of population, physical growth and development of children is another important field of anthropological research. The pattern of human growth serves as a type of mirror that reflects the biocultural evolution of human population. According to Tanner (1988), "The study of growth is important in elucidating the mechanism of evolution, for the evolution of morphological characters necessarily comes about through alteration in the inherited pattern of growth and development. Growth also occupies an important place in the study of individual differences in form and function of man, for many of these also arise through differential rates of growth of particular parts of the body relative to others." Further, Eveleth and Tanner (1990) have also observed "A Child's growth rate reflects, perhaps 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 height and weight reflect accurately the state of a nation's public health and the average nutritional status of its citizens, when appropriate allowance is made for differences, if any, in genetic potential. This is especially so in developing and disintegrating countries." Since human growth and development is also largely influenced by socio-environmental factors like nutrition, infection, occupation, income and religion, it is very vital for understanding the biocultural variation and evolution of human populations (Tanner 1988, Eveleth and Tanner, 1990; Bogin, 1999).

The findings of the present study on growth patterns of children belonging to the three religious groups, viz., Muslims, Christians and Niam Khasis, are presented in Chapter V. Using the fourth degree polynomial model by which the height is equal to $64.19 + 8.59(\text{Age}) - 0.47(\text{Age})^2 + 0.03(\text{Age})^3 - 5.46\ (\text{Age})^4$ cm for boys and to $65.53 + 7.79(\text{Age}) - 0.43(\text{Age})^2 + 0.04(\text{Age})^3 - 0.001(\text{Age})^4$ cm for girls, the estimated value for adult height is found to be 154.20 cm for males and 146.83 cm for females. This indicates that the girls have reached their adult height by the age of 18, while the boys still continue to grow. The present observation seems to confirm that observation among the Assamese Muslim girls of Assam, though it is not so in the case of boys (Begum and Choudhury, 1999).

Comparison with NCHS and ICMR Growth References

In order to have a better understanding of the growth status of children in the present study, an attempt has been made to compare their weight and height with those given by the U.S. National Centre for Health Statistics (NCHS, 2000) and Indian Council of Medical Research (ICMR, 1972). We shall restrict only to weight and height as data on other anthropometric measurements are not available in the latest NCHS growth references (NCHS, 2000).

The mean weight of Khasi boys plotted against the NCHS percentiles is shown in Figure 7.1. It can be observed from the Figure that the mean weight of the Khasi boys is more or less to the 25th percentiles of NCHS growth reference from 3 to 6 years of age. From 6 to 8 and 13 to 16 years of age, the curve for the mean weight of Khasi boys lies between 5th and 10th percentiles, and it is closer to the 10th percentile from 8 to about 11 years of age. From 11 to 13, it is closer to the 5th percentile of the growth reference, and from 16 years onwards the growth curve for the mean weight of the Khasi boys lies below the 5th percentile. It may be mentioned that the 50th percentile of the NCHS data is generally considered as 100 percent normal growth for children.

Like in the case of boys, the mean weight of girls falls at 25th percentile of the NCHS reference from 3 to 6 years of age, and thereafter it drops into 10th percentile up to about the age of 10 (Figure 7.2). From 10 years onwards, the growth curve for the weight of Khasi girls lies more or less between the 5th and 10th percentiles of the NCHS reference.

It is obvious that the mean weights of Khasi boys and girls are far below the 50th percentile of the NCHS growth reference especially at higher age groups. It is likely that ethnic difference in growth pattern does prevail especially in the higher age groups. In order to have a better understanding of this problem, an attempt has also been made to compare the present findings with the growth reference given by the Indian Council of Medical Research (ICMR, 1972), although it has been criticized that the ICMR growth reference does not represent all sections of the Indian population, and the data are old now. It is also suggested that the children belonging to the high economic class of the Indian population show more or less similar pattern of growth to those in the developed countries (Gopalan, 1992). Therefore, it is advisable to use the international growth reference, that is the NCHS data, for assessing the growth and nutritional status of Indian children. Accordingly, it is not surprised if this is the reason that the ICMR or other authorities have not published any new data on growth of Indian children.

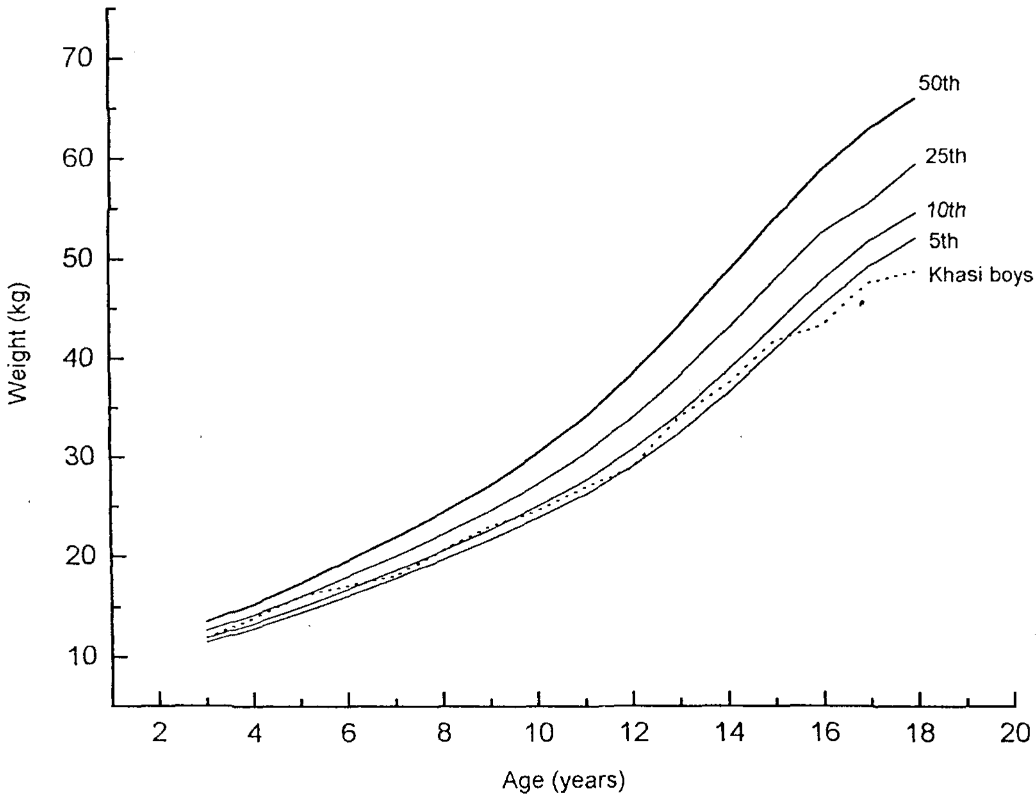


Figure 7.1. Mean weight of Khasi boys plotted on NCHS percentiles

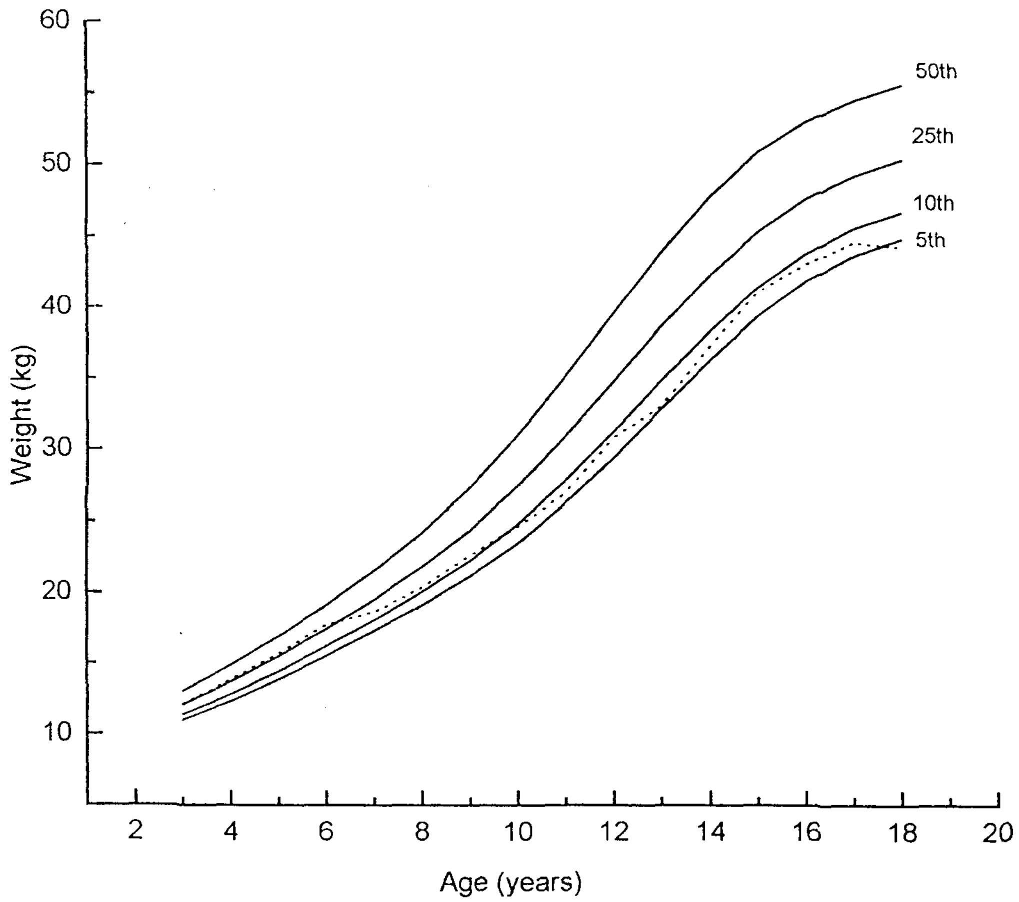


Figure 7.2. Mean weight of Khasi girls (dotted) plotted against NCHS percentiles

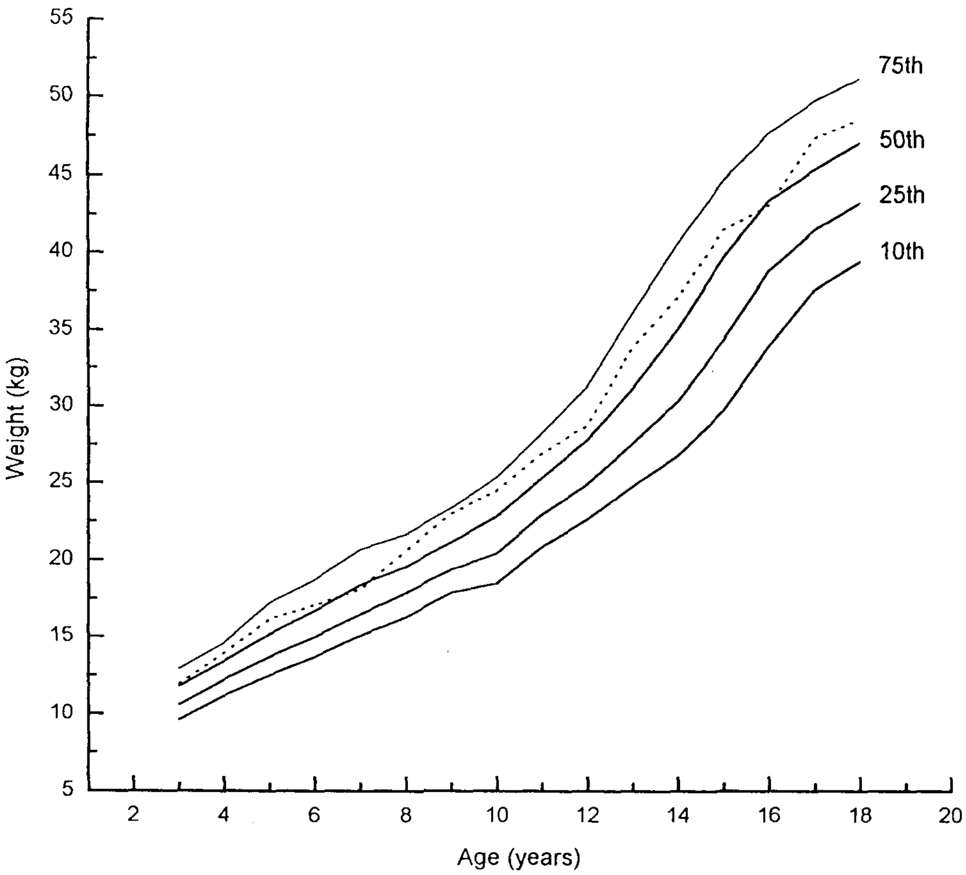


Figure7.3. Mean weight of Khasi boys (dotted) against ICMR percentiles

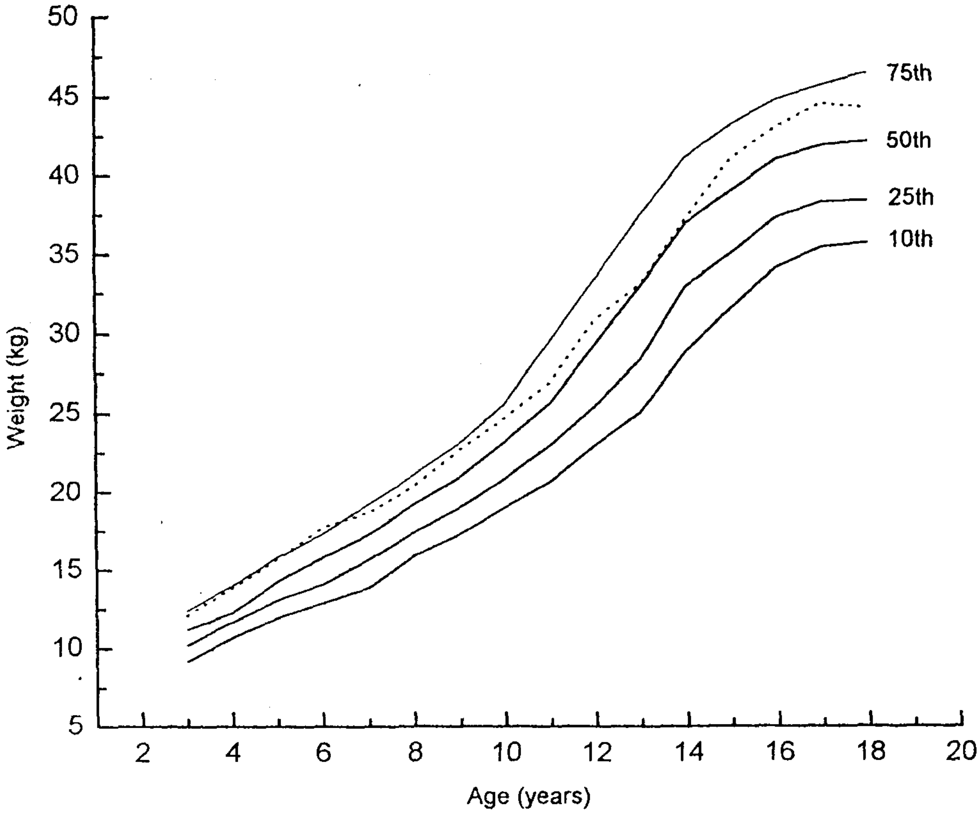


Figure.7.4. Mean weight of Khasi girls (dotted) against ICMR percentiles

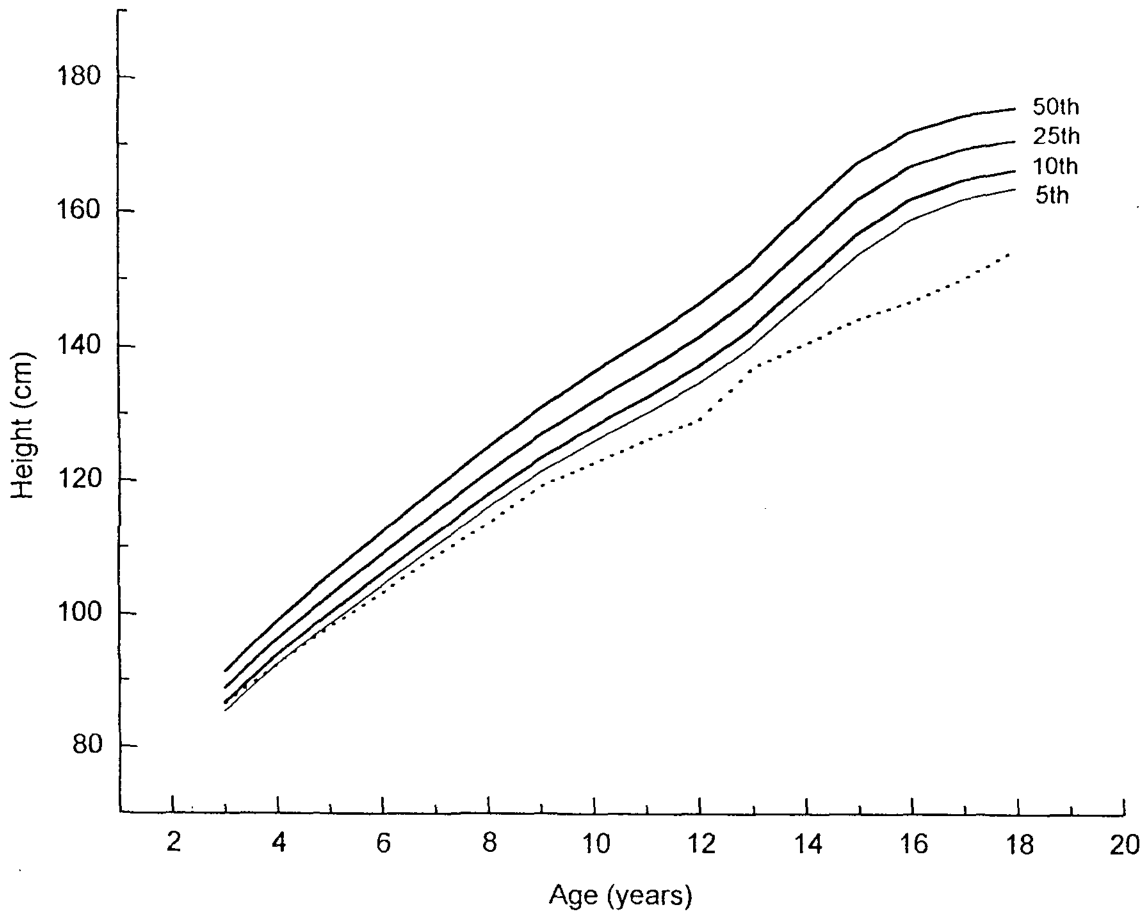


Figure 7.5. Mean height of Khasi boys (dotted line) plotted against NCHS percentiles

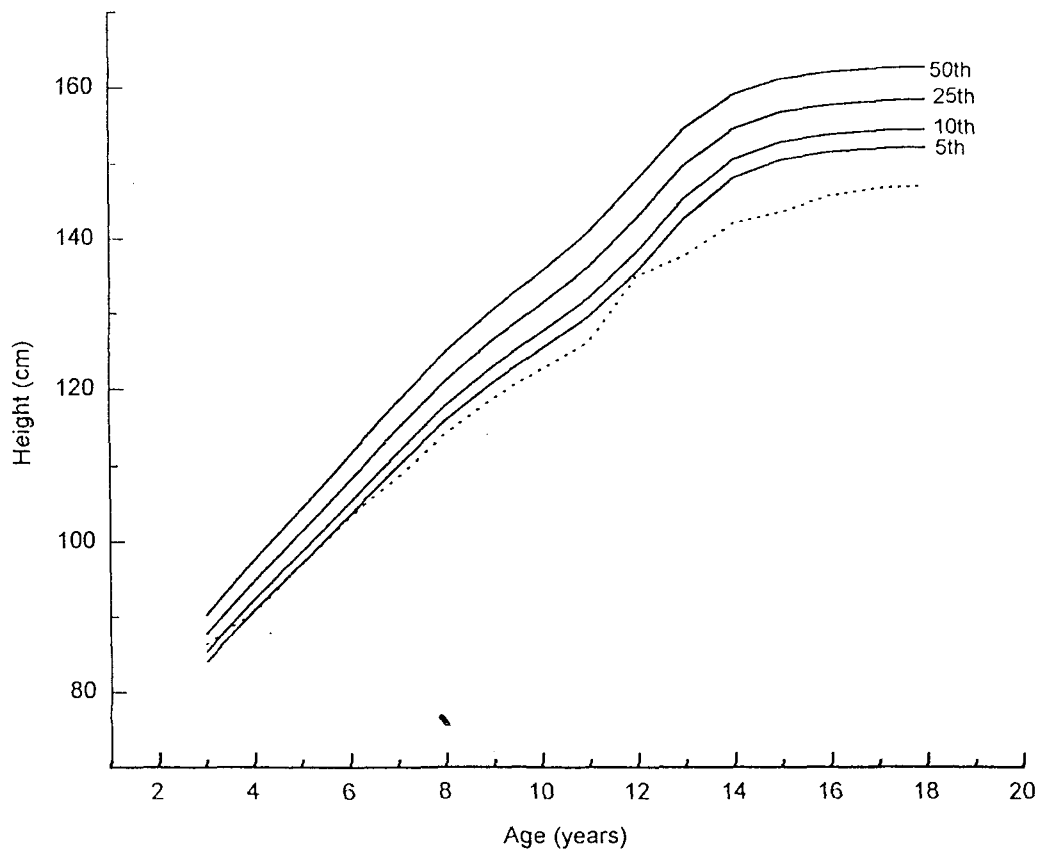


Figure 7.6. Mean height of Khasi girls(dotted) plotted against NCHS percentiles

Figure 7.3 shows the mean weight of Khasi boys plotted against the percentiles of the ICMR growth reference. It can be observed that the mean weight of the Khasi boys is above the 50th percentile from 3 to 18 years of age. Similar trend has been observed in the case of girls as shown in Figure 7.4. It is seen that the Khasi girls are more or less in the 75th percentile of the ICMR reference from 3 to 6 years of age, and thereafter they are similar to the boys in which the growth curve lies between 75th and 50th percentiles. Thus, the Khasi boys and girls are heavier than the ICMR children, but much lighter than the American children.

Height

With respect to height, Figure 7.5 shows the mean height of Khasi boys plotted against NCHS percentiles. It can be observed that the Khasi boys are more or less in the 5th percentile of the NCHS reference from 3 to about 6 years of age, and thereafter the growth curve of Khasi boys falls much below the 5th percentile. Similarly, the growth curve for the mean height of girls is more or less in the 5th percentile from about 3 to 7 years, and thereafter it falls below the 5th percentile, except at 12 years of age, which is characterized by an adolescent growth spurt in girls (Figure 7.6).

Plotted against the ICMR percentiles, Figure 7.7 shows that the mean height for boys is comparable to the 25th percentile from 3 to 4 years of age, and thereafter it fluctuates between 10th and 25th percentiles up to about 15 years of age. From 15 years of age, the growth curve for boys falls below the 10th percentile of the ICMR reference. Nevertheless, it indicates that the Khasi boys are much shorter than the American boys, especially from the age of 7 onwards, but they are comparable to the Indian children as reported by the ICMR. In the case of girls, Figure 7.8 indicates that the growth curve is at about 50th percentile at the age of 3 years, it lies about 25th percentile of the ICMR growth reference from 4 to 10 years of age, and thereafter it fluctuates below and above the 25th percentile up to about 13 years of age. The curve tends to lie between the 10th and 25th percentiles from 13 years of age. Overall, it indicates that the girls are more comparable to the ICMR reference than the boys, although they are much shorter than the American children.

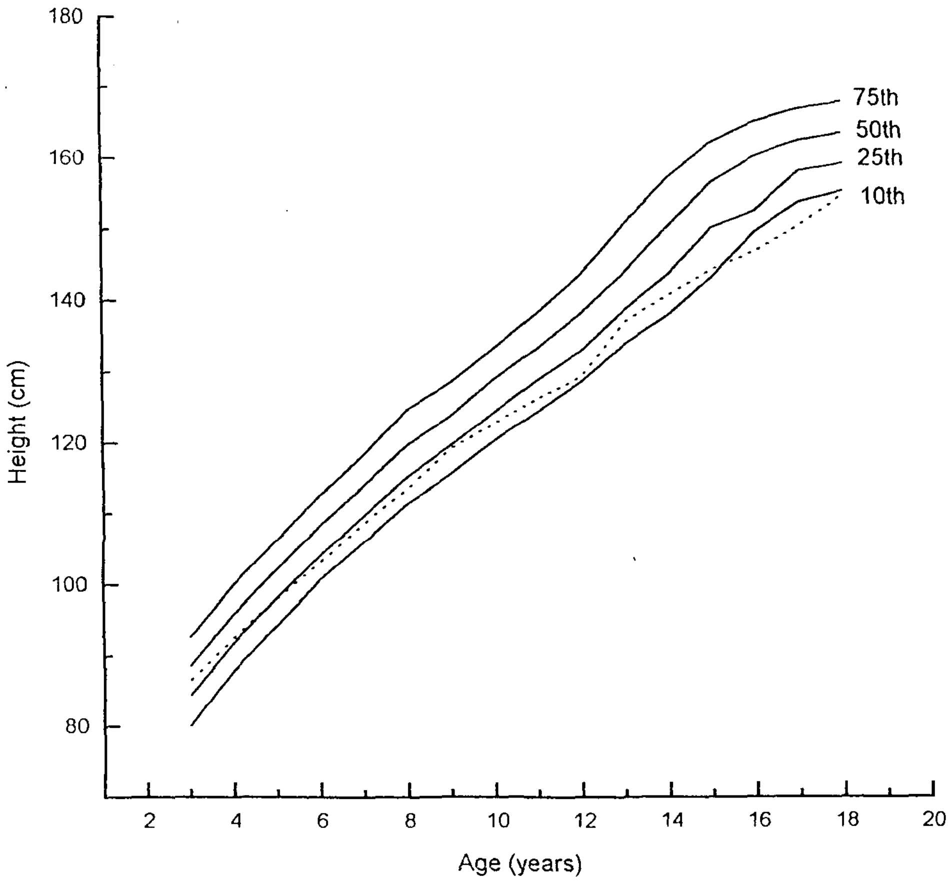


Figure7.7. Mean height of Khasi boys (dotted) against ICMR percentiles

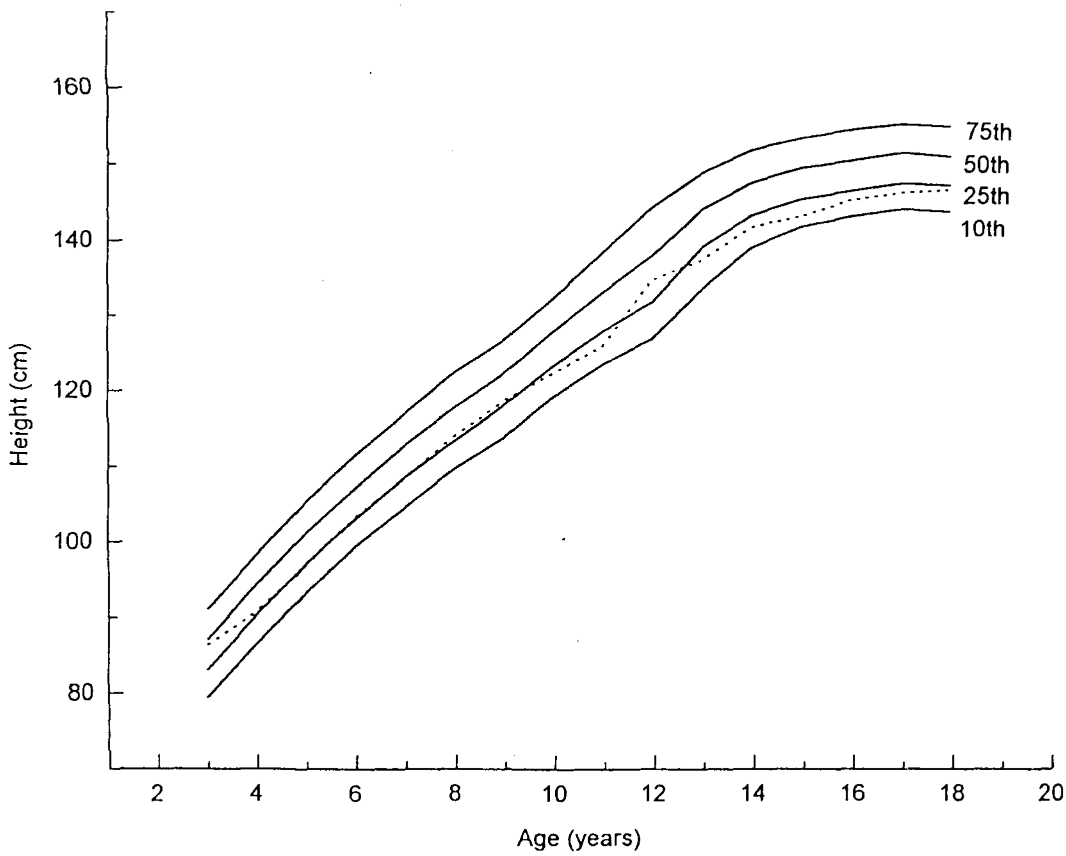


Figure 7.8. Mean height of Khasi girls(dotted) plotted against ICMR percentiles

Comparison with Neighbouring Populations

As already mentioned in Chapter II, very few growth studies have been carried out in Northeast India. Recently, two growth studies were published: one among the War Khasi of Meghalaya (Khongsdier, 1996a) and the other among the Assamese Muslims of Assam (Begum and Choudhury, 1999). Thus, we shall restrict our comparison with only the War Khasi and Assamese Muslims children.

Weight

It can be observed from Figure 7.9 that the Khasi boys are more or less similar to the Assamese Muslim and War Khasi boys from 3 to 11 years, and thereafter the Assamese Muslim boys are heavier than the Khasi boys of Shilong and War area, except at about 13 years of age when all the three groups of boys show a similar pattern of growth in weight. The War Khasi boys lie in between the Assamese and Khasi boys from 11 to 13 years, and thereafter they are more or less like the Khasi boys of the present study. As far as girls are concerned, Figure 7.10 shows that all the three groups of girls are by and large similar in weight from 3 to 10 years of age. From 10 to 16 years of age, the Assamese Muslim girls are heavier than the Khasi and War Khasi girls, and thereafter they are surpassed by the Khasi girls of Shillong. In comparison with the War Khasi girls, the Khasi girls of the present study are slightly lower in weight from 10 to 14 years of age, and thereafter they are heavier than the War Khasi girls.

Height

Figure 7.11 shows that the Khasi boys are shorter than the War Khasi and Assamese Muslim boys all through age groups. Thus, it is contrary to expectation that the Khasi boys of Shillong may be taller than their counterparts in the War Khasi. Instead, it is also seen that the War Khasi boys are slightly taller than the Assamese Muslim boys from 3 to 5 years of age. From 5 to 7 years of age, they are more or less similar in height, and thereafter they are surpassed by the Assamese Muslim boys. Like in the case of boys, the War Khasi girls are taller than the Assamese Muslim girls from 3 to 5 years, and they are in between the Khasi and Muslim girls from 6 to 14 years; thereafter they tend to be in the same height with their coevals in Shillong (Figure 7.12).

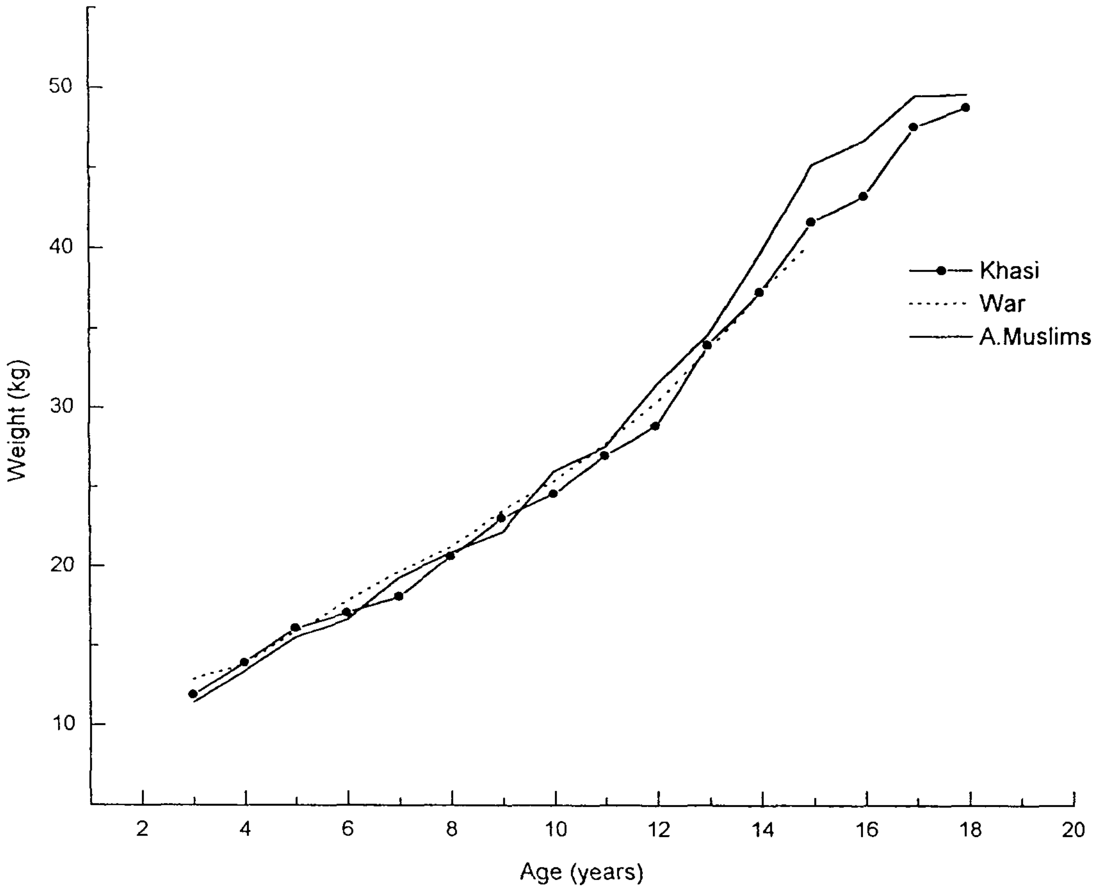


Figure 7.9. Mean weight of boys

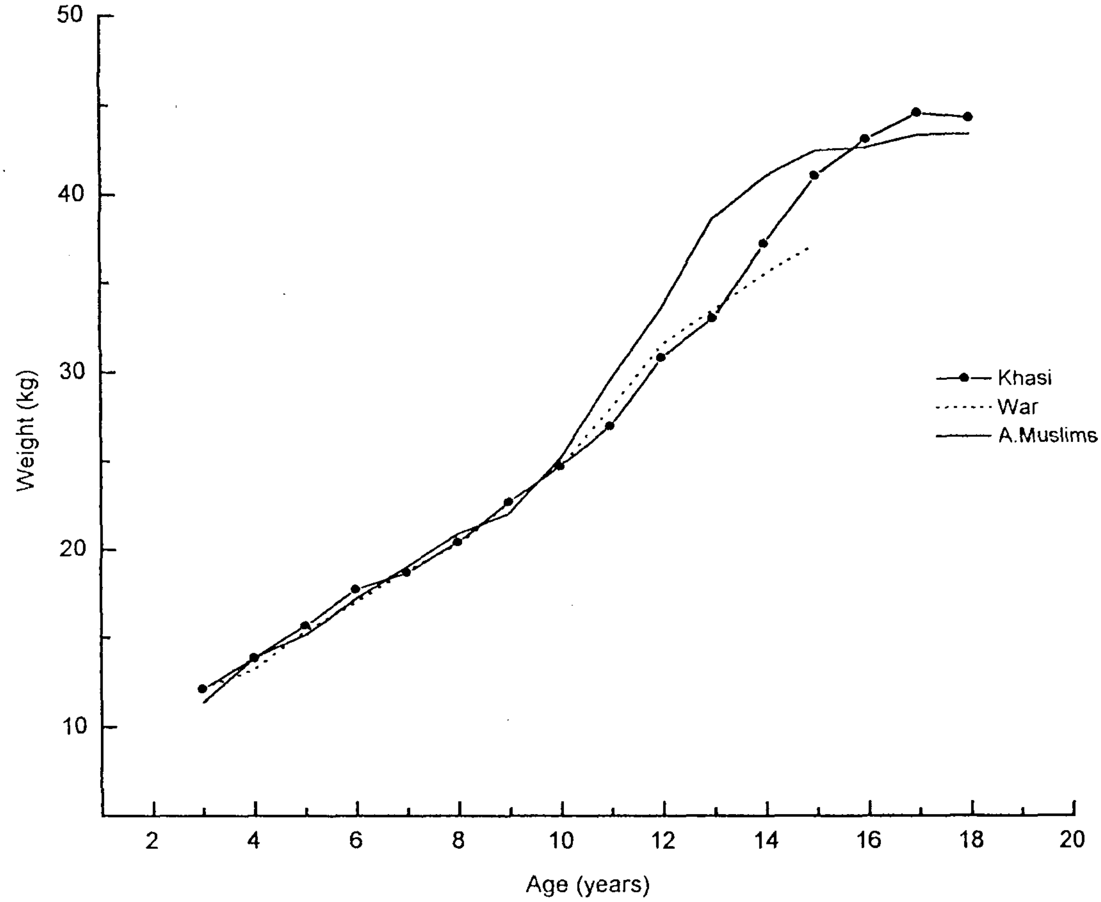


Figure 7. 10. Mean weight of girls

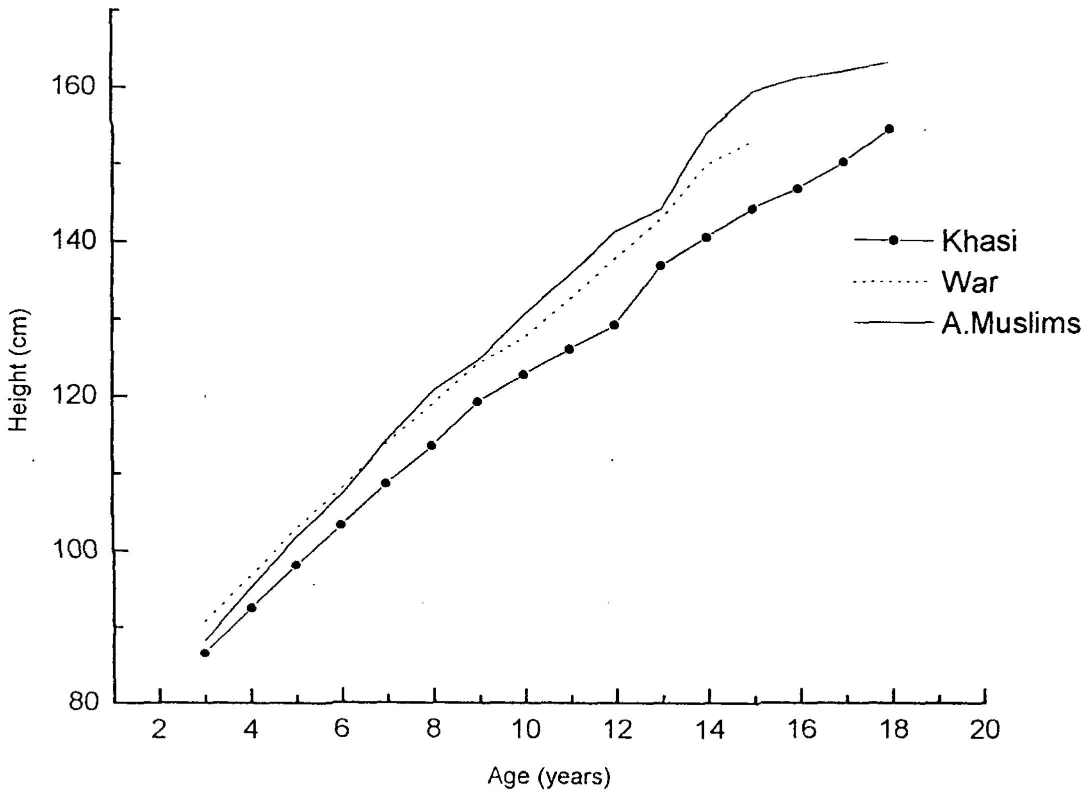


Figure 7.11. Height of boys

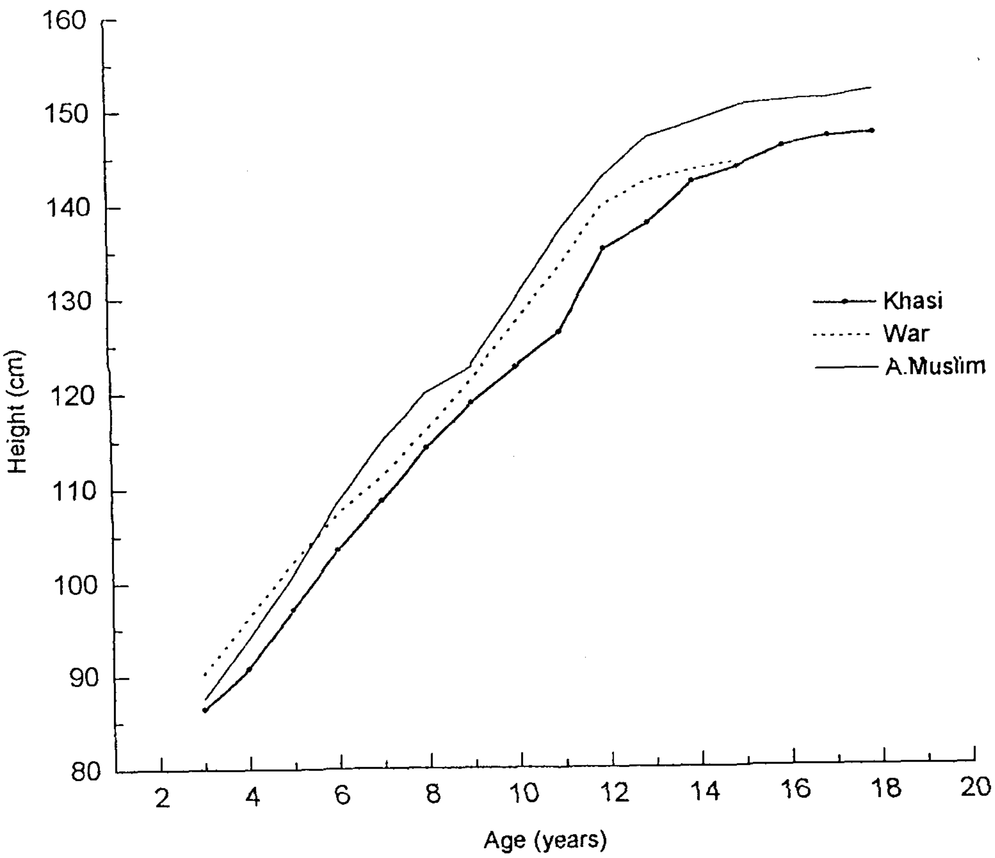


Figure 7.12. Height of girls

Sitting Height

Figure 7.13 shows the mean sitting height of the Khasi boys in comparison with the War Khasi and Assamese Muslim boys. It can be observed that the Khasi boys are lower in sitting height across age groups, i.e., from 3 to 18 years of age. The mean sitting height in the War Khasi boys is higher than in the Assamese Muslim boys from the age of 3 to 6 years; they are more or less similar from 6 to 9 years of age, and thereafter, they are surpassed by Muslim boys. The same trend is observed in the case of girls (Figure 7.14) which indicates that the Khasi girls have the lowest sitting height across age groups, except from 17 years of age when they tend to have a similar sitting height with the Assamese Muslim girls. From 3 to 6 years of age, the War Khasi girls are higher in sitting height than both the Khasi and Assamese Muslim girls, and from about 14 to 15 years of age they are shorter in sitting height than the Khasi girls.

Head Circumference

Like in the case of height and sitting height, Figure 7.15 shows that the Khasi boys have a lower head circumference than the War Khasi and Assamese Muslim boys across age groups. On the other hand, the mean head circumference in the War Khasi boys is in the middle of those for the Khasi and Assamese Muslim boys from 3 to 13 years of age, and thereafter it is higher in the latter than in the former. Unlike in the case of boys, the mean head circumference in Khasi girls is higher than that for the War Khasi girls from 6 to 7 years, and it is also higher than that for the Assamese Muslim girls from 16 to 17 years of age (Figure 7.16). Nevertheless, the War Khasi girls have broader head than the Khasi girls of the present study across age groups, except from 6 to 7 years which is higher in the latter. With respect to the difference between the War Khasi and Assamese Muslim girls, Figure 7.16 shows that the latter have broader head than the former from 3 to 12 years of age, and thereafter it is higher in the former.

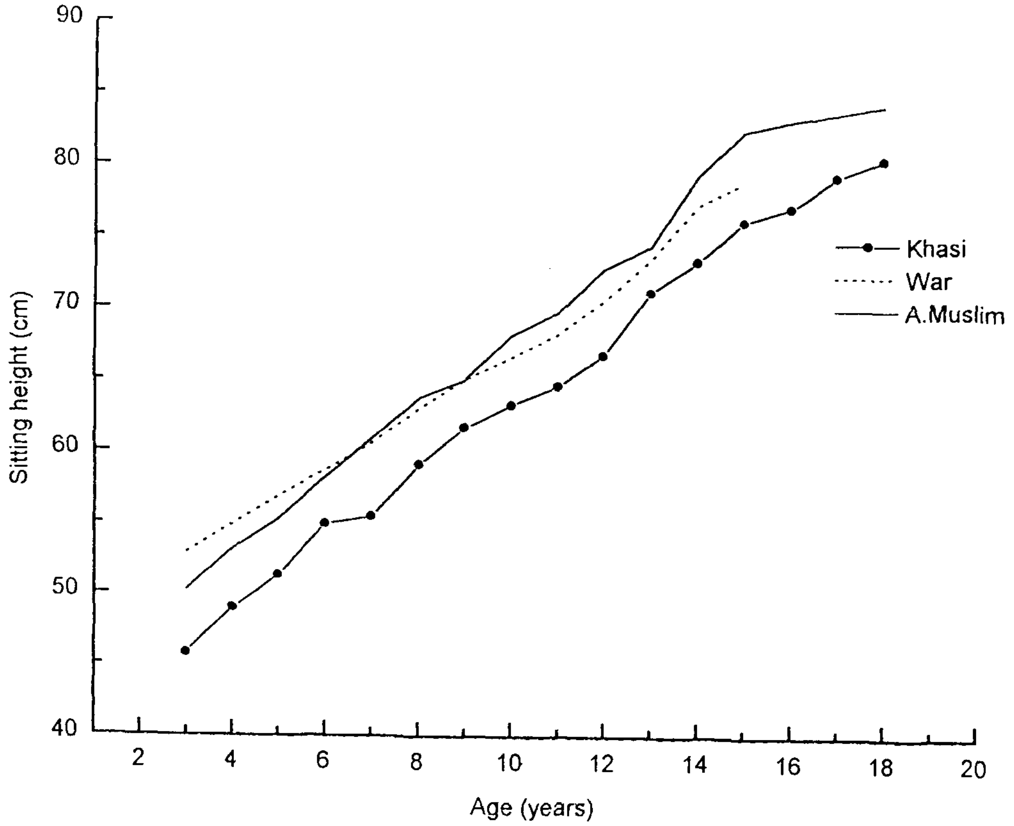


Figure 7.13. Sitting height of boys

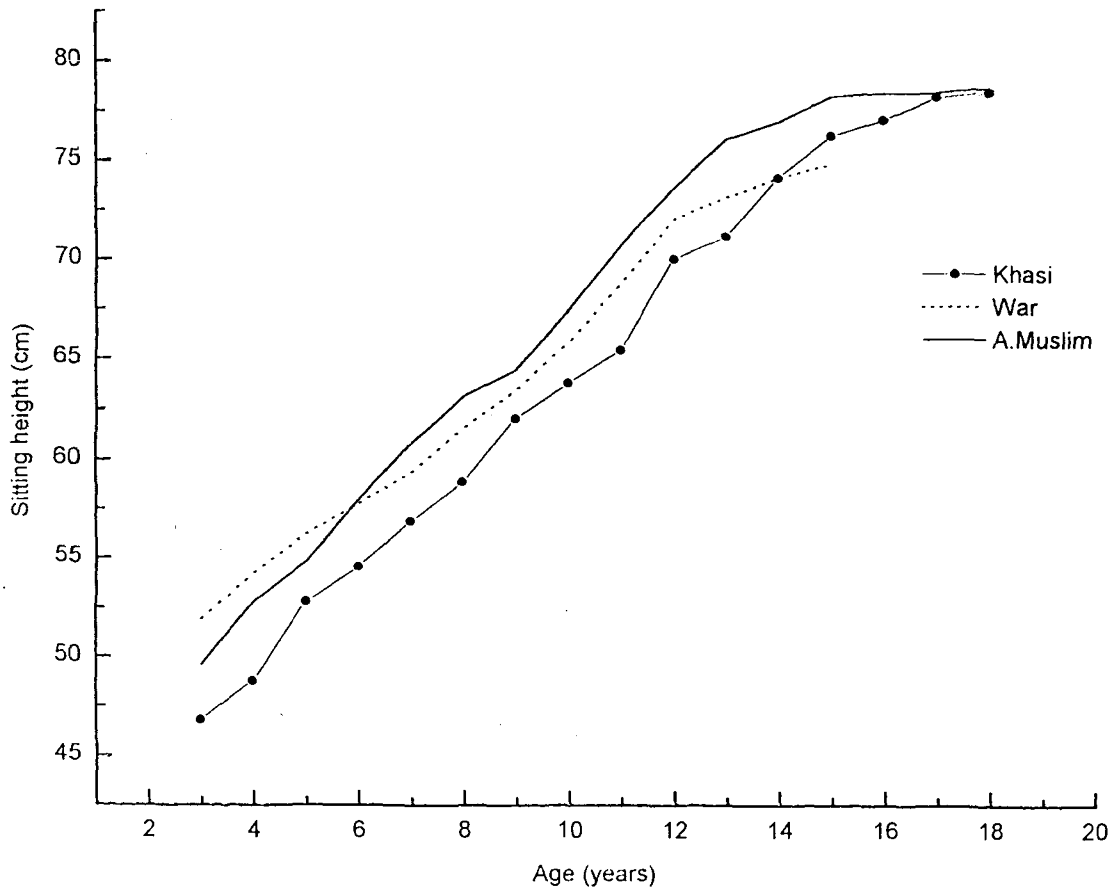


Figure 7.14. Sitting height of girls

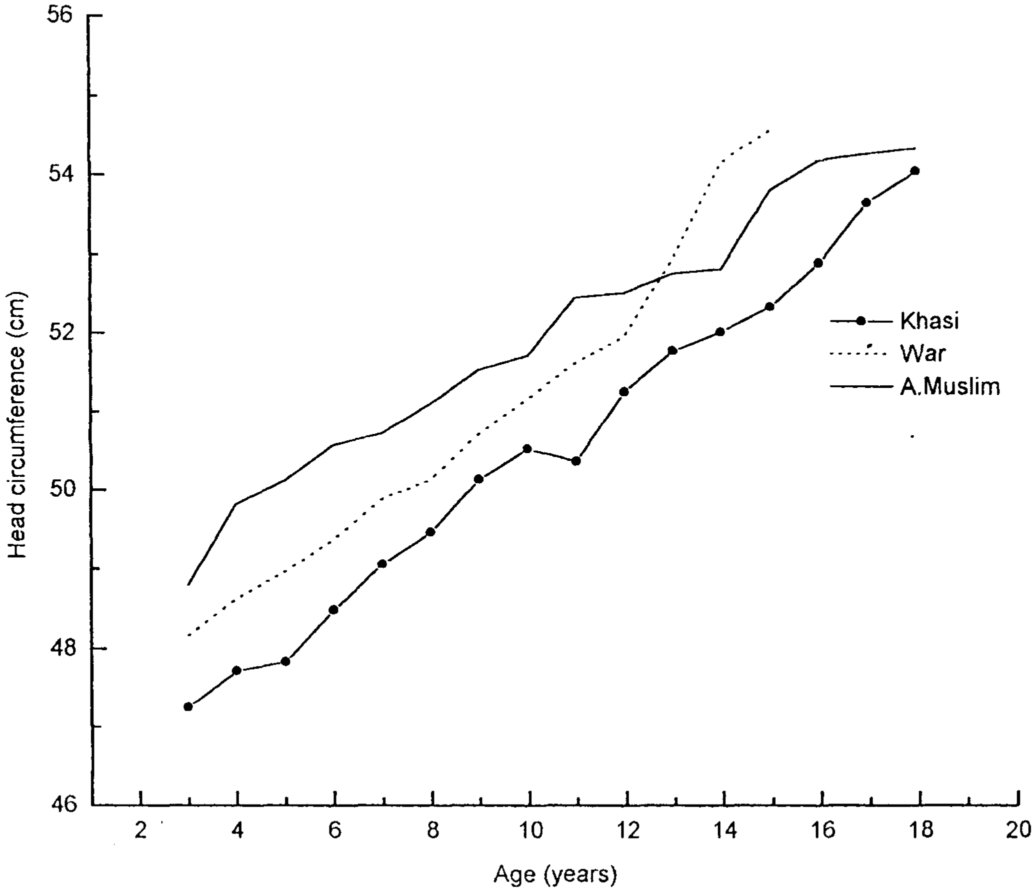


Figure 7. 15. Head circumference of boys

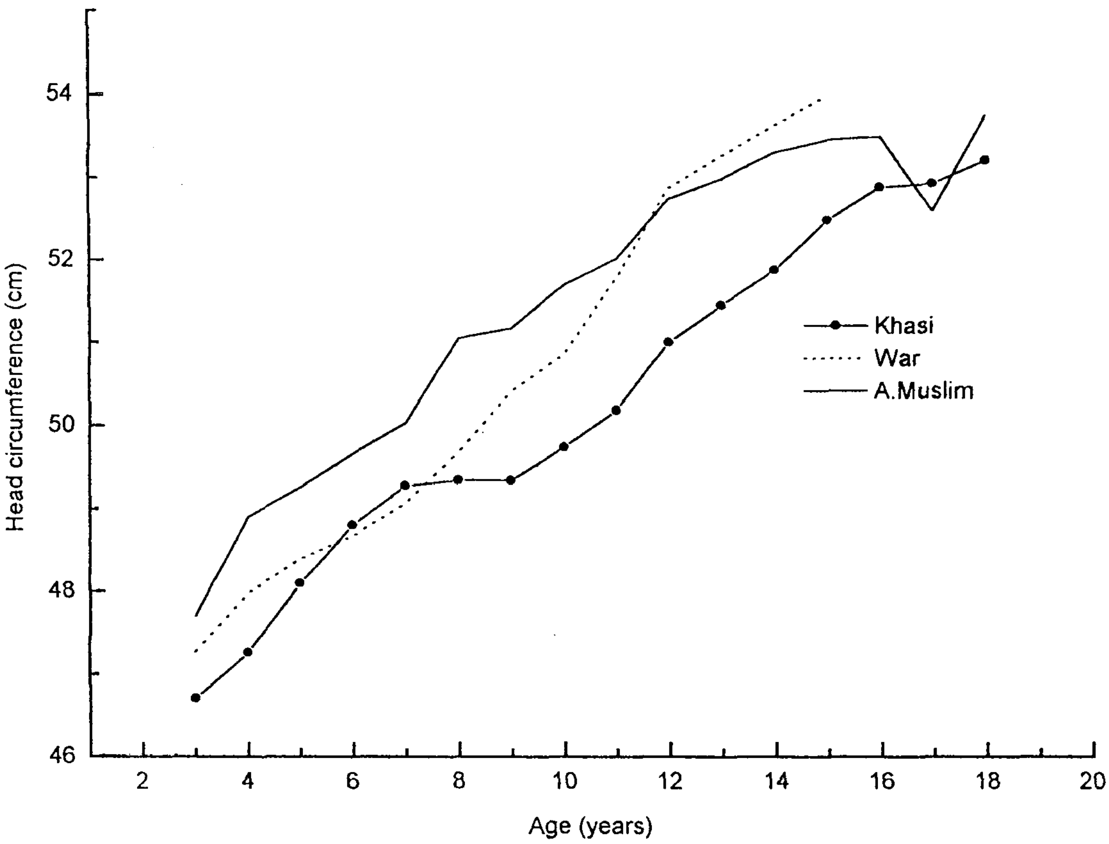


Figure 7.16. Head circumference of girls

Mid Upper Arm Circumference

Figure 7.17 shows the mean arm circumference of the Khasi boys in comparison with the War Khasi and Assamese Muslim boys. It can be seen that like in the case of other measurements the arm circumference is lower in the boys of the present study when compared with the War Khasi and Assamese Muslim boys. This is true in all the age groups. On the other hand, the War Khasi and Assamese Muslim boys are more or less similar in mid upper arm circumference, although it is higher in Assamese Muslims from 3 to 4 years and 14 years onwards. Like in the case of boys, Figure 7.18 shows that the mean value of mid upper arm circumference is lower in the girls of the present study when compared to the War Khasi and Assamese Muslim girls across age groups. Further, the Figure shows that the growth curve for the mid upper arm circumference of the War Khasi boys is more or less similar to that for the Assamese Muslim girls from 10 to 12 years, and it higher in the War Khasi from 7 to 8 years. In other age groups, the mean value of mid upper arm circumference in the Assamese Muslim girls is higher than that in the War Khasi girls.

In view of the above comparison, it is obvious that the Khasi children of the present study are much shorter and lighter than the American children, but they are more or less comparable in weight and height to the Indian children as reported by the ICMR. In comparison with the War Khasi and Assamese children, the children of the present study are by and large similar in weight to the War Khasi and Assamese children, especially from 3 to about 11 years of age. But the children of the present study are shorter than the War Khasi and Assamese children in all age groups, and it is true in the case of sitting height as well. Similarly, the head and mid upper arm circumferences are lower in Khasi children of the present study when compared with the War Khasi and Assamese Muslim children.

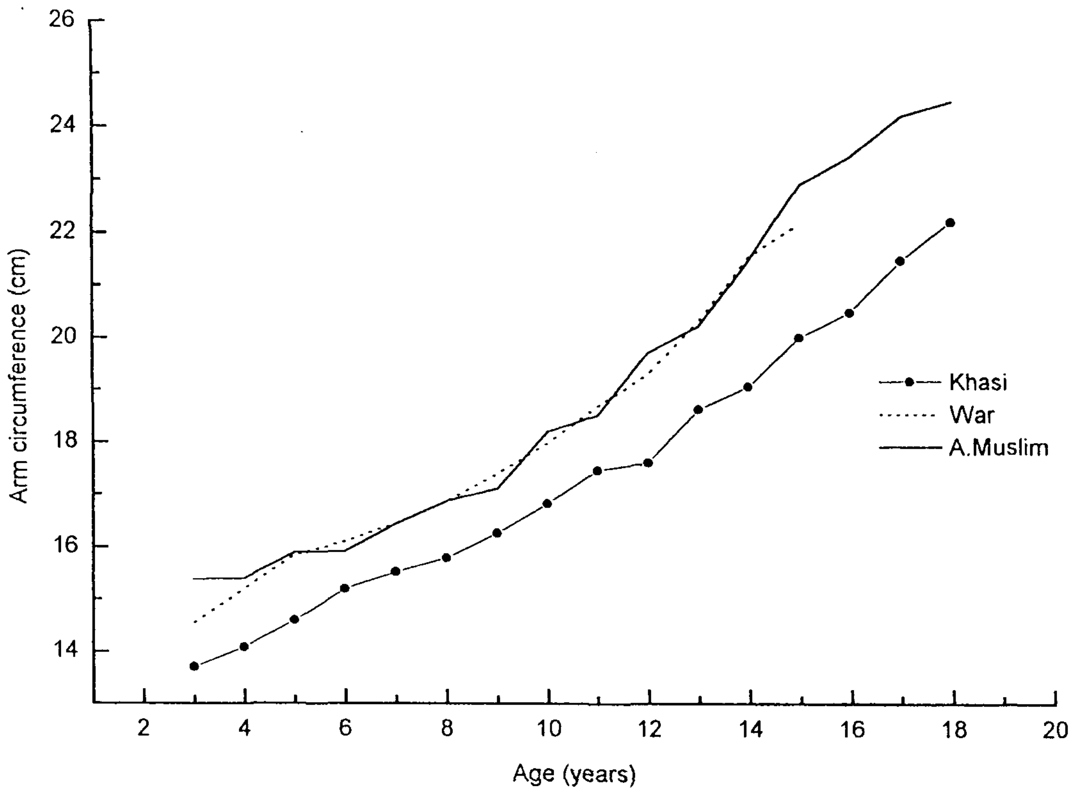


Figure 7.17. Arm circumference of boys

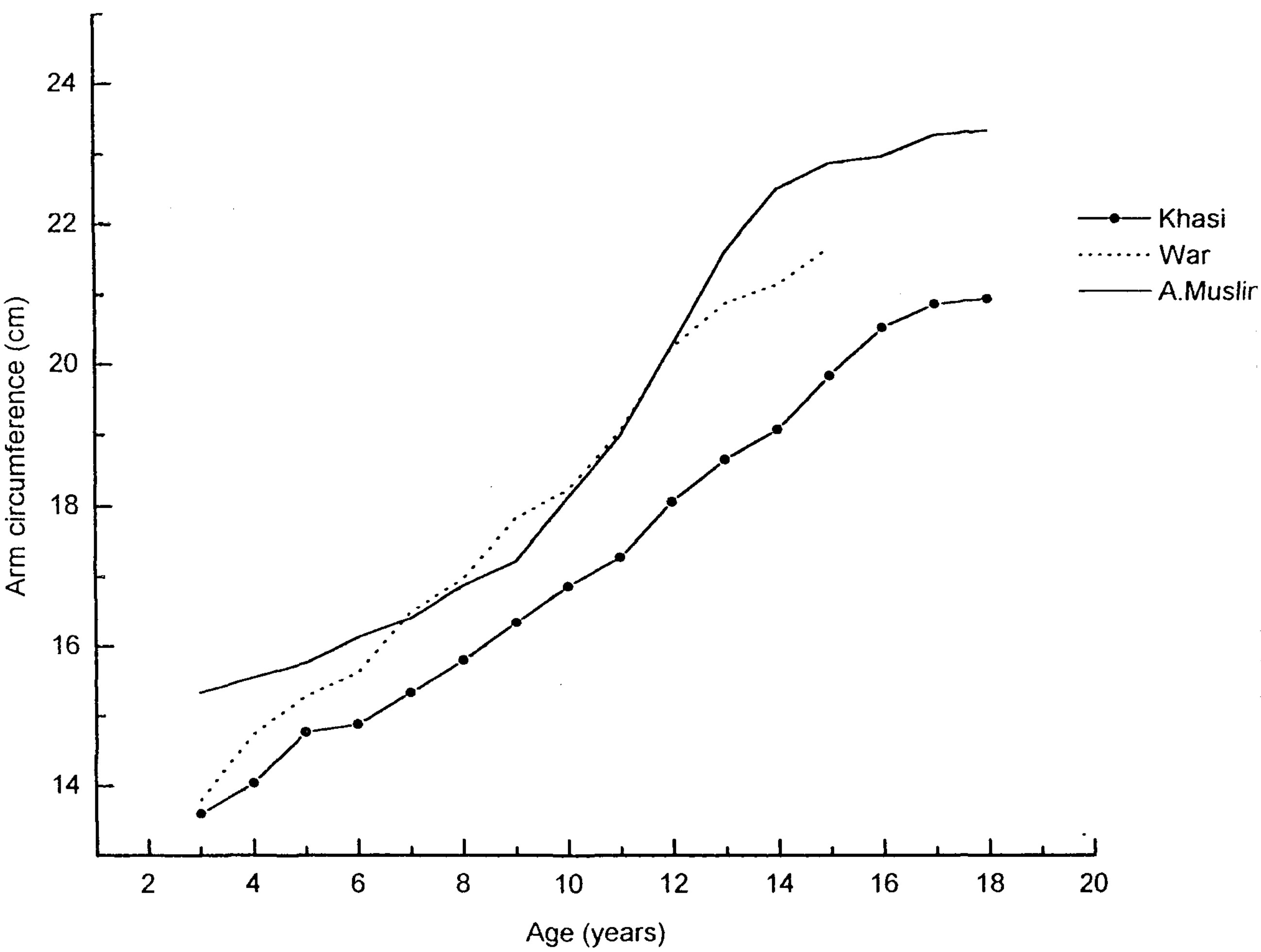


Figure 7. 18. Arm circumference of girls

NUTRITIONAL STATUS

One of the major health problems in many developing countries is the widespread prevalence of undernutrition and infectious diseases (WHO, 1990). It is generally reported that the basic causes of undernutrition and infections in developing countries are poverty, poor hygienic conditions and little access to preventive and health care (Mitra, 1985; WHO, 1990). Hence, assessment of the nutritional status of population has attracted the attention of not only the nutritionists and other biological scientists, but also the economists and other social scientists with a view to understanding the health and socioeconomic status of the population (Osmani, 1992). Nutritional status is defined as the physical expression of the relationship between the nutrient intakes, or bio-availability of nutrients, and the physiological requirements of an individual (Brown, 1984). This physical expression of the relationship between nutrient intakes and physiological requirements of a person can be measured by a number of methods. Of different methods, anthropometry is one that is generally used for measuring the magnitude of undernutrition at both individual and population levels. Anthropometric measurements and indices like weight, height, mid upper arm circumference, skinfold thickness, weight for age, height for age, weight for height, body mass index, indices of upper arm circumference, etc., (Jelliffe, 1966; Frisancho, 1990) are used for assessing the nutritional status of children. In the present study we have taken into consideration three anthropometric indices, i.e., weight for age, height for age and body mass index (BMI, for assessing the nutritional status of children in the present population.

It is observed in Chapter VI that the frequencies of mild, moderate and severe forms of underweight are 44.71%, 30.42% and 1.85% in boys and 48.32%, 22.59% and 1.32% in girls, respectively. It is found that the prevalence of underweight is higher in boys (76.98%) than in girls (72.23%), and the difference is statistically significant (χ^2 = 24.94, DF = 3, P < 0.000). However, most of the underweight children are in the categories of mild and moderate degrees of undernutrition.

With respect to height for age, an indicator of growth retardation, about 95% of boys and girls in the present population are stunt. Whether stunting or short stature of these children should be regarded as growth retardation, thereby indicating of high undernutrition, is a moot question of interest. It has been suggested that the use of national and international population references for assessing the nutritional status of children in terms of height for age may lead to overestimation of undernutrition in children of the short stature population like the Khasis (Khongsdier, 1996b). The same is true in the case of the present population which indicates the high prevalence of underweight and growth retardation according to NCHS growth references. This may also have certain implications if we take into consideration the lower frequency of undernutrition according to body mass index (BMI). It is observed that the frequencies of mild, moderate and severe forms of chronic energy deficiency in the children aged 3 to 9 years of age are respectively 12%, 6% and 8% in boys and 18%, 6% and 8% in girls.

In the case of children aged 10 to 18 years, about 95 % of boys and girls are well nourished in the present population. These results clearly indicate that the prevalence of undernutrition according to BMI is not as high as that indicated by weight and height for age. This may be due to the fact that weight for age and height for age are derived as percentage of the median of the international population reference, whereas BMI is directly obtained as a proportion of weight to the square of height of an individual, thereby it is independent of the so-called standard weight or height. As observed in other populations, BMI seems to be the better indicator of nutritional status than any other indices taken for the present study. Nevertheless, the present findings also indicate that the children in the higher age groups are better in nutritional status than those in the lower age groups, i.e., 3 to 9 years of age.

Nutritional Status and Socio-economic Condition

It is generally reported that the widespread of undernutrition in developing countries is associated with poor hygienic conditions and socio-economic condition of the populations (Mitra, 1985; WHO, 1990). Therefore, assessment of the nutritional status of population has attracted the attention of not only the nutritionists and other biological scientists, but also the economists and other social scientists with a view to understanding the health and socioeconomic status of the population. In the present study, we have also been an attempt to show the prevalence of undernutrition according to religious and income groups of the population. This may be described as follows:

Religion

With respect to religious groups, it is observed that the mean values of all these anthropometric indices are higher in the Muslim children than in the Christian and Niam Khasi children. After adjusting for the effect of economic condition, the one way analysis of covariance (ANCOVA) indicates that the differences in anthropometric indices between religious groups are highly significant for both boys and girls, except the BMI in girls. According to Scheffe's multiple range test, the Muslim boys are significantly higher than the Christian boys in weight for age (Difference ± standard error:5.01 ± 0.81, P < 0.000) and height for age (1.70 ± 0.39, P < 0.000). With respect to BMI, there is an absence of significant difference according to Scheffe's test, but it is significant according to Least Square Significance Difference (0.94 ± 0.44, P < 0.03). The differences between the Muslim and Niam Khasi boys are also significant in respect of all indices (Weight for age: 6.88 ± 0.79, P < 0.000; Height for age: 2.07 ± 0.38, P < 0.000; BMI: 0.96 ± 0.43, P < 0.03). On the other hand, the differences between Christian and Niam Khasi boys are significant only in respect of weight for age (1.87 ± 0.72, P < 0.03). Nevertheless, it is clear that the Muslim boys are heavier than the Christian and Niam Khasi boys in respect of all anthropometric indices, thereby suggesting that the Muslim boys are better in nutritional status.

Among girls the differences between Muslims and Christians according to Scheffe' test are significant in respect of weight for age (3.89 ±0.84, P < 0.000) and height for age (1.86 ± 0.35, P < 0.000), but not in respect of BMI. But the differences between Christian and Niam Khasi girls are not significant in respect of all indices, except in the case of weight for age (2.08 ± 0.76, P < 0.02). Thus, it indicates that the Christian and Niam Khasi children are by and large similar in height for age and BMI, although the former are higher in weight for age than the latter.

In order to have a better understanding of the effect of religion on nutritional status of Khasi children, an attempt has also been made to show the percentage distribution of weight for age according to three religious groups. It is found that about 62.54%, 79.23% and 84.04% of the boys in Muslims, Christians and Niam Khasis, respectively, are underweight. Among girls, these frequencies of underweight are found to be 61.98%, 75.11% and 76.74%, respectively. The Chi-square values indicate that the differences between religious groups in respect of weight for age are highly significant (Boys: $\chi^2 = 70.82$, DF = 6, P < 0.000; Girls: $\chi^2 = 46.87$, DF = 6, P < 0.000). Thus, the Muslim Khasi boys and girls are better in weight for age when compared to their counterparts belonging to Christianity (Boys: $\chi^2 = 38.75$, DF = 2, P < 0.000; Girls: $\chi^2 = 20.20$, DF = 2, P < 0.000) and Niam Khasi (Boys: $\chi^2 = 66.58$, DF = 2, P < 0.000; Girls: $\chi^2 = 40.94$, DF = 2, P<0.000). On the other hand, the Christian Khasi children are heavier than the Niam Khasi children, although the differences are not statistically significant in the case of boys (Boys: $\chi^2 = 4.04$, DF = 2, P > 0.05; Girls: $\chi^2 = 8.56$, DF = 2, P < 0.01). Thus, the Muslim children are heavier than the Christian and Niam Khasi children, and the differences between the Christian and Niam Khasi children are significant only in the case of girls, i.e., the Christian girls are heavier than the Niam Khasi girls.

Like in the case of weight for age, the Muslim Khasi children are taller than the Christian and Niam Khasi children. It is found that the prevalence of stunting or growth retardation in boys is about 94.69%, 96.57% and 95.60% respectively in the Muslim, Christian and Niam Khasis. In the case of girls, these frequencies are 92.05%, 94.47% and 97.37%, respectively. The Chi-square values indicate that the differences in the percentage distribution of normal, mild, moderate and severe forms of nutritional status in respect of height for age are highly significant for both boys and girls (Boys: $\chi^2 = 24.89$, DF = 6, P < 0.001; Girls: $\chi^2 = 40.32$, DF = 6, P < 0.000).

It indicates that the children of Muslim Khasi are less retarded when compared with the Christian and Niam Khasi children, despite the fact that the prevalence of stunting is high in all the religious groups. With respect to the difference between the Christian and Niam Khasi children, the frequency of mild and moderate forms of growth retardation is higher in the Christian boys than in the Niam Khasi boys, but the frequency of severe form is higher in the latter than in the former, despite the absence of statistical difference. In the case of girls, the situation is reverse, which shows that the prevalence of mild and moderate forms of growth retardation is higher in the Niam Khasis than in the Christian Khasis, but the frequency of severe form of growth retardation is higher in the latter than in the former, although these differences are not statistically significant. So the Christian and Niam Khasi children are by and large similar in the prevalence of growth retardation. The significant differences between religious groups as indicated by the overall Chi-square test are mainly due to the differences between the Khasi Muslim children and other religious groups.

With respect to BMI, in the age group 3 to 9 years, about 19.74%, 24.88%% and 31.15% of boys and 21.18%, 19.34% and 29.36% of girls in the Muslims, Christians and Niam Khasis, respectively, have suffered from chronic energy deficiency. Thus it indicates that the prevalence of chronic energy deficiency is lower among the Muslims than that among the Christians and Niam Khasis, though it is lower among the Christians in the case of girls. However, the Chi-square test indicates that the differences between religious groups are significant only in boys (χ^2 = 18.76, DF= 6, P < 0.01) but not in girls (χ^2 = 7.81, DF= 6, P > 0.05). In the age group 10-18 years, the differences between religious groups in respect of BMI are not statistically significant for both boys and girls. Thus, it indicates that religion plays little role in influencing the BMI of the children in the present study, although the influence of religion on weight for age and height for age seems to be important. It clearly shows that the Muslim children are heavier and taller than the Christian and Niam Khasi children. One possible explanation of such a trend in the Muslims may be due to intermixture, i.e., the Muslim children are by and large the product of the intermixture between the Khasi females and the Muslim males who migrated to Meghalaya from other parts of India.

Economic Condition

With the exception of few cases, the mean values of weight for age, height for age and BMI are lower in the LIG when compared to the MIG and HIG. Adjusting for religion, the ANCOVA test also indicates that the differences between income groups are significant in respect of all anthropometric indices for both boys and girls. According to Scheffe's test, the LIG children are significantly lower than those in the MIG and HIG in respect of all the three anthropometric indices, irrespective of the difference between LIG and MIG in respect of BMI for girls (1.20 ± 0.36, P < 0.004). Likewise, the differences between MIG and HIG children are highly significant for weight for age, height for age and BMI.

In order to have a better understanding of the effect of economic condition on the nutritional status of the children in the present study, we have also made an attempt to show the prevalence of undernutrition according to three income groups. With respect to weight for age, it is found that about 81.90%, 76.60% and 67.73% of the boys and 79.52%, 72.94% and 58.96% of girls are underweight in the LIG, MIG and HIG, respectively. It indicates that the proportion of underweight children decreases with the rise in income levels of the household. The Chi-square values also indicate that the differences between income groups in respect of the distribution of children according to different degrees of underweight are highly significant for both boys (χ^2 = 107.09, DF = 6, P < 0.000) and girls (χ^2 = 62.08, DF = 6, P < 0.000). Thus, it suggests that the income of household is very important in influencing the nutritional status of children according to weight for age as has been observed with regards to ANCOVA test.

With respect to height for age, the prevalence of stunting is very high in all the income groups for both boys and girls, but the percentage is higher in the lower income groups when compared with the HIG. Such a trend is also observed with respect to the prevalence of severe forms of growth retardation, which is much higher in the LIG and MIG when compared with the HIG. These differences between income groups in respect of height for age are statistically significant for both boys (χ^2 = 102.50, DF = 6, P < 0.000) and girls (χ^2 = 99.15, DF = 6, P < 0.000). This clearly indicates that income of the household plays a very important role in influencing the height for age of the children of the present study.

With respect to BMI, the differences between income groups in respect of BMI are not significant in girls for both the age groups 3-9 and 10-18 years. But in the case of boys, the income of household seems to be important and the differences between income groups are significant for both the age groups. For the age group 3-9 years, the prevalence of chronic energy deficiency in boys is about 31.11%, 22.75% and 21.09% in LIG, MIG and HIG, respectively. These frequencies are about 8.36%, 1.04% and 3.90% respectively in the age group 10-18 years. Thus, it is obvious that the prevalence of chronic energy deficiency is higher in the LIG when compared to the MIG and HIG, and the influence of the income of household is clearly significant in BMI of boys, although it is also perceptible in girls.

CONCLUDING REMARKS

Growth and Nutritional Status

In comparison with international and national growth references, the Khasi children of the present study are much shorter and lighter than the U.S. NCHS children, but they are more or less comparable in weight and height to the Indian children as reported by the ICMR. In comparison with neighbouring populations, the children of the present study are by and large similar in weight to the War Khasi and Assamese children, especially from 3 to about 11 years of age. But they are shorter than the War Khasi and Assamese children in all age groups, and it is true in the case of sitting height as well. Similarly, the head and mid upper arm circumferences are lower in Khasi children of the present study when compared with the War Khasi and Assamese Muslim children.

These findings may have certain implications for ethnic or genetic variation in growth and nutritional status of population. It is obvious that anthropometric indices like height for age and even weight for age in relation to the so-called international standards (references) cannot be used as indicators of the nutritional status in a short stature population like the Khasi, especially in the higher age groups (Khongsdier, 1996b). Thus, BMI may be considered a better indicator of the nutritional status of children in the present study. It is likely that differences in stature between populations may be related not only to nutrition, but also to physical environment and genetic factors (Payne, 1992). However, this does not mean to reject the international references completely; their use is very important for comparative studies.

It may however be noted that the differences between religious groups are mainly due to the differences between the Muslim children and the Christian and Niam Khasi children. It is found that the Muslim children are heavier and taller than the Christian and Niam Khasi children, and there is not much difference between the Christians and Niam Khasis in respect of growth pattern, except in few cases.

Thus, it indicates that religion plays little role in influencing the BMI of the children in the present study, although the influence of religion on weight for age and height for age seems to be important. It clearly shows that the Muslim children are heavier and taller than the Christian and Niam Khasi children. One possible explanation of such a trend in the Muslims may be due to intermixture, i.e., the Muslim children in the present study are by and large the product of the intermixture between the Khasi females and the Muslim males who migrated to Meghalaya from different corners.

CHAPTER VIII
SUMMARY

Introduction

Human evolution and variation are the two major objectives of study in physical anthropology. These two objectives of study are overlapping, and they cover a vast area of biological interest ranging from simple anthropometric study to molecular study of human evolution and variation. Recently, efforts have also been made to understand the relationship between human biology, especially to those aspects relating to health and nutrition, and various socio-cultural factors (Strickland and Tuffrey, 1997). In fact, it is now believed that the human biological processes are largely influenced by various sociocultural aspects of the human society. Thus, it is quite imperative on the part of physical anthropologists to undertake such studies with a view to understanding not only the processes of human evolution, but also the health and nutritional aspect of human population.

From an evolutionary point of view, demographic parameters like fertility and mortality are very important to understand the genetic make up of a population. It is theoretically believed that natural selection, one of the major evolutionary forces, is operating on human population through differential fertility and mortality (Crow, 1958; Johnston, 1973). Similarly, other demographic parameters like population size, mating patterns admixture rate, migration, etc., are very helpful in understanding the biological characteristics of the population (Basu, 1969; Ghosh, 1976; Khongsdier and Ghosh, 1994). However, demographic parameters like fertility and mortality are largely influenced by various socioeconomic factors like religion, education, income, occupation, age at marriage, adoption of family planning, etc. (Mosley and Chen, 1984; Mahadevan, 1986; Muhuri, 1995; World Bank, 1999; Caldwell *et al.*, 1999; and others). So, it is quite imperative on the part of physical anthropologists to undertake studies on the effect of socioeconomic conditions on demographic parameters, particularly on fertility and mortality.

Besides the demographic aspects of population, physical growth and development of children is another important field of anthropological research. By the term growth, we mean a " quantitative increase in size or mass" of an organism, while development refers to a "progression of changes, either quantitative or qualitative, that leads from an undifferentiated or immature state to a highly organized, specialized, and mature state" (Bogin, 1999). The pattern of human growth serves as a type of mirror that reflects the biocultural evolution of human population. "Human biocultural evolution produced the pattern of growth and development that converts a single fertilized cell, with its complement of deoxyribonucleic acid (DNA) into a multicellular organism composed of hundreds of different tissues, organs, behavioral capabilities and emotions" (Bogin, 1999).

According to Tanner (1988), "The study of growth is important in elucidating the mechanism of evolution, for the evolution of morphological characters necessarily comes about through alteration in the inherited pattern of growth and development. Growth also occupies an important place in the study of individual differences in form and function of man, for many of these also arise through differential rates of growth of particular parts of the body relative to others". Further, Eveleth and Tanner (1990) have also observed "A Child's growth rate reflects, perhaps 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 height and weight reflect accurately the state of a nation's public health and the average nutritional status of its citizens, when appropriate allowance is made for differences, if any, in genetic potential. This is especially so in developing and disintegrating countries". Therefore a well-designed growth study is very important tool for assessing the health status of a population. Since human growth and development is also largely influenced by socio-environmental factors like nutrition, infection, occupation, income and religion, it is very vital for understanding the biocultural variation and evolution of human populations (Tanner 1988, Eveleth and Tanner, 1990).

In the light of the above circumstances, demographic parameters and physical growth are helpful not only in understanding the process of human evolution and variation, but also reflect the health and economic condition of a population. In India, growth studies are very recent in origin, which still warrants further researches. So, it may be essential to conduct more researches on physical growth and development of children with a view to understanding the economic conditions and health and/or nutritional status of the different populations. It may be mentioned here that very few growth studies have so far been published in Northeast India (see review, Khongsdier and Ghosh, 1998). Moreover, almost all studies have been carried out among some populations of Assam only. Likewise, demographic studies of populations are very limited in number in this part of the country (Khongsdier, 2001).

With this end in view, we have undertaken a study on demography and growth pattern among the Khasi children of Shillong in Meghalaya with a view to understanding the following objectives:

1. To understand the demographic structure of the three religious groups of the Khasis, namely, Christians, Muslims and Niam Khasis of Shillong.
2. To understand the growth pattern and nutritional status of children aged 3 to 18 years.
3. To assess the effects of some socioeconomic factors like religion, income of household, etc., on demographic parameters, and growth patterns of children.

MATERIALS AND METHODS

Study Area and population

Khasi population is mainly distributed in Khasi and Jaintia hills of the State of Meghalaya. The term "Khasis" is a generic name referring to any one or all the five major subgroups, namely, Khynriams, Pnars, Bhois, Wars and Lyngngams. However, in the present study, we are mainly concerned with the Khynriams, who are also known as the Khasi proper.

The fieldwork was conducted in different intervals between November 1996 and February 1998 in Shillong. No sampling technique was applied for the selection of samples at both individual and population levels. However, an effort was made to include in our study the three major religious groups, namely, Christian Khasis, Khasis of traditional religion (referred to herein as Niam Khasis), and Muslim Khasis. The Christian Khasis and Niam Khasis are distributed all over the Khasi hills, but the Muslim Khasis are mainly concentrated in Shillong, the capital of the state. Therefore, the present study was confined to Shillong only. According to our list of Muslim households prepared with the help of Islamic Organization of Shillong, the Muslim Khasis are restricted to certain localities such as Laban, Bishnupur, Garikhana, although some of them are also scattered in Nongthymmai, Laitumkhrah, Lawsohtun and Lummawbah areas. Therefore, data for the present study were collected from 584 households of the three religious groups inhabiting in the above mentioned localities of Shillong.

Demographic data: The nature of demographic data collected for the present study was based on those parameters suggested by the World Health Organization Working Group (WHO, 1964, 1968). Structured schedules were prepared relating to household census, fertility, mortality and socioeconomic parameters, and these schedules were completed through in-depth interview with the heads or elder members of households. A household schedule was used for the collection of data on individual records and socioeconomic parameters like name of informant, age, sex, marital status, relationship to head of the household, date and place at which record was taken, clan, tribe, religion, occupation, education, monthly income, community affiliation, total number of family members, place of birth, place of residence, etc. The fertility and mortality schedules were used for collection of data on pregnancy records of each mother, which include total number of conception, total number of live-births, birth order; age, sex and marital status of each offspring; number of dead children, sex, date of birth, age at death, causes of death, if any, number of reproductive wastage (abortions and still- births).

Data on Growth of Children: A cross-sectional method of study was followed for collection of data on physical growth of 2719 children aged 3 to 18 years (Eveleth and Tanner, 1990), taking into consideration the following anthropometric measurements:

Weight (kg)

Height vertex (cm)

Sitting height (cm)

Biacromial diameter (cm)

Bi-iliac diameter (cm)

Head circumference (cm)

Mid upper arm circumference (left) (cm)

Chest girth (cm)

An attempt was made to follow as far as possible the standard techniques of taking the measurements as described in Weiner and Lourie (1981). For assessing the nutritional status of children, we have adopted three anthropometric indices - weight for age, height for age and weight for height - which are considered as the indicators of nutritional status. These indices were derived as percentage of the international standard or reference, i.e., the growth reference of the U.S. National Centre for Health Statistics (NCHS, 2000).

Socio-economic Categories

In the present study, three important socio-economic variables were taken into consideration. These include religion, monthly income of the household and level of education. These socio-economic variables were classified arbitrarily into a different group and/or category with a view to understanding their influence on demographic characteristics and growth and nutritional status of the study population. Our classification may be briefly described as follows:

Religious groups: The Khasi population (mostly Khynriams) of the present study is divided into three broad religious groups, namely, the Christian Khasis, Niam Khasis and Muslim Khasis. By *Christian Khasis*, we mean those Khasis who have embraced Christianity or those Khasis who are Christians by faith, and the *Niam Khasis* refer to those Khasis who have followed and maintained their traditional religion. On the other hand, the Muslim Khasis are those Khasis who have embraced Islam, and the children belonging to this religious group are by and large the product of the intermixture between the Khasi females and Muslim males.

Income groups: The interval estimation based on standard deviation of the per capita monthly income of household was adopted for classifying the three economic groups (Khongsdier, 1997). Accordingly, the three economic groups were classified as follows:

Above ($\bar{X} + 4SD/\sqrt{N}$) = High income group (HIG)

($\bar{X}$ - 4SD/√N) to (Mean + 4SD/√N) = Middle income group (MIG)
Below ($\bar{X}$ - 4SD/√N) = Low income group (LIG)

Educational Level: The data on educational attainment of individuals in the present study were arbitrarily classified as follows: Individuals who were unable to read and write were classified as **Illiterate.** The individuals who were able to read and write and those who attended school up to standard IV were grouped into **Primary** level of education. **Secondary level** of education includes all those persons who attended school up to below matriculation. The individuals with education up to matriculation and above are included in the category of **Higher level** of education due to inadequacy of data.
Statistical Analyses: The data collected for the present study are quantified and analysed statistically, using SPSS Window software. The data are presented in terms of means, standard deviation, standard error and proportions or percentages. The differences between two means were tested, using t-student test, while the differences between more than two means were determined, using one-way analysis of variance (ANOVA). Analysis of covariance was also carried out for testing the differences among means, allowing for the effects of other covariates. The differences between proportions were tested, using chi-square test. Multiple regression analysis was also carried out for understanding the effects of socio-economic factors on demographic parameters and growth patterns of children. Logistic regression analysis was used for analyzing the effects of maternal age, education, income and religion on infant mortality.

FINDINGS OF THE PRESENT STUDY

The findings of the present study are presented in three chapters. In chapter IV, we deal with the demographic characteristics of the three religious groups. The growth and nutritional status of children are presented in Chapters V and VI, respectively.

Demographic characteristics: The findings on important demographic characteristics of the three religious groups are as follows:

1. According to Sundbarg's classification of population, a population is said to be *progressive* when the number of persons in relation to the total population are

40.0%, 50.00% and 10.00% in the age groups 0-14, 15-49 and 50 + years, respectively. The population is referred to as *stationary* if these frequencies are 33.00%, 50.00% and 17.00%, respectively; while the frequencies of 20.00%, 50.00% and 30.00%, respectively, are the characteristics of *regressive* population (Khongsdier, 2001). Following these classifications of population, the three religious groups of the Khasi population are found to be *progressive type.*

2. The over all sex ratio, i.e., the number of males per 100 females, is found to be 96.54, 95.14 and 97.99 in the Christians, Muslims and Niam Khasis, respectively, which is low despite absence of statistical difference from the ideal sex ratio of 1:1 for all the religious groups.

3. The mean age at marriage is much higher in males than in females for all religious groups. Among males it is found to be 25.48 ± 0.19, 25.45 ± 0.17 and 25.94 ± 0.21 years in the Christians, Muslims and Niam Khasis, respectively. In the case of females, these mean values are 20.32 ± 0.21, 20.30 ± 0.19 and 20.35 ± 0.25 years, respectively. The mean age at marriage among the Muslim, Christian and Niam Khasi women of the present study is higher than those reported for the populations of Assam (Sengupta and Gogoi, 1995), but it is more less similar to that reported for the War Khasi (Khongsdier, 2001).

Fertility

1. The mean live births per mother living in wedlock till the age of 45 are found to be 4.50 ± 0.13, 4.89 ± 0.18 and 4.82 ± 0.15 in the Christians, Muslims and Niam Khasis, respectively. Although it is slightly higher in the Muslims and Niam Khasis, the one-way analysis of variance (ANOVA) indicates that the differences between religious groups are not statistically significant ($F = 190$, $P > 0.05$). These mean live births to women living in wedlock for the three religious groups are similar to those reported for the Christian (4.08) and Non-Christian (4.91) War Khasis (Khongsdier, 2001).

2. With regard to all married women of all ages, the mean live births are 4.93 ± 0.14, 5.31 ± 0.17 and 5.18 ± 0.15 in the Christians, Muslims and Niam Khasis, respectively, and the mean surviving children are 4.51 ± 0.11, 4.77 ± 0.14 and 4.61 ± 0.13, respectively. Thus, it indicates that the mean live births and surviving

children are higher in the Muslims and Niam Khasis in comparison with the Christians, despite the absence of statistical significance (Live births: F= 1.57, P > 0.05; Surviving children: F = 1.01, P> 0.05). In comparison with other populations, the three religious groups of the present study have higher live births than the Christian (4.81) War Khasis (Khongsdier, 2001) and the Kochs of Garo Hills (Kotal, 2001).

3. The age specific fertility rate is found to have reached its peak point in the age group 25- 29 years in all the religious groups, and the total fertility rates are 5.38, 5.85 and 5.85 in the Christians, Muslims and Niam Khasis, respectively. Thus, it indicates that the fertility rates are slightly higher in the Muslims and Niam Khasis when compared with the Christians. The total fertility rate in these three religious groups is more or less similar to the War Khasi, but much higher than that reported for the state of Meghalaya (NCHS, 1999) and the Kochs of Garo hills (Kotal, 2001), although it is not as high as that reported for the Dalus (Patra and Kapoor, 1996).

Mortality

1. The infant mortality rates (i.e., number of deaths before 1 year of life per 100 live births) are 6.82%, 8.39% and 8.60% in the Christians, Muslims and Niam Khasis, respectively. Thus, the infant mortality rates are lower in the Christians than in the Muslims and Niam Khasis, despite the absence of statistical difference (χ^2 = 3.60, DF = 2, P > 0.05). With respect to juvenile mortality, the frequency is more or less same in the Christians (1.74%) and Muslims (1.68%), but it is higher in the Niam Khasis (2.33%), though the differences between the religious groups are not statistically significant (χ^2 = 1.79, DF = 2, P > 0.05).
2. The infant mortality rates in the Christians of the present study are similar to Christian War Khasis (6.89%), while the rates in the Muslims and Niam Khasis are similar to the Non-Christian War Khasi (Khongsdier), and for the state of Meghalaya (NCHS, 1999). However, the religious groups of the present study have lower infant and juvenile mortality rates than the Dalus (Patra and Kapoor, 1996) and Chapra Kochs (Kotal, 2001) of Garo hills.

3. With respect to reproductive wastage, it is found that the still birth rates (i.e., number of still-births per 100 pregnancies) are 3.16%, 3.18% and 3.56% in the Christians, Muslims and Niam Khasis respectively, and the abortion rates to these three religious groups (i.e., number of abortions per 100 pregnancies) are 4.32%, 4.64% and 4.60%, respectively. Thus, the rates of reproductive wastage (i.e., number of abortions and still-births per 100 pregnancies) are 7.47%, 7.82% and 8.16% in the Christians, Muslims and Niam Khasis, respectively. It appears that the Muslims and Niam Khasis are more or less similar in the frequency of reproductive wastage, and it is slightly higher in the Christians, despite the absence of statistical difference ($\chi^2 = 0.42$, DF = 2, $P > 0.05$). Like in the case of infant mortality, the frequencies of reproductive wastage in the three religious groups of the present study are similar to those reported for the War Khasis (Khongsdier, 2001), but higher than those reported for the Dalus (4.93%) of Garo hills (Patra and Kapoor, 1996).

Socio-economic Correlates: In this thesis, an attempt has also been made to show the relationship between the demographic parameters and socio-economic factors like age of mothers, age at marriage, education of mothers, and income of household for all the three religious groups. The findings may be briefly described as follows:

1. It is found that the mean number of live births per married woman decreases with the rise in age at marriage. It holds true for the Christians, Muslims and Niam Khasis. The results of the multiple regression analysis on the effect of age at marriage on the number of live births after controlling for other factors like age, educational level, and income are shown in Chapter IV. It is found that the coefficient of regression (b± SE) on the effect of age at marriage (independent variable) on the number of live births (dependent variable) is negatively significant for all the religious groups (Christians: $b = -0.220 \pm 0.033$, $t = 6.74$, $P < 0.0001$, Muslims: $b = -0.218 \pm 0.041$, $t = 5.43$, $P < 0.0001$, and Niam Khasis: $b = -0.186 \pm 0.044$, $t = 4.27$, $P < 0.0001$). Thus, the present findings indicate that age at

marriage is a very important factor in controlling the fertility rates for all the religious groups.

2. As regards education, the coefficient of regression on the effect of education (independent variable) on the number of live births (dependent variable) is negative, but not significant in the Christians ($b = -0.136 \pm 0.098$, $t = 1.39$, $P > 0.05$) and Muslims (-0.002 ± 0.124, $t = 0.02$, $P > 0.05$), although it is negatively significant in the Niam Khasis (-0.448 ± 0.127, $t = 3.52$, $P < 0.0001$). Thus, the present findings indicate that the education is not as important as expected in controlling the fertility rates among the Muslim and Christian Khasis, but it is certainly important in the Niam Khasis.

3. It is also found that the mean number of live births tends to decrease significantly with the increasing level of income level of the mothers for all the religious groups. The results of the multiple regression analysis (Chapter IV) show that the effect of income on the number of live births after controlling for other factors like age, age at marriage, and educational level is negatively significant for all the religious groups (Christians: $b = -0.832 \pm 0.151$, $t = 5.52$, $P < 0.0001$, Muslims: $b = -0.739 \pm 0.189$, $t = 3.92$, $P < 0.001$, and Niam Khasis: $b = -0.987 \pm 0.161$, $t = 6.12$, $P < 0.0001$). Thus, the present findings indicate that the income of the household is a very important in controlling the fertility rates in the present population, irrespective of religious groups.

In view of all the socio-economic factors, the fertility rate in the present population is negatively associated with the age at marriage and income levels of mothers. The effect of education, on the other hand, is not clearly perceptible in the present study, except among the Niam Khasi mothers, which indicates that educational level of the mothers is also very important in regulating the fertility rate. The effect of religion on fertility rate is not significant, although the total fertility rate is more or less same among the Muslims and Niam Khasis, but it is lower in the Christians.

With respect to infant mortality (Chapter IV), it is found that the regression coefficient ($\beta \pm$ standard error) of infant mortality (dependent variable) on maternal age is positively significant (0.021 ± 0.008, $P < 0.011$), and it is negatively significant with respect to education (-0.150 ± 0.074, $P < 0.043$) and income (-1.283 ± 0.125, $P < 0.000$).

On the other hand, the effect of religion on infant mortality is not statistically significant (0.051 ± 0.101, $P > 0.05$). Thus, it indicates that maternal age, education and income are very important in influencing infant mortality in the present population.

GROWTH PATTERN

In the present study, we have described the growth pattern of the Khasi both boys and girls taking into consideration the body weight, height, sitting height, biacromial diameter, bi-iliac diameter, head circumference, arm circumference and chest circumference.

Estimation of adult height: According to fourth degree polynomial model by which the height is equal to $64.19 + 8.59(\text{Age}) - 0.47(\text{Age})^2 + 0.03(\text{Age})^3 - 5.46\,(\text{Age})^4$ cm for boys and to $65.53 + 7.79(\text{Age}) - 0.43(\text{Age})^2 + 0.04(\text{Age})^3 - 0.001(\text{Age})^4$ cm for girls, the estimated value for adult height is found to be 154.20 cm for males and 146.83 cm for females. This indicates that the girls have reached their adult height by the age of 18, while the boys still continue to grow. The present observation seems to confirm that observation among the Assamese Muslim girls of Assam, though it is not so in the case of boys (Begum and Choudhury, 1990).

Growth Pattern in Comparison With NCHS and ICMR Growth References

In order to have a better understanding of the growth status of the children in this study, an attempt has been made to compare their weight and height with those given by the U.S. National Centre for Health Statistics (NCHS, 2000) and Indian Council of Medical Research (ICMR, 1972). We have restricted only to weight and height as data on other anthropometric measurements are not available in the latest NCHS growth reference.

With respect to weight, it has been observed that the mean weight of the Khasi boys is more or less to the 25th percentiles of NCHS growth reference from 3 to 6 years of age. From 6 to 8 and 13 to 16 years of age, the curve for the mean weight of Khasi boys lies between 5th and 10th percentiles, and it is closer to the 10th percentile from 8 to about 11 years of age. From 11 to 13 years, it is closer to the 5th percentile of the growth reference, and from 16 years onwards the growth curve for the Khasi boys lies below the

5th percentile. It may be mentioned that the 50th percentile of the NCHS data is generally considered as 100 per cent normal growth for children.

Like in the case of boys, the mean weight of girls falls at 25th percentile of the NCHS reference from 3 to 6 years of age, and thereafter it drops into 10th percentile up to about the age of 10. From 10 years onwards, the growth curve for the weight of Khasi girls lies more or less between 5th and 10th percentiles of the NCHS reference.

It is found that the mean weights of Khasi boys and girls are far below the 50th percentile of the NCHS growth reference especially at higher age groups. It is likely that ethnic difference in growth pattern does exist especially children in the higher age groups. In order to have a better understanding of this problem, an attempt has also been made to compare the present findings with the growth reference given by the Indian Council of Medical Research (ICMR, 1972), although it has been criticized that the ICMR growth reference does not represent all sections of the Indian population. It is also suggested that the children belonging to the high economic class of the Indian population show more or less similar pattern of growth to those in the developed countries (Gopalan, 1992). Therefore, it is recommended to use the international growth reference, i.e., the NCHS data, for assessing the growth and nutritional status of Indian children. Accordingly, it is not surprised if this is the reason that the ICMR or other authorities have not published any new data on growth of Indian children.

It is observed that the mean weight of the Khasi boys is above the 50th percentile of the ICMR reference from 3 to 18 years of age. A similar trend is observed in the case of girls (Chapter VII). The Khasi girls are more or less in the 75th percentile of the ICMR reference from 3 to 6 years of age, and thereafter they are similar to the boys in which the growth curve lies between 75th and 50th percentiles. Thus, the Khasi boys and girls are heavier than the ICMR children, but much lighter than the American children.

Height

It is observed that the Khasi boys are more or less in the 5th percentile of the NCHS reference from 3 to about 6 years of age, and thereafter the growth curve of Khasi boys falls much below the 5th percentile. Similarly, the growth curve for girls is more or less in the 5th percentile from about 3 to 7 years, and thereafter it falls below the 5th percentile, except at 12 years of age, which is characterized by an adolescent growth spurt in girls.

Plotted against the ICMR percentiles, the mean height for boys is comparable to the 25th percentile from 3 to 4 years of age, and thereafter it fluctuates between 10th and 25th percentiles up to about 15 years of age. From 15 years of age, the growth curve for boys falls below the 10th percentile of the ICMR reference. Nevertheless, the present findings indicate that the Khasi boys are much shorter than the American boys, especially from the age of 7 onwards, but they are comparable to the Indian children as reported by the ICMR. In the case of girls, the growth curve is at about 50th percentile at the age of 3 years, it lies about 25th percentile of the ICMR growth reference from 4 to 10 years of age, and thereafter it fluctuates below and above the 25th percentile up to about 13 years of age. The curve tends to lie between the 10th and 25th percentiles from 13 years of age. Overall, it indicates that the girls are more comparable to the ICMR reference than the boys, although they are much shorter than the American children.

Comparison with Neighbouring Populations

Very few growth studies have been carried out in Northeast India. Recently, two growth studies were published: one among the War Khasis of Meghalaya (Khongsdier, 1996a) and the other among the Assamese Muslims of Assam (Begum and Choudhury, 1999). Thus, we shall restrict our comparison with only the War Khasi and Assamese Muslims children.

Weight

The Khasi boys are found to be more or less similar to the Assamese Muslim and War Khasi boys in weight from 3 to 11 years (Chapter VII). Thereafter, the Assamese Muslim boys are heavier than the Khasi boys of Shillong and War area, except at about 13 years of age when all the three groups of boys show a similar pattern of growth in weight. The War Khasi boys lie in between the Assamese and Khasi boys from 11 to 13 years, and thereafter they are more or less like the Khasi boys of the present study. As far as girls are concerned, all the three groups of girls are by and large similar in weight from 3 to 10 years of age. From 10 to 16 years of age, the Assamese Muslim girls are heavier than the Khasi and War Khasi girls, and thereafter they are surpassed by the Khasi girls of the present study. In comparison with the War Khasi girls, the Khasi girls of the present study are slightly lower in weight from 10 to 14 years of age, and thereafter they are heavier than the War Khasi girls.

Height
The Khasi boys are found to be shorter than the War Khasi and Assamese Muslim boys for all age groups. Thus, it is in contrary to expectation that the Khasi boys of Shillong may be taller than their counterparts in the War Khasi area. Instead, it is also seen that the War Khasi boys are slightly taller than the Assamese Muslim boys from 3 to 5 years of age. From 5 to 7 years of age, they are more or less similar in height, and thereafter they are surpassed by the Assamese Muslim boys. Like in the case of boys, the War Khasi girls are taller than the Assamese Muslim girls from 3 to 5 years, and they are in between the Khasi and Muslim girls from 6 to 14 years; thereafter they tend to be in the same height with their coevals in Shillong.

Sitting Height
It is observed that the Khasi boys are lower in sitting height than the War Khasi and Assamese Muslim boys across age groups, i.e., from 3 to 18 years of age (Chapter VII). The mean sitting height of the War Khasi boys is higher than that of the Assamese Muslim boys from the age of 3 to 6 years; they are more or less similar from 6 to 9 years of age, and thereafter, they are surpassed by Muslim boys. A similar trend is observed in the case of girls, which indicates that the Khasi girls have the lowest sitting height across age groups, except from 17 years of age when they tend to have a similar sitting height with the Assamese Muslim girls. From 3 to 6 years of age, the War Khasi girls are higher in sitting height than both the Khasi and Assamese Muslim girls, and from about 14 to 15 years of age they are shorter in sitting height than the Khasi girls.

Head Circumference
Like in the case of height and sitting height, the Khasi boys have a lower head circumference than the War Khasi and Assamese Muslim boys across age groups (Chapter VII). On the other hand, the mean head circumference in the War Khasi boys is in the middle of those for the Khasi and Assamese Muslim boys from 3 to 13 years of age, and thereafter it is higher in the latter than in the former. Unlike in the case of boys, the mean head circumference in Khasi girls is higher than that for the War Khasi girls from 6 to 7 years, and it is also higher than that for the Assamese Muslim girls from 16 to 17 years of age. Nevertheless, the War Khasi girls have broader head than the Khasi girls of the present study across age groups, except from 6 to 7 years which is higher in the latter. With respect to the difference between the War Khasi and Assamese Muslim girls,

it is observed that the latter have broader head than the former from 3 to 12 years of age, and thereafter it is higher in the former.

Mid Upper Arm Circumference

It can be seen that like in the case of other measurements the arm circumference is lower in the boys of the present study when compared with the War Khasi and Assamese Muslim boys (Chapter VII). This is true in all the age groups. On the other hand, the War Khasi and Assamese Muslim boys are more or less similar in mid upper arm circumference, although it is higher in Assamese Muslims from 3 to 4 years and 14 years onwards. Like in the case of boys, it is found that the mean value of mid upper arm circumference is lower in the girls of the present study when compared to the War Khasi and Assamese Muslim girls across age groups. Further, the growth curve for the mid upper arm circumference of the War Khasi girls is more or less similar to that for the Assamese Muslim girls from 10 to 12 years, and it higher in the War Khasi from 7 to 8 years. In other age groups, the mean value of mid upper arm circumference in the Assamese Muslim girls is higher than that in the War Khasi girls.

In view of the above comparison, it is obvious that the Khasi children of the present study are much shorter and lighter than the American children, but they are more or less comparable in weight and height to the Indian children as reported by the ICMR. In comparison with neighbouring populations, the children of the present study are by and large similar in weight to the War Khasi and Assamese children, especially from 3 to about 11 years of age. But they are shorter than the War Khasi and Assamese children in all age groups, and it is true in the case of sitting height as well. Similarly, the head and mid upper arm circumferences are lower in Khasi children of the present study when compared with the War Khasi and Assamese Muslim children.

Growth Status and Socio-economic condition

In order to understand the effect of socio-economic condition on the growth status of Khasi children, we have made an attempt to show how the growth of children is related to religion and income of the households. It is found that religion and income of the household are very important in influencing the growth pattern of children in the present study (Chapter V). It may, however, be noted that the differences between religious groups are mainly due to the differences between the Muslim children and the Christian and Niam Khasi children. It is found that the Muslim children are heavier and taller than the Christian and Niam Khasi children, and there is not much difference between the Christians and Niam Khasis in respect of growth pattern, except in few cases.

NUTRITIONAL STATUS

Nutritional status is defined as the physical expression of the relationship between the nutrient intakes, or bio-availability of nutrients, and the physiological requirements of an individual (Brown, 1984). This physical expression of the relationship between nutrient intakes and physiological requirements of a person can be measured by a number of methods. Of different methods, anthropometry is one that is generally used for measuring the magnitude of undernutrition at both individual and population levels. Anthropometric measurements and indices like weight, height, mid upper arm circumference, skinfold thickness, weight for age, height for age, weight for height, body mass index, indices of upper arm circumference, etc., (Jelliffe, 1966; Frisancho, 1990) are used for assessing the nutritional status of children. In the present study, we have taken into consideration three anthropometric indices, i.e., weight for age, height for age and body mass index (BMI, for assessing the nutritional status of children in the present population.

Weight for age

Weight for age, expressed as percentage of individual weight to the median or 50th percentile of the international population reference (i.e., NCHS reference or standard) is generally considered as one of the indicators of underweight. It is found that the mean weight for age is higher in girls than in boys from 3 to 7 years of age, except at the age of 5 when both boys and girls show a similar mean value (Chapter VI). It is also found that the differences between boys and girls in respect of mean weight for age are not statistically significant from 8 to 14 years of age, although the girls are higher in mean value at the age of 13, that is, during the maximum growth spurt of their adolescent period. On the other hand, the mean weight for age is significantly higher in girls than in boys from 14 to 18 years, which indicates the great sex dimorphism during adolescent period.

Following the cut-off points suggested by Comez *et al.* (1956), the frequencies of mild, moderate and severe forms of underweight are 44.71%, 30.42% and 1.85% in boys and 48.32%, 22.59% and 1.32% in girls, respectively (Table 6.2). It indicates that most of the underweight children are in the categories of mild and moderate degrees of undernutrition. Overall, it suggests that the prevalence of underweight is higher in boys (76.98%) than in girls (72.22%), and the difference is statistically significant ($\chi^2 = 24.94$, DF = 3, P < 0.000).

Height for age

In the present study, height for age is expressed as percentage of individual weight to the median of the NCHS population reference. It is widely accepted as one of the best indicators of stunting or short stature due to inadequate nutrition of undernutrition. Like in the case of weight for age, the differences between boys and girls in height for age are not significant from 3 to 13 years of age, despite the significant difference at the age of 12 (Chapter VI). But from 14 years onwards, the mean height for age is significantly higher in girls than in boys.

Following the cut-of points proposed by Visweswara Roa *et al.*(1986), about 95% of boys and girls in the present population are stunt. Whether stunting or short stature of these children should be regarded as growth retardation, thereby indicating of high undernutrition, is a moot question of interest. It has been suggested that the use of national and international population references for assessing the nutritional status of children in terms of height for age may lead to overestimation of undernutrition in children of the short stature population like the Khasis (Khongsdier, 1996b). In the present study, an attempt has also been made to show the different levels of growth retardation as per the ICMR reference of height for age. It shows that about 84.85% of boys and 77.41% of girls have a growth retardation, although the frequency is lower than that derived from the NCHS standard. So the present findings seem to confirm those observations made among the War Khasi (Khongsdier, 1996b). The same is true in the case weight for age since weight is also correlated with height.

With regard to sex differences in nutritional status, which is to a great extent independent of standard, the prevalence of growth retardation, especially those children with moderate and severe forms of undernutrition, is significantly higher in boys than in girls ($\chi^2 = 58.85$, DF = 3, P < 0.000). Whether or not these findings are associated with the matrilineal system of the society is a different question because we do not have data on child care of the society. But the results of the present study indicate that girls are better than boys in nutritional status.

Body mass index

Body mass index (BMI) is generally considered as the best indicator of fatness or thinness and wasting due to chronic energy deficiency (Ferro-Luzi *et al.*, 1992). It is obtained as weight (kg) divided by height (m^2) of the individual, and it is independent of age. It is found that there is not much difference between boys and girls in respect of BMI, although it is significantly higher in boys than in girls at the ages 13, 17 and 18.

As regards the nutritional status according to BMI, we have followed the cut-off point of 15.0 for the children aged 3 to 9 years (Visweswara Rao *et al.*, 1986), whereas the cut-off point of 18.5 proposed by Ferro-Luzi *et al.* (1992) has been adopted for assessing the nutritional status of children aged 10 to 18 years. It is observed that the frequencies of mild, moderate and severe forms of chronic energy deficiency in the children aged 3 to 9 years of age are respectively 12%, 6% and 8% in boys and 18%, 6% and 8% in girls. Thus, the frequency of mild chronic energy deficiency is about 6% higher in girls than in boys, although the difference between sexes is not statistically significant (χ^2 = 6.44, DF = 3, P > 0.05). In the case of children aged 10 to 18 years, about 95 % of boys and girls are well nourished in the present population.

In view of these results, it is obvious that the children in the higher age groups are better in nutritional status than those in the lower age groups, i.e., 3 to 9 years of age. Another important point is that the nutritional status of children according to BMI is much better than that observed with respect to weight for age and height for age. This may be due to the fact that weight for age and height for age are derived as percentage of the median of the international population reference, whereas BMI is directly obtained as a proportion of weight to the square of height of an individual, thereby it is independent of the so-called standard weight or height. As observed in other populations, BMI seems to be the better indicator of nutritional status than any other indices taken for the present study.

Nutritional Status and Socio-Economic Condition

It is generally reported that the widespread of undernutrition in developing countries is associated with poor hygienic conditions and socio-economic condition of the populations (Mitra, 1985; WHO, 1990). Therefore, assessment of the nutritional status of population has attracted the attention of not only the nutritionists and other biological scientists, but also the economists and other social scientists with a view to understanding the health and socioeconomic status of the population. In the present study, we have also been an attempt to show the prevalence of undernutrition according to religious and income groups of the population. This may be described as follows:

Religion

With respect to religious groups, it is observed that the mean values of all these anthropometric indices are higher in the Muslim children than in the Christian and Niam Khasi children (Chapter VI). After adjusting for the effect of economic condition, the one way analysis of covariance (ANCOVA) indicates that the differences in anthropometric indices between religious groups are highly significant for both boys and girls, except the BMI in girls. According to Scheffe's multiple range test, the Muslim boys are significantly higher than the Christian boys in weight for age (Difference ± standard error:5.01 ± 0.81, $P < 0.000$) and height for age (1.70 ± 0.39, $P < 0.000$). With respect to BMI, there is an absence of significant difference according to Scheffe's test, but it is significant according to Least Square Significance Difference (0.94 ± 0.44, $P < 0.03$). The differences between the Muslim and Niam Khasi boys are also significant in respect of all indices (Weight for age: 6.88 ± 0.79, $P < 0.000$; Height for age: 2.07 ± 0.38, $P < 0.000$; BMI: 0.96 ± 0.43, $P < 0.03$). On the other hand, the differences between Christian and Niam Khasi boys are significant only in respect of weight for age (1.87 ± 0.72, $P < 0.03$). Nevertheless, it is clear that the Muslim boys are heavier than the Christian and Niam Khasi boys in respect of all anthropometric indices, thereby suggesting that the Muslim boys are better in nutritional status.

Among girls the differences between Muslims and Christians according to Scheffe' test are significant in respect of weight for age (3.89 ±0.84, $P < 0.000$) and height for age (1.86 ± 0.35, $P < 0.000$), but not in respect of BMI. But the differences between Christian and Niam Khasi girls are not significant in respect of all indices, except in the case of weight for age (2.08 ± 0.76, $P < 0.02$). Thus, it indicates that the Christian and Niam Khasi children are by and large similar in height for age and BMI, although the former are higher in weight for age than the latter.

In order to have a better understanding of the effect of religion on nutritional status of Khasi children, an attempt has also been made to show the percentage distribution of weight for age according to three religious groups. It is found that about 62.54%, 79.23% and 84.04% of the boys in Muslims, Christians and Niam Khasis, respectively, are underweight (Table 6.9). Among girls, these frequencies of underweight are found to be 61.98%, 75.11% and 76.74%, respectively. The Chi-square values indicate that the differences between religious groups in respect of weight for age are highly significant (Boys: $\chi^2 = 70.82$, DF = 6, $P < 0.000$; Girls: $\chi^2 = 46.87$, DF = 6, $P < 0.000$). Thus, the Muslim Khasi boys and girls are better in weight for age when compared to their counterparts belonging to Christianity (Boys: $\chi^2 = 38.75$, DF = 2, $P < 0.000$; Girls: $\chi^2 = 20.20$, DF = 2, $P < 0.000$) and Niam Khasi (Boys: $\chi^2 = 66.58$, DF = 2, $P < 0.000$; Girls: $\chi^2 = 40.94$, DF = 2, $P<0.000$). On the other hand, the Christian Khasi children are heavier than the Niam Khasi children, although the differences are not statistically significant in the case of boys (Boys: $\chi^2 = 4.04$, DF = 2, $P > 0.05$; Girls: $\chi^2 = 8.56$, DF = 2, $P < 0.01$). Thus, the Muslim children are heavier than the Christian and Niam Khasi children, and the differences between the Christian and Niam Khasi children are significant only in the case of girls, i.e., the Christian girls are heavier than the Niam Khasi girls.

Like in the case of weight for age, the Muslim Khasi children are taller than the Christian and Niam Khasi children. It is found that the prevalence of stunting or growth retardation in boys is about 94.69%, 96.57% and 95.60% respectively in the Muslim, Christian and Niam Khasis. In the case of girls, these frequencies are 92.05%, 94.47% and 97.37%, respectively. The Chi-square values indicate that the differences in the percentage distribution of normal, mild, moderate and severe forms of nutritional status in respect of height for age are highly significant for both boys and girls (Boys: $\chi^2 = 24.89$, DF = 6, $P < 0.001$; Girls: $\chi^2 = 40.32$, DF = 6, $P < 0.000$).

It indicates that the children of Muslim Khasi are less retarded when compared with the Christian and Niam Khasi children, despite the fact that the prevalence of stunting is high in all the religious groups. With respect to the difference between the Christian and Niam Khasi children, the frequency of mild and moderate forms of growth retardation is higher in the Christian boys than in the Niam Khasi boys, but the frequency of severe form is higher in the latter than in the former. However, these differences between the two religious groups are not statistically significant (χ^2 = 1.54, DF =3, P> 0.05). In the case of girls, the situation is reverse, which shows that the prevalence of mild and moderate forms of growth retardation is higher in the Niam Khasis than in the Christian Khasis, but the frequency of severe form of growth retardation is higher in the latter than in the former, although these differences are not statistically significant (χ^2 = 6.94, DF =3, P> 0.05). So the Christian and Niam Khasi children are by and large similar in the prevalence of growth retardation. The significant differences between religious groups as indicated by the overall Chi-square test are mainly due to the differences between the Khasi Muslims children and other religious groups.

On the basis of BMI, in the age group 3 to 9 years, about 19.74%, 24.88%% and 31.15% of boys and 21.18%, 19.34% and 29.36% of girls in the Muslims, Christians and Niam Khasis, respectively, have suffered from chronic energy deficiency. Thus it indicates that the prevalence of chronic energy deficiency is lower among the Muslims than that among the Christians and Niam Khasis, though it is lower among the Christians in the case of girls. However, the Chi-square test indicates that the differences between religious groups are significant only in boys (χ^2 = 18.76, DF= 6, P < 0.01) but not in girls (χ^2 = 7.81, DF= 6, P > 0.05). In the age group 10-18 years, the differences between religious groups in respect of BMI are not statistically significant for both boys and girls. Thus, it indicates that religion plays little role in influencing the BMI of the children in the present study, although the influence of religion on weight for age and height for age seems to be important. It clearly shows that the Muslim children are heavier and taller than the Christian and Niam Khasi children. One possible explanation of such a trend in the Muslims may be due to intermixture, i.e., the Muslim children are by and large the product of the intermixture between the Khasi females and the Muslim males who migrated to Meghalaya from other parts of India.

Economic Condition

With the exception of few cases, the mean values of weight for age, height for age and BMI are lower in the LIG when compared to the MIG and HIG (Chapter VI). Adjusting for religion, the ANCOVA test also indicates that the differences between income groups are significant in all anthropometric indices for both boys and girls. According to Scheffe's test, the LIG children are significantly lower than those in the MIG and HIG in respect of all the three anthropometric indices, irrespective of the difference between LIG and MIG in respect of BMI for girls (1.20 ± 0.36, $P < 0.004$). Likewise, the differences between MIG and HIG children are highly significant for weight for age, height for age and BMI.

In order to have a better understanding of the effect of economic condition on the nutritional status of the children in the present study, we have also made an attempt to show the prevalence of undernutrition according to three income groups. With respect to weight for age, it is found that about 81.90%, 76.60% and 67.73% of the boys and 79.52%, 72.94% and 58.96% of girls are underweight in the LIG, MIG and HIG, respectively. It indicates that the proportion of underweight children decreases with the rise in income levels of the household. The Chi-square values also indicate that the differences between income groups in respect of the distribution of children according to different degrees of underweight are highly significant for both boys ($\chi^2 = 107.09$, DF = 6, $P < 0.000$) and girls ($\chi^2 = 62.08$, DF = 6, $P < 0.000$). Thus, it suggests that the income of household is very important in influencing the nutritional status of children according to weight for age as has been observed with regards to ANCOVA test.

With respect to height for age, the prevalence of stunting is very high in all the income groups for both boys and girls, but the percentage is higher in the lower income groups when compared with the HIG. Such a trend is also observed with respect to the prevalence of severe forms of growth retardation, which is much higher in the LIG and MIG when compared with the HIG. These differences between income groups in respect of height for age are statistically significant for both boys ($\chi^2 = 102.50$, DF = 6, $P < 0.000$) and girls ($\chi^2 = 99.15$, DF = 6, $P < 0.000$). This clearly indicates that income of the household plays a very important role in influencing the height for age of the children of the present study.

With respect to BMI, the differences between income groups in respect of BMI are not significant in girls for both the age groups 3-9 and 10-18 years. But in the case of boys, the income of household seems to be important and the differences between income groups are significant for both the age groups. For the age group 3-9 years, the prevalence of chronic energy deficiency in boys is about 31.11%, 22.75% and 21.09% in LIG, MIG and HIG, respectively. These frequencies are about 8.36%, 1.04% and 3.90% respectively in the age group 10-18 years. Thus, it is obvious that the prevalence of chronic energy deficiency is higher in the LIG when compared to the MIG and HIG, and the influence of the income of household is clearly significant in BMI of boys, although it is also perceptible in girls.

CONCLUDING REMARKS

The findings of the present study were broadly presented into demographic, growth and nutritional aspects. As regards demographic aspects, it is observed that the three religious groups of the Khasi population are found to be *progressive type*, i.e., all the three religious groups are characterized by a fairly high rate of fertility. The total fertility rate in these three religious groups is more or less similar to the War Khasi, but much higher than the Kochs of Garo hills. Although it is slightly higher in the Muslims and Niam Khasis, the differences between religious groups in fertility rates are not statistically significant, indicating the insignificant effect of religion on fertility rate in the Khasi population. In other words, it is obvious that Family Planning Programme has gain little momentum in the Khasi population, irrespective of religious groups. Moreover, it is also observed that education of the mothers does not play a significant role in regulating the fertility rate among the Muslim and Christian Khasis, although it is important in the Niam Khasi women. This insignificant effect of education on fertility rate in the Muslims and Christians is in contrast to the observation in other populations (Murthi *et al.*, 1995), and it is difficult to give any clear-cut explanation. It is well known that Islam does not expressly forbid the voluntary restriction of birth, but children are regarded as the richest blessing that Allah bestows and therefore any attempt to prevent fertility is against the wishes of God (Choudhury, 1982). Of course, it generally reported that Muslims have higher fertility rate followed by the Hindus and Christians (Irudaya Rajan and Rao, 1991). Likewise, the Bible does not specifically prohibit birth control, but certain Christian denominations like the Catholic Church are against the use of artificial means of birth control (Irudaya Rajan and Rao, 1991). Thus, it is likely that even education of the mothers may not become so important in such a situation.

In the present study, the term Christians" refers to all Christian denominations including the Roman Catholics. Unfortunately, we have not collected data on specific Christian denomination and, therefore, we are not in position either to refute or support the contention that fertility rate is higher in the Catholics than in any other Christian denominations. We hope that further studies will throw much more light in this regard. The effect of other factors like age at marriage and income of the household on fertility rate seems to be very important in the Khasi population, irrespective of religious groups. The effect of age at marriage on fertility is by and large universal since the reproductive period is shorter in the case of those mothers with higher age at marriage. On the other hand, the significant effect of the income of household on fertility rate in this population is likely to be related to the fact that people belonging to the higher economic groups are more conscious of the socio-economic welfare of their children. It is likely that they have higher aspiration for better education and higher economic status, thereby reducing the birth rate with a view to providing their children with such facilities.

With regard to infant mortality, it is observed that the rate increases with the increasing age of the mothers. This may be due to the fact that mothers of higher age groups have higher fertility rate, which is theoretically correlated with higher infant mortality rate. The inverse relationship between infant mortality and educational as well as income level is according to the general observation in other populations, which indicate that mothers belonging to the higher educational and income levels are more conscious of the health of their children, and they have more access to modern medical amenities, etc. On the other hand, religion does not seem to play very important role in influencing infant mortality rate.

According to the present findings the girls have reached their adult height by the age of 18, while the boys still continue to grow. In comparison with international and national growth references, the Khasi children of the present study are much shorter and lighter than the U.S. NCHS children, but they are more or less comparable in weight and height to the ICMR children. In comparison with neighbouring populations, the children of the present study are by and large similar in weight to the War Khasi and Assamese children, especially from 3 to about 11 years of age. But they are shorter than the War Khasi and Assamese children in all age groups, and it is true in the case of sitting height as well. Similarly, the head and mid upper arm circumferences are lower in Khasi children of the present study when compared with the War Khasi and Assamese Muslim children.

These findings may have certain implications for ethnic or genetic variation in growth and nutritional status of population. It is obvious that the anthropometric indices like height for age and even weight for age in relation to the so-called international standards (references) cannot be used as indicators of the nutritional status in a short stature population like the Khasis, especially in children of higher age groups (Khongsdier, 1996b). Thus, BMI may be considered a better indicator of the nutritional status of children in the present study. It is likely that differences in stature between populations may be related not only to nutrition, but also to physical environment and genetic factors (Payne, 1992). However, this does not mean to reject the international references completely; their use is very important for comparative studies.

The differences between income groups seem to confirm the earlier observations that children belonging to the higher economic groups are better in growth and nutritional status than their counterparts in the lower economic strata (Gopalan, 1992). The simple reason is that children in the higher economic strata have better nutrition and health facilities. But the most significance of the present findings is the differences between religious groups in respect of growth and nutritional status. It is found that the Muslim children are heavier and taller than the Christian and Niam Khasi children, and there is not much difference between the Christians and Niam Khasis in respect of growth pattern, except in few cases. One possible explanation of such a trend in the Muslims may be due to intermixture, i.e., the Muslim children in the present study are by and large the product of the intermixture between the Khasi females and the Muslim males who migrated to Meghalaya from different areas.

References

Abraham, S., Lowenstein, F.W. and O'Connell, D.E. 1975. *Preliminary findings of the first health and nutrition examination survey, United States, 1971-72: Anthropometric and clinical findings, DHEW Publication No. 75-1229.* Rockville, Maryland: Public Health Services.

Adamchak, D.J. and Mbizvo, M.T. 1994. The impact of husband's and wife's education and occupation on family size in Zimbebwa. *J. Biosoc. Sci.*, **26**: 553-558.

Addo, A.A., Kareem, F.M., Sampson, T.I. and Jibrin, C.L. 1988. Anthropometry and nutrient intake of Nigerian school children from ecological zones. *Ecol. Food Nutr.*, **21**: 271-285.

Agarwala, S. N. 1962. *Age at Marriage in India. Bombay*: Kitab Mahal Pvt.

Agarwala, S.N.1964. A demographic study on six urbanised villages, *Mimeograph.* Delhi: Institute of Economic Growth.

Agarwala, S. N. 1972. *India's population Problem.* Bombay and New Delhi: Tata McGraw-Hill Publishing House.

Ahmed Das, F. and Saikia, J.R. 1999. Some aspects of the fertility of the Garo women of Pochimbasti Garo village in Sibsagar district, Assam. *J. Hum. Ecol.*, **10**: 273-277.

Amin, R. 1988. Infant and child mortality in Bangladesh. *J. Biosoc. Sci.*, **20**: 29-65.

Amirkhakimi, G.H. 1974. Growth from birth to 2 years of rich urban and poor rural Iranian children compared with Western norms. *Ann. Hum. Biol.*, **1**: 427-442.

Arnold, F., Choe, M.K. and Roy, T.K. 1998. Son preference, the family building process and child mortality in India. *Popn. Stud.*, **52**: 301-315.

Atinmo, T. and Hart, A. 1980. Assessment of nutritional status of school children in the river state of Nigeria. *Nig. J. Nutr. Sci.*, **1**: 111-117.

Aly, H.Y. 1990. Demographic and socioeconomic factors affecting infant mortality in Egypt. *J. Biosoc. Sci.*, **22**: 447-451.

Ayeni, O. and Oduntan, S.O. 1978. The effects of sex, birth weight, birth order and maternal age on infant mortality in a Nigerian community. *Ann. Hum. Biol.*, **5**: 363-358.

Balakhrishna, R. 1951. Report on the economic survey of Madras City 1954-57. New Delhi: Planning Commission.

Balakrishnan, T. R. and Chen, J. 1990. Religiosity, nuptiality and reproduction in Canada. *Canad. Rev. Soc. Anthrop.*, **27**: 316-340.

Bareh, H. 1967. *The History and Culture of the Khasi People.* Calcutta: Naba Mudran Pvt.Ltd.

Barnes, R. H. 1969. Effects of malnutrition on mental development. Truths and half-truths. *J. Home Eco.*, **61**: 671-676.

Barua, S. 1983. The Hajongs of Meghalaya: A biodemographic study. *Hum. Sci.*, **32**: 190-200.

Basu, A. 1969. The Pahira: A population genetical study. *Am. J. Phys. Anthrop.*, **31**: 399-416.

Basu, A., Majumder, P. Ghosh, A.K. and Biswas, S. 1980. Human biological variation in Asia, with special reference to India. In: Human Biological Diversity, edited by Hiernaux, J. *et al.* Paris: Masson.

Beall, C.M., Baker, P.T. and Baker, T.S. 1977. The effects of high altitude on adolescent growth spurt in Southern Peruvian Americans. *Hum. Biol.*, **49**: 109-124.

Becker, G. 1981. *A Treatise on the Family.* Cambridge: Harvard University Press.

Begum, G and Choudhury, B.1999. Age changes in some somatometric characters of the Assamese Muslims of Kamrup district, Assam. *Ann. Hum. Biol.*, **26**: 203-217.

Bhakta, G. P. 1992. *Geography of Meghalaya.* Shillong: Akashi Book Depot.

Bharati, P. 1981. Economic condition and demography among the Himalayas of Chakpota village, Howrah district, West Bengal. *J. Biosoc. Sci.*, **13**: 345-356.

Bharati, P. and Basu, A. 1990. A study on the effects of nutrition on fertility and mortality among the Mahishyas of Howrah district, West Bengal. *J. Ind. Anthrop. Soc.*, **25**: 185-189.

Bharati, P. and Dastidar, M.G. 1990. Maternal education, fertility and mortality in a Bengali population sample. *J. Ind. Anthrop. Soc.*, **25**: 90-93.

Bicego, T. G. and Boerma, J. T. 1993. Maternal education and child survival: A comparative study of survey data from 17 countries. *Social Sci. Med.*, **36**:1207-1227.

Bogin, B. 1999. *Patterns of Human Growth*, 2nd edition. Cambridge: Cambridge University Press.

Botha-Antom, E. 1968. Intellectual development related to nutritional status. *J. Trop. Padiat.*, **14**: 112-115.

Bransby, E.R., Burn, J.L., Magee, H.E. and Mackecknie, D.M. 1964. Effect of certain social conditions on the health of school children. *Brit. Med. J.*, **2**: 767-769.

Bredan, A.S., Nanduri, S.K. and Biswas, S.M. 1984. Comparison of nutritional status of Libyan primary school children in different socioeconomic areas of Tripoli. *Ecol. Food Nutr.*, **15:** 293-298.

Brown, K.H. 1984. Measurement of dietary intake. *Popn. Dev. Rev. (Suppl.)*, **10**:69-91.

Bumpass, L. 1969. Age at marriage as a variable in socioeconomic differentials in fertility. *Demography*, **6**: 45-54.

Busfield, J. 1972. Age at marriage and family size: Social causation and social selection hypothesis. *J. Biosoc. Sci.*, **4**: 117-134.

Caldwell, John C. 1977. The economic rationality of high fertility: Investigation illustrated with Nigerian Survey data. *Popn. Stud.*, 31: 5-27.

Caldwell, John C. 1979. Education as a factor in mortality decline: An examination of Nigerian data. *Population Studies*, **33**: 395-413.

Caldwell, John C. 1982. *Theory of Fertility Decline*. New York: Academic Press.

Caldwell, J.C., Barkat-E-Khuda, Caldwell, B., Pieris, I. and Caldwell, P. 1999. The Bangladesh Fertility decline: An interpretation. *Popn. Dev. Rev.*, **25**: 67-84.

Campbell, V.S. 1978. New approaches to the assessment of nutritional status, selection and utilization of nutritional indicators- the Jamaica experience. Paper presented at the IXth International Congress of Nutrition.

Chandrasekhar, S. 1972. *Infant mortality, population growth and family planning in India*. London: George Allen & Unwin Ltd.

Chang, H.C., Warren, R.D. and Pendeltol, B.F. 1979. Testing and clarifying, a micro-model of socioeconomic change and fertility. *Social Biol.*, **23**: 30-50.

Chatterjee, S.K. 1951. Kirata-Jana-Krti: The Indo-Mongoloids (cited in Das, 1978).

Chen, L. C. 1982. Where have women gone? Insight from Bangladesh on low sex ratio of India's population. *Eco. Pol. Weekly*, **17**: 364-372.

Chong, Y.H., Tee, E.S., Ng, T.K.W., Kandiah, M., Hussain, R.H., Tee, P.H. and Shahid, S.M. 1984. Status of community- Nutrition in poverty Kampungs. Bull No. 22. Kuala Lampur: Institute for Medical Research.

Choudhury, B., Begum, C. and Barua, T. 1992. Growth patterns of school children of Gauhati city. *Bull. Dept. Anthrop. Gau. Univ.*, **6**: 74-84.

Choudhury, R. 1982. *Social Aspects of Fertility with Special Reference to Developing Countries*. Delhi: Vikas Publishing House.

Choudhury, R.H. 1984. The influence of female education, labour participation and age at marriage on fertility behaviour in Bangladesh. *Social Biol.*, **31**: 59-74.

Choudhury, R.P. 1988. Child mortality determinants among two tribes of Raj Mahall hills (Bihar). *Ind. Phys. Hum. Genet.*, **14**: 71-83.

Cleland, J., Phillips, J. F., Amin, S. and Kamal,G. M. 1994. *The Determinants of Reproductive Change in Bangladesh: Success in Challenging Environment*. Washington,, D.C.: The World Bank.

Cochrane, S.H. 1983. Effect of education and urbanisation on fertility. In *Determinants of fertility in developing countries*, Vol. 2, edited by Bulatao, R.A. and Lee, R.D. New York: Academic Press.

Comez, F., Galvan, R.R., Frenk, S., Cravioto, J.M., Chavez, R. and Vazquez, J. 1956. Mortality in the second and third degree malnutrition. *J. Trop. Pediat.*, **2**: 77-83.

Crow, J. F. 1958. Some possibilities for measuring selection intensities in man. *Hum. Biol.*, **30**: 1 – 13.

D'Souza, S. and Bhuiya, A. 1982. Socio-economic mortality differentials in a rural area of Bangladesh. *Popn. Dev. Rev.*, **8**: 753-769.

Das, B.M. 1970. Anthropometry of the tribal groups of Assam, India, Mimeograph. Miami: Field Research Project.

Das, B.M. 1978. *Variation in Physical Characteristics in the Khasi Population of North-East India*. New Delhi: D.R Publishers & Distributors.

Das, B.M. 1979. Some aspects of variation and ongoing human evolution. Presidential address at the 66th Session of the Indian Science Congress, Hyderabad. Calcutta: Indian Science Congress Association.

Das, B.M. 1987. *The Peoples of Assam*. New Delhi: Gian Publishing House.

Das, B.M. and Das, P.B. 1969-71. A study on some aspects of growth of the Assamese boys. *J. Gau. Univ. Sci.*, **20-22**: 51-65.

Das, B.M. and Das, P.B. 1972. A study of growth of the head in Assamese boys. *Bull. Dept. Anthrop. Gau. Univ.*, **1**: 88-96.

Das, B.M. and Das, P.B. 1982. Child mortality among rural Assamese. *Bull. Anthrop. Surv. Ind.*, **31**: 14-29.

Das, B.M. and Devi, B. 1982. Weight, crown heel length and head circumference of new born Assamese babies. *Bull. Anthrop. Surv. Ind.*, **31**: 1-13.

Das, P.B. 1973. A cross-sectional study of growth in height and weight of an endogamous caste of Assam. *Bull. Dept. Anthrop. Gau. Univ.*, **2**: 24-31.

Das, P.B. 1974. A comparative study of growth in respect of height, weight and chest circumference of rural Assamese boys. *Bull. Dept. Anthrop. Dibru. Univ.*, **3**: 52-57.

Das, P.B. and Choudhury, B. 1992. A mix-longitudinal study of growth of Assamese children from 8 to 16 years. . *Bull. Dept. Anthrop. Gau. Univ.*, **6**: 61-69.

Dasgupta, I., Dasgupta, P. and Das Choudhury, A.B. 1997. Familial resemblance in height and weight in an endogamous Mahishya caste population of rural West Bengal. *Am. Hum. Biol.*, **9**: 7-9.

Dasgupta, P. 2000. Population and resources: An exploration of reproductive and environmental externalities. *Popn. Dev. Rev.*, **26**: 643-689.

Dastidar, M.G. and Gupta, R. 2000. A study on family planning, fertility and ideal family size among the Hindu and Muslim slum dwellers of Calcutta city. In: *Contemporary Research in Anthropology*, edited by Khongsdier, R. New Delhi: Commonwealth Publishers.

Davis, K. 1951. *The Population of India and Pakistan*. Princeton: Princeton University Press.

Davis, K. and Blake, J. 1956. Social structure and fertility: An analytical framework. *Eco. Dev. Cul. Change*, **4**:221-238.

DIPR 1991. *Meghalaya: Land and People*. Shillong: The Directorate of Information and Public Relation.

Dixon, R.B. 1922. The Khasi and the racial history of Assam. *Man in India*, 2: 1-13.

Desai, P., Standard, K.L. and Miall, W.E. 1970. Socio-economic and cultural influence on child growth in rural Jamaica. *J. Biosoc. Sci.*, **2**: 133-143.

Dore, R.D. 1953. Japanese rural fertility: Some social and economic factors. *Popn. Stud.*,**7**: 62-88.

Downs, E.F. 1964. Nutritional dwarfing: A syndrome of early protein-calorie malnutrition. *Am. J. Clin. Nutr.*, **15**: 275-281.

Driver, E.D. 1963. *Differential Fertility in Central India*. Princeton: Princeton University Press.

Dutta, R. and Seal, S.C. 1974. A study of relationship of socio-economic factors, fertility and family planning in a community in West Bengal. *Ind. J. Pub. Health*, **18**: 78-92.

Dutta Banik, N.D., Nayar, S., Krishna, R., Raj, L. and Taskar, A.D. 1970. A semi-longitudinal study on physical growth of primary school children in Delhi. *Ind. J. Pediat.*, **37**: 453-459.

Easwaran, P.P., Kurien, E.S. and Devadas, R.P. 1972. Height and weight of 6-8 year old children in selected schools in Coimbatore. *Ind. J. Nutr. Dietet.*, **9**: 135-144.

Easwaran, P.P., Sakthivelmani, A. and Devadas, R.P. 1974. Height and weight of 7,8 and 9 year old children in selected schools in Coimbatore. *Ind. J. Nutr. Dietet.*, **11**: 63-71.

Edward, G., Stockwell, C. and Goza, F.W. 1996. Racial difference in the relationship between infant mortality and socio-economic status. *J. Biosoc. Sci.*, **28**: 73-83.

Ekanan, I.I. 1972. A further note on the relation between economic development and fertility. *Demography*, **9**: 382-398.

Eveleth, P.B and Tanner, J.M. 1976. *World Wide Variation in Human Growth*, 1st Edition. Cambridge: Cambridge University Press.

Eveleth, P.B and Tanner, J.M. 1990. *World Wide Variation in Human Growth*, 2nd Edition. Cambridge: Cambridge University Press.

Ewbank, D., Henin, R. and Kekovole, J. 1986. An integration of demographic and epidemiologic research on mortality in Kenya. In: *Determinants of Mortality Change and Differentials in Developing countries*. WHO Publication Studies No. 94. Geneva: WHO.

Ferro-Luzzi, A. 1967. Reddito e stato di nutrizione in Italia. Quad. Nutr., **27** (cited in Ferro-Luzzi *et al.*, 1970).

Ferro-Luzzi, A., D'Amicis, A., Ferrini, A.M. and Maiale, G. 1979. Nutrition, environment and physical performance of pre-school children in Italy. *Biblio. Nutr. Diet.*, **27**: 85-106.

Ferro-Luzzi, A., Sette, S., Franklin, M. and James, W.P.T. 1992. A simplified approach of assessing adult chronic energy deficiency. *Eur. J. Clin. Nutr.*, **46**, 173-186.

Freedman, R. 1982. Fertility decline.1. Theories. In: *International Encyclopedia of Population*, Vol.1. New York: Macmillan and Free Press.

Freeny, G. and Feng, W. 1993. Parity progression and birth intervals in China: The influence of policy in hastening fertility decline. *Popn. Dev. Rev.*, **19**: 61-101.

Frisancho, A.R. 1978. Nutritional influences on human growth and maturation. *Yearbook Phys. Anthrop.*, **21**: 174-191.

Frisancho, A.R. 1990. *Anthropometric Standard of the Assessment of Growth and Nutritional Status*. Michigan: University of Michigan Press.

Fry, E.I., Chang, K.S.F., Lee, M.M.C. and Ng, C.K. 1965. The amount and distribution of subcutaneous tissue in southern Chinese children from Hongkong. *Am. J. Phys. Anthrop.*, **23**: 69-79.

Garn, S.M. 1966. Nutrition in physical anthropology. . *Am. J. Phys. Anthrop.*, **24**: 289-292.

Garn, S.M. 1980. Human growth. *Annual rev. Anthrop.*, **9**:275-292.

Garn, S.M., Pesick, S.D. and Pilkington, J.J. 1984. The interaction between prenatal and socioeconomic effects on growth and development in childhood. In: *Human Growth and Development*, edited by Borms, J., Hauspie, R., Sand, A., Susanne, C. and Hebbelinck, M New York: Plenum Press.

Gazetteer of India 1991. *Meghalaya District Gazetteers: Khasi Hills District*. Shillong: Government of Meghalaya, Department of Arts and Culture.

Ghosh, A. K. 1976. The Kota of Nilgiri Hills: A demographic study. *J. Biosoc. Sci.*, **8**: 17-26.

Ghosh, A. Roy, K. and Mohan, K. 1983. A study of the effects of some biocultural factors on human fertility. *J. Soc. Res.*, **26**: 113-136.

Ghosh, A.K. and Khongsdier, R. 1997. Bio-anthroplogical profile of Meghalaya. In: *Studies in Anthropology: Recent Perspectives*, edited by Sengupta, S. New Delhi: Inter-India Publications.

Goldstein, H. 1971. Factors influencing the height of seven year old children - results from the Nutritional Development Study. *Hum. Biol.*, **43**: 92-111.

Gopalan, C. 1988. Nutrition problems and programmes in South East Asia. WHO Regional Health Paper 15.

Gopalan, C. 1992. Undernutrition: Measurement and Implications. In: *Nutrition and Poverty*, edited by Osmani, S.R. Oxford: Clarendon Press.

Greulich, W.W. 1957. A comparison of the physical growth and development of American born and native Japanese children. *Am. J. Phys. Anthrop.*, **15**: 489-515.

Groenewold, W.G.F. and Tilahun, M. 1990. Anthropometric indicators of nutritional status, socioeconomic factors and mortality in hospitalized children in Addis Ababa. *J. Biosoc. Sci.*, **22**: 373-379.

Grounds, J.G. 1964. Mortality of children under six years old in Kenya with reference to contributory causes, especially malnutrition. *J. Trop. Med. Hyg.*, **67**: 257 (cited in Stephenson *et al.*, 1979).

Gulati, S.C. 1969. Impact of literacy, urbanization and sex ratio on age at marriage in India. *Artha Bijnana*, 2 (cited in Gulati, 1988).

Gulati, S.C. 1988. *Fertility in India: An Econometric Analysis of a Metropolis*. New Delhi: Sage Publications.

Gurdon, P.R.T. 1907. *The Khasis*. London: Macmillan & Co.

Habicht, J.P, Martorell, R., Yarbrough, C., Malina, R.M. and Kein, R.E. 1974. Height and weight standards for pre-school children. How relevant are ethnic differences in growth potentials? *Lancet*, **1**: 611-615.

Haddon, A.C. 1929. *The Race of Man and Their Distribution*. Cambridge: Cambridge University Press.

Hamill, P.V.V., Johnston, F.E. and Lameshaw, S. 1972. *Height and weight of children: Socioeconomic status. Vital Health Statistics Series Vol. 11*. Washington, D.C.: Department of Health Education and Welfare Publications.

Hauspie, R.C., Wachholder, A., Sand, E.A. and Susanne, C. 1992. Body length, body weight and head circumference in Belgian boys and girls aged 1-36 months: Sex differences and effect of socioeconomic status. *Acta Med. Auxol.*, **24**: 149-158.

Hazarika, A.N.J.A. 1974. A comparative study of growth, girth of thorax and weight of Ahom and Kalita boys. *Bull. Dept. Anthrop. Dibru. Univ.*, **3**: 73-77.

Hazzaa, A.L. 1990. Anthropometric measurements of Soudi boys aged 6-14 years. *Ann. Hum. Biol.*, **17**:33-41.

Hertzig, M.E., Birch, H.G., Richardson, S.A. and Tizard, J. 1972. Intellectual levels of school children severely malnourished during the first two years of life. *Pediat.*, **49**: 814-824.

Hipshon Roy, U. 1990. Knowing a Khasi through the institution. Seng Kut Snem Ninety First Year Sovenir, 1899-1990, p.40-42.

Hooton, F.A. 1946. *Up from the Ape*. New York: Macmillan Press.

Husain, I.Z. 1970. Educational status and differential fertility in India. *Social Biol.*, **17**: 132-139.

Indian Council of medical Research (ICMR) 1972. Growth and physical development of Indian infants and children. *ICMR Technical Report Series No. 18*. New Delhi: ICMR.

Irshad-Ali, A.N.M. 1992. Islam in tribal societies of North-East India. Some aspects of the process of cultural contact. *Bull. Dept. Anthrop. Gau. Univ.*, **6**: 46-52.

Irudaya Rajan, S. and Rao, S. 1991. Can we explain demography through culture? *Man in Indian*, **71**:383-399.

Khongsdier, R. 2001. *Demographic genetics of an Indian population*. Itanagar: Himalayan Publishers (In Press).

Khongsdier, R. and Ghosh, A. K. 1994. Bio-demographic study among the War Khasi of Meghalaya. *J. Ind. Anthrop. Soc.*, **29**: 195-202.

Khongsdier, R. and Ghosh, A. K. 1996. Relevance of population study in physical anthropology. In: *Communities of North-East India*, ed. by Ahmed Das, F. and Barua, I. New Delhi: Mittal Publications.

Khongsdier, R. and Ghosh, A. K. 1998. Human growth studies in North-East India: A review. In: *North East India: The Human Interface*, edited by Raha, M.K. and Ghosh, A.K. New Delhi: Gyan Publishing House.

Kirk. D. 1968. Factors affecting Moslem natality. In: *Population and Society: A Text Book of Reading*, edited by Charles, B.N. Boston: Houghton Mifflin.

Knodel, J. and G.W. Jones, G.W. 1996. Does promoting girls' schooling miss the mark? *Popn. Dev. Rev*, **22** : 683-702.

Kollehlon, K.T. 1994. Religious affiliation and fertility in Libya. *J. Biosoc. Sci.*, **26**: 493-507.

Kondel, J., Sottipong, G.R., Soiwatcharin, P. and Pracca, S. 1999. Religion and reproduction: Muslims in Budhist Thailand. *Popn. Stud.*, **53**: 149-164.

Kost, K. and Amin, S. 1992. Reproductive and socio-economic determinants of child survival: Confounded, interactive and age dependent effects. *Social Biol.*, **39**: 139-150.

Kost, K. and Amin, S. 1992. Reproductive and socioeconomic determinants of child survival: Confounded, interactive and age dependent effects. Social Biol., 39: 139-150.

Kotal, M. 2001. Personal communication.

Lampl, M., Johnston, F.E. and Malcolm, L.A. 1978. The effects of protein supplementation on the growth and skeletal maturation of New Guinean school children. *Ann. Hum. Biol.*, **5**: 219-227.

Lasker, G.W. and Mascie-Taylor, C.G.N. 1989. Effects of social differences and social mobility on growth in height, weight and body mass index in a British cohort. *Ann. Hum. Biol.*, **16**: 1-8.

Lee, R.B. 1979. *The !Kung San.* Cambridge: Cambridge University Press.

Lindgren, G. 1976. Height, weight and menarche in Swedish urban school children in relation to socioeconomic and regional factors. Ann. Hum. Biol., 3: 501-528.

Lloyd, C.B. 1991. The contribution of the World Fertility Survey to an understanding of the relationship between women's work and fertility. *Stud. Fam. Plann.*, **24**: 144.

Mahadevan, K. (ed.) 1986. *Fertility and Mortality: Theory, Methodology and Empirical Issues.* New Delhi: Sage Publications.

Mahadevan, K. 1979. *Sociology of Fertility.* New Delhi: Sterling Publishers Pvt. Ltd.

Majumdar, D.N. 1966. *Social Contours of and Industrial City.* New Delhi: Asia Publishing House.

Malhotra, A., Vanneman, R. and Kishor, S. 1995. Fertility, dimensions of patriarchy, and development in India. *Popn. Dev. Rev.*, **21**: 281-305.

Malina, R,M. and Himes, J.H. 1978. Patterns of childhood mortality and growth in a rural Zapotec community. *Ann. Hum. Biol.*, **5**: 517-531.

Mandelbaum, D.G. 1974. *Human Fertility in India.* Delhi: Oxford University Press.

Martorell, R. and Ho, T. J. 1984. Malnutrition, morbidity and mortality. *Popn. Dev. Rev. (Suppl.),* **10**: 49-68.

Mathur, P.R.G. 1975. The Muslim Khasi of Meghalaya. Perspective of tribal development and Administration. Hyderabad.

McIntosh, C. Alison and Finkle, Jason L. 1995. The Cairo conference on population and development: A new paradigm? *Popn. Dev. Rev.*, **21**: 223-260.

Mckay, D.A. 1969. The arm circumference as a public health index or protein calorie malnutrition of early childhood. X. Experience with the mid-arm circumference as a nutritional indicator in the survey in Malaysia. *J. Trop. Pediat.*, **15**: 213-216.

Milani, S., Vignolo, M. and Aicardi, G. 1999. Ups and downs of adult height: Models for describing and interpreting the secular trend in the Italian population. *Acta Med. Auxol.*, **31**: 125-132.

Miller, B.D. 1981. *The Endangered Sex: Neglect of Female Children in Rural North India.* New York: Cornell University Press.

Misuraca, A., Capobienco, S., Abete, E. and Greco, L. 1995. Growth in Carpi 1903-1993: Actual growth of the native children. *Acta Med. Auxol.*, **27**: 27-38.

Mitchell, H.S., Rynbergen, H.J., Anderson, L. and Debble, M.V. 1976. *Nutrition in Health and Disease*. Philadelphia: J.B. Lippincott Co.

Mitra, A. 1978. *India's Population: Aspects of Quality and Control*, Vol.1. New Delhi: Abhinav Publications.

Mitra, A. 1985. The nutrition situation in India. In: *Nutrition and Development*, edited by Biswas, M. and Andersen, P. Oxford: Oxford University Press.

Mitra, D.D. 1939. A study of diet and nutrition in North Bengal, Upper Assam and Calcutta. *Ind. J. Med. Res.*, **27**: 441-451.

Mockus, I., Franco, A., Monitoya, M., Alfonso, L.M. and Alzate, A. 1995. Anthropometric variables of students at a Columbian State University. *Acta Med. Auxol.*, **27**: 139-144.

Molnar, S. 1992. *Human Variation: Races, Types, and Ethnic Groups*. Englewoods Cliffs, New Jersey: Prentice Hall Inc.

Mosley, W. H. and Chen, Lincoln C. 1984. An analytical framework for the study of child survival in developing countries, *Popn. Dev. Rev. (Suppl.)*, **10**: 25-45.

Muhuri, P.K. 1995. Health programs, maternal education, and differential child mortality in Matlab, Bangladesh. *Popn. Dev. Rev.*, **21**: 813-834.

Mukherjee, R. 1951. A study on differences in physical development by socio-economic strata. *Sankhya*, **11**: 47-56.

Mukherjee, S.B. 1962. *Studies on Fertility Rate in Calcutta*. Calcutta: Bookland Pvt.

Mukhopadhayay, B. 1981. A comparative microdemographic study of two communities in Coastal Midnapore district, West Bengal. *J. Biosoc. Sci.*, **13**: 479-489.

Murthi, M., Guio, A.C. and Dreze, J.1995. Mortality, fertility, and gender bias in India: A district-level analysis. *Popn. Dev. Rev.*, **21**: 745-782.

Musaiger, A.O., Gregory, W.B. and Haas, J.D. 1989. Growth patterns of school children in Bahrain. *Ann. Hum. Biol.*, **16**: 155-166.

Nag, M. 1962. Factors affecting human fertility in non-industrial societies. A cross-cultural study. New Haven: Department of Anthropology, Yale University.

Nag, M. 1965. Effect of Christianity on a few aspects of Khasi culture. *Bull. Anthrop. Surv. Ind.*, **3**: 95-116.

Nag, M. 1981. Impact of social development and economic development on mortality: A comparative study of Kerala and West Bengal, Paper No. 78, The Population Council, New York.

Nath, D.C., Land, K.C. and Singh, K.K. 1994. Birth spacing, breastfeeding and early child mortality in a traditional Indian society: A hazard model analysis. *Social Biol.*, **41**: 169-180.

National Centre for Health Statistics (NCHS) 2001. CDC Growth Charts: United States. http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/datafiles.htm (Visited on 25-05-2001).

National Family Health Survey (NFHS) 1999. *Northeastern States*. Bombay: Population Research Centre, International Institute for Population Sciences

National Nutrition Monitoring Bureau. 1980. Report on urban populations, 1975-1979. Nutritional News, Vol.3, Hyderabad: NIN.

National Sample Survey (NSS) 1970. Tables with notes on family-planning. 16^{th} Round, July 1960-June 1961, No.116. Delhi: Government of India, The Cabinet Secretariat.

National Sample Survey (NSS) 1971. Tables with notes on the fertility and mortality rates in urban areas of India, 16^{th} Round, July 1960-August 1961, No.180. Delhi: Government of India, The Cabinet Secretariat.

Newman, M.T. 1975. Nutritional adaptation in man. In: *Physiological Anthropology*, edited by Daman, A. London: Oxford University Press.

Nnanyelugo, T.O. 1983. Anthropometric indices and measurements on primary school children of contrasting parental occupations in Nsukka Nigeria. *Nutr. Abst. & Rev.*, **53**: 546.

Ongeri, S.K. 1975. Nutritional problems among Kenyan children. *Environ. Child health*, **21**: 6-14.

Osmani, S.R. 1992. On some controversies in the neasurement of undernutrition. In: *Nutrition and Poverty*, edited by Osmani, S.R. Oxford: Clarendon Press.

Parker, R. E. 1973. Introductory *Statistics for Biology*. London: Edward Arnold (Publishers) Ltd.

Patnaik, M.M. 1981. Age at marriage and fertility behaviour. *Ind. J. Soc. Work*, **XLII**: 239-246.

Patra, P.K. and Kapoor, A.K. 1996. Some demographic traits among the Dalu of West Garo Hills, Meghalaya. *Man in India*, **76**:273-278.

Payne, P.1992. Assessing undernutrition: The need for a reconceptualization. In: *Nutrition and Poverty*, edited by Osmani, S.R. Oxford: Clarendon Press.

Peel, J. 1970. The Hull Family Survey of couples, 1966. *J. Biosoc. Sci.*, **2**: 45-70.

Post, G.B., Kemper, H.C.G., Welten, D.C. and Coudert, P. 1997. Dietary pattern and growth of 10-12 year old Bolivian girls and boys: Relation between altitude and socio-economic status. *Am. Hum. Biol.*, **9**: 51-62.

Poston, D.L., Jr. 2000. Social and economic development and the fertility transitions in mainland China and Taiwan. *Popn.Dev. Rev. (Suppl.)*, **26**: 40-60.

Puffer, R.R. and Serrano, C.V. 1973. Patterns of mortality in childhood. Washington, D.C.: Pan American Health Organization Paper No. 262.

Rajalakshmi, R. (ed.) 1981. *Applied Nutrition*, 3rd edition. New Delhi: Oxford and IBH Publishing Co.

Raman, M.V. 1973. Summary statement: Calcutta fertility survey-1970 (cited in Gulati, 1978).

Rao, B.D. and Busi, B.R. 1993. An analysis of growth patterns between rural Yadava and Badabalija girls of North Coastal Andhra Pradesh: Preece and Baines Model. *Man in India*, **73**: 275-287.

Rao, D.H. and Sastry, D.H. 1977. Growth pattern of well-to-do Indian adolescents and young adults. *Ind. J. Med. Res.*, **66**: 950-956.

Rao, K.S. 1961. Anthropometric measurements and indices in nutritional survey. In: ICMR Special Report Series No. 36.

Rao, K.V. 1980. Efficiency of anthropometric indices for the diagnosis of malnutrition. *Courrier*, **30**: 113-121.

Rao, K.V. 1987. Vital statistics and nutritional status of Indians. *Ind. J. Nutr. Dietet.*, **24**: 272-297.

Rao, M.N. and Mathen, K.K. 1970. Rural field study of population control, Singur (1957-1969). Calcutta: All India Institute of Hygiene and Public Health.

Rao, N.S. 1976. Patterns of income distribution and fertility levels with special reference to India. *J. Fam. Welfar.*, **23**: 63-64.

Rao, S.R., Pandey, A. and Shajy, K.I. 1998. Child mortality in Gao: A cross-sectional analysis. *Social Biol.*, **44**: 101-109.

Redaiah, V.P. and Kapoor, S.K. 1992. Socio-biological factors in under five deaths. *Ind. J. Pediat.*, **59**:567-571.

Reddy, P.Y.B. and Rao, A.P. 2000. Growth pattern of the Sugalis- a tribal population of Andhra Pradesh, India. *Ann. Hum. Biol.*, **27**: 67-81.

Rele, J. R. 1963. Fertility differentials in India. *Milkb. Mem. Fund. Quart.*, **41**: 183-197.

Rele, J. R., and Kanitkar, T. 1977. Fertility differentials by religion in Greater Bombay: Role explanatory variable. In: *The economic and Social Supports for High Fertility*, edited by Ruzicka, L.T. Australian University, Department of Demography.

Rona, R.J. and Chin, S. 1982. National study of health and growth: Social and family factors and obesity in primary school children. *Ann. Hum. Biol.*, **9**:131-145.

Rona, R.J. Swan, A.B. and Altman, D.G. 1978. Social factors and height of primary school children in england and Scotland. *J. Epidemiol. Comm. Health*, **32**: 147-154.

Roy, S. 1994. Khasi Muslim. In: *People of India: Meghalaya* Vol. XXXII, edited by Singh, K.S. Calcutta: Anthropological Survey of India.

Russo, E.G. and Toselli, S. 1997. Anthropometric characteristics and physical performance in a sample of Italian children, 11-14 years old. *Acta Med. Auxol.*, **29**: 13-20.

Rutstein, S. O. 1984. Infant and child mortality: Levels, trends and demographic differentials. WFS Comparative Studies, No.43.

Rutstein, S.O. 2000. Factors associated with trends in infant and child mortality in developing countries during the 1990s. *Bull. WHO*, **78**:1256-1270.

Saikia, U.S., Steele, R. and Dasvarma, G. 2001. Culture, religion and reproductive behaviour in two indigenous communities of Northeast India: A discussion of some preliminary findings. Paper presented at XXIV IUSSP General Conference, 18-24th August, 2001, Salvador, Brazil.

Satyanarayana, K., Naidu, N. and Rao, B.S.N. 1980. Adolescent growth spurt among rural Indian boys in relation to their nutritional status in early childhood. *Ann. Hum. Biol.*, **7**: 359-365.

Schultz, P. T. 1984. Studying the impact of household economic and community variables on child mortality, *Popn. Dev. Rev. (Suppl.)*, **10**: 215-235.

Scrimshaw, N. S. and Gordon, J.E. (eds.) 1968. *Malnutrition, Learning and Behaviour.* Cambridge: MIT Press.

Sen, T. 1994. *A Guide to Anthropometry.* Calcutta: The World Press Pvt. Ltd.

Sengupta, S. and Gogoi, G. 1995. Some demographic variables among the Kaibartas of Dibrugarh district, Assam: A preliminary appraisal. *Bull. Deptt. Anthrop. Dibru. Univ.*, **23**: 86-95.

Sharma, J. C. 1992. Nutritional factors in health, physical growth and development and politics. Presidential address at the 79th Indian Science Congress, Baroda. Calcutta: Indian Science Congress Science Association.

Sharma, J. C. 1995. Human growth and assessment of nutritional status. In: *Application Areas of Anthropology*, edited by Mahajan, A and Nath, S. New Delhi: Reliance Publishing House.

Sinha, J.N. 1957. Differential fertility and family limitation in an urban community of utter Pradesh. Popn. Stud., 11: 157-169.

Smith, A.M., Chinn, S. and Rona, R.J. 1980. Social factors and height gain of primary school children in England and Scotland. *Ann. Hum. Biol.*, **7**: 115-124.

Smith, J.P. and Ward, M.P. 1984. *Women wages and work in the twentieth century. Report R-3119-NICHD.* Santa Monica Calif: The Rand Cor.

Snedecor, G. W. and Cochran, W. G. 1967. *Statistical Methods.* New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.

Srinivasan, k.A. 1967. Perspective study of the fertility behaviour of a group of a married women in rural India. Designs and findings of the first round of inquiry. *Popn. Rev.*, **11**: 46-60.

Stephenson, L.S., Latham, M.G. and Janson, A. 1983. A comparison of growth standards: Similarities between Harvard, Denver and Privileged African children and differences with Kenyan rural children. Cornel International Nutrition, Monograph Series No. 12.

Stinson, S. 1980. The physical growth of high altitude Bolivian Aymara children. *Am. J. Phys. Anthrop.*, **52**: 377-385.

Stinson, S. 1982. The effect of high altitude on the growth of children socioeconomic status in Bolivia. . *Am. J. Phys. Anthrop.*, **59**: 61-71.

Stoeckel, J. and Choudhury, M.A. 1969. Differential fertility in rural areas of East Pakistan. *Milkb. Mem. Fund Quart.*, **47**: 189-198.

Strickland, S.S. and Tuffrey, V.R. 1997. *Form and Function: A Study of Nutrition, Adaptation and Social Inequality in Three Gurung Villages of the Nepal Himalayas*. London: Smith-Gordon and Co.

Sukkar, M.Y. Kemm, J.R. , Makeen, A.M. and Khalid, M.H. 1979. Anthropometric survey of children in rural Khartoum, Sudan. *Ann. Hum. Biol.*, **6**: 187-198.

Syiemlieh, D.R. 1994. Notes from a Missionary's letter. Paper presented at the Shillong Chapter of the Church History Association of India, 30th September.

Tanner, J.M. 1962. *Growth at Adolescence*, 2nd edition. Oxford: Blackwell Scientific Publication.

Tanner, J.M. 1966. Growth and physique in different populations of mankind. In: *The Biology of Human Adaptability*, edited by Barker, P.T. and Weiner, J.S. Oxford: Clarendon Press.

Tanner, J.M. 1988. Human growth and constitution. *In Human Biology: An Introduction to Human Evolution, Variation, Growth and Adaptability*, 3rd edition, edited by G.A. Harrison, G.A, Tanner, J.M, Pilbeam, D.R.and Baker, P.T. Oxford: Oxford University Press.

Terrell, T.R. and Mascie-Taylor, C.G.N. 1991. Biosocial correlates of stature in a 16 year old Britain cohort. *J. Biosoc.Sci.*, **23**: 401-408.

Thompson, W.S. and Lewis, D.T. 1980. *Population Problems*, 5th edition. New Delhi: Tata Mcgraw Hill Publishing House.

United Nations (UN) 1961. The Mysore population study. No. ST/SOA/Series A. In: *Population Studies No. 34*. New York: Department of Economic and Social Affairs.

United Nations (UN) 1967. World Population Conference, 1965, Vol.2. Selected Papers and Summaries: Fertility, Family Planning and Mortality. New York: Department of Economic and Social Affairs

United Nations (UN) 1976. Fertility and family planning in Europe around 1970. A comparative study of 12th National Surveys. In: *Population Studies, no. 58*. New York: department of Economic and Social Affairs.

United Nations (UN) 1985. *Socio-economic Differentials in Child Mortality in Developing Countries*. New York: Department of International Economics and Social Affairs.

United Nations International Children Emergency Fund (UICEF) 1991. Infancy and early childhood – The vulnerable years. In: *Children and Women in India- A Statistical Analysis*. New Delhi: UNICEF.

Verghese, K.P. Scott, R.B. Teizeira, G. and Perguson, A.D. 1969. Studies in growth and development. XII. Physical growth of North American Negro children. *Pediat.*, **44**: 243-247.

Verma, G.R., Babu, B.V. and Rohini, A. 1999. A study on fertility and its socio-demographic determinants among rural population of West Godavari district, Andhra Pradesh. *J. Hum. Ecol.*, **10**: 179-182.

Verma, K.K. 1977. *Culture, Ecology and Population*. New Delhi: National Publishing House.

Vijayaraghavan, K., Singh, D. and Swaminathan, M.C. 1974. Arm circumference and fat fold at triceps in well nourished Indian school children. *Ind. J. Med. Res.*, **62**: 994-1001.

Visweswara Rao, K., Balakrishna, N. and Adinarayana, K. 1986. Critical limits of some anthropometric measurements and indices for the assessment of nutritional status. *Ind. J. Nutr. Dietet.*, **23**: 88-98.

Visweswara Rao, K., Balakrishna, N., Thimmayama, B.V.S, and Rao, P. 1990, Indices and critical limits of malnutrition for use among adults. *Man in India*, **70**: 351-367.

Wagstaff, A. 2000. Socioeconomic inequalities in child mortality: Comparisons across nine developing countries. *Bull. WHO*, **78**: 19-29.

Weiner, J. S. and Lourie, J.A. 1981. *Practical Human Biology*. London: Academic Press.

Westoff, C.F. 1962. *Family Growth in Metropolitan America*. Princeton: Princeton University Press.

WHO 1964. Research in population genetics of primitive groups. *WHO Technical Report Series No. 279*. Geneva: WHO.

WHO 1968. Research in human population genetics. *WHO Technical Report Series No. 387*. Geneva: WHO.

WHO 1986. Use and interpretation of anthropometric indicators of nutritional status. *Bull. WHO*, **64**: 929-941.

WHO 1989. *Global Nutritional Status*. Geneva: WHO

WHO 1990. Diet, nutrition, and the prevention of chronic disease. *Technical Report Series No. 797*. Geneva: World Health Organization.

Winick, M. 1968. Nutrition and cell growth. *Nutr. Rev.*, **26**: 195-197.

World Bank. 1974. *Population Policies and Economic Development*. Baltimore, London: Johns Hopkins University Press.

World Bank. 1986. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*. Washington, D.C.: World Bank.

World Bank 1999. *World Development Report 1998/99*. New York: Oxford University Press.

Yep, R., Binkin, N.J. and Trowbridge, F.L. 1988. Altitude of childhood growth. *J. Pediat.*, 113: 486-489.

Zathar, Z. 1988. Birth spacing in Pakistan. *J. Biosoc. Sci.*, **20**: 175-194.