A STUDY ON NUTRITION AND HEALTH STATUS
IN RELATION TO
SOME BIO-SOCIAL FACTORS AMONG THE WAR KHASI OF MEGHALAYA

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

R. KHONSDIER
DEPARTMENT OF ANTHROPOLOGY
NORTH EASTERN HILL UNIVERSITY
SHILLONG - 793014
JULY, 1995

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Dated. 9th June, 1995.

CERTIFICATE

Certified that the thesis entitled "A Study on Nutrition and Health Status in Relation to some Bio-Social Factors among the War Khasi of Meghalaya" is the record of original work done by Shri Romendro Khongsdier, that the contents of this thesis did not form a basis of the award of any previous degree to him, or to the best of my knowledge, to anybody else, and that the thesis has not been submitted by him for any research degree in any other University.

In habit and character Shri Romendro Khongsdier is a fit and proper person for the Degree of Doctor of Philosophy.

(A. K. GHOSH)
SUPERVISOR.

ACKNOWLEDGEMENTS

I must express my deep sense of indebtedness to Prof. A.K. Ghosh for his help and constant guidance, without which this work could not have been brought into its present form. I am very grateful to the Director, Anthropological Survey of India, for giving permission and providing necessary facilities. I am also very grateful to Dr. R. K. Pathak, Head of the Department of Anthropology, NEHU, for helping and providing necessary facilities.

I specially wish to express my gratefulness to Dr. Ranjan Gupta and Dr. P. Bharati for their interest and sustained help in supplying the secondary materials related to the present work. I am greatly indebted Dr. D.Tyagi, Deputy Director, Anthropological Survey of India, and Dr.(Mrs) Tulika Sen for their valuable comments and suggestions. Thanks are due to Dr. K. Visweswara Rao, Deputy Director, National Institute of Nutrition, for providing secondary materials, Mr. K.K. Bhattacharya for suggestions and Ms. Jaya Gupta for drawing the systematic-random sampling of villages. Thanks are also due to Mr. Nitul K. Gogoi, Mr. L. S. Gashnga, and Mr. F. Khongwar for their help in carrying out this work.

I owe my deep appreciation to the Editorial Board, Acta Medica Auxologica, for their valuable comments on nutritional anthropometry.

In the field, I received help and cooperation from many people and Organisations. Special thanks are due to Mr. K.K. Dkhar, Mr. Sainbor Khonglam, Mr. Donbor Roy Khonglam, Mr. Bellan Tariang, Mr. K. Khongtani, Mr. O. Khongstia, Mr.D. Tangsong, Mr. Anthony Ksing and Mr. Koles Thongni. In fact, I must be very thankful to all my colleagues, friends and well-wishers from within and outside of the Department of Anthropology, NEHU, and Anthropological Survey of India, Shillong, for their encouragement and interest in the present work.

Last but not least, I am very grateful to all my family members who have rendered sustained help and moral support.

Dated, Shillong,
The 14th July, 1995.

(R. Khongsdier)

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CHAPTER I

INTRODUCTION

1.1. STATEMENT OF THE PROBLEM

One of the central themes of physical anthropology is to find out and understand the biological variations in human populations and the causes of such variations. It is true that at the initial stages, the physical anthropologists were largely involved in researches on taxonomic classifications of mankind. But since the middle of the present century, they have shifted from the so-called taxonomic research to population genetical research with a view to understanding the various processes of human evolution and variation. Subsequently, the various aspects of human variation like physical growth, environmental adaptation, etc. have also become the subject matters of interest among the physical anthropologists. Recently, efforts are being directed to understand the relationship between human biological traits and various physical as well as socio-environmental factors (Basu et al., 1980b). It is now believed that biological processes and health are largely influenced by various socio-environmental proximates (Newman, 1975). So, though population genetics is still considered as the theoretical backbone of physical anthropology (Kirk, 1978), it is quite imperative on the part of physical anthropologists to understand the effect of various socio-environmental factors on well-being of human population(s).

Nutrition, along with other socio-environmental factors, is generally known to be associated with many biological and health oriented traits such as physical growth, adult body dimensions, haematological traits, infant mortality, etc. Thus, it cannot be denied that a study of the inter-relationship between/among nutritional status, socio-economic factors and biological characteristics of human population is a very important aspect of research in the field of physical anthropology (Basu, 1987; Bharati, 1989). Such studies are very few in India, especially in the north-eastern region of of the country.

Nutrition, which reflects the socio-economic condition of a community, is one of the vital environmental factors for the study of human evolution and variation (Newman, 1975) and/or the health status of a community. In this regard, it may be mentioned that the World Health Organisation (WHO, 1971) has defined health as a "...complete physical, mental and social well-being and not merely the absence of disease and infirmity". However, for the purpose of the present study, health is narrowly defined as a physical well-being of an individual or a population in terms of certain biological traits that are easily examined such as physical growth, adult body dimensions, infant mortality, haematological traits, etc.

The effect of nutrition on health and other biological characteristics has been revealed in many studies (Ghosh and Bhatt, 1961; Morley, 1969; Gopalan et al., 1971; Chandra, 1981; McMurray et al., 1981; Martorrel and Ho, 1984; Eveleth and Tanner, 1990; and others). Dumont and Rosier (1969) have estimated that out 60 million deaths in the world every year, 10 to 20 millions are due to dietary causes. In developing countries, at least one third of the people is reported to have a diet with protien deficiency (FAO/WHO Expert Committee, 1965). In India, about 80 % of the population is confined to rural areas, where there are widely prevalent-nutritional deficiencies(Vijayaraghavan et al.(1985). But studies on nutritional status of population are still limited, especially with reference to regional, ethnic, socio-economic and cultural variations, and so far no such study, to the best of our knowledge, has been carried out in the north-eastern region of the country.

1.2. OBJECTIVES OF THE PRESENT STUDY

In view of the fact that no study has so far been undertaken in the north-eastern region in general and among the War Khasi in particular on the effect of bio-social factors(including nutrition) on health status, we propose to undertake a study on nutrition and health status in relation to some bio-social factors among the War Khasi of Meghalaya. Accordingly, the main objectives of the present study are as follows:-

1. To describe the dietary/nutritional status of the War Khasi, following as far as possible the recommended dietary intakes, given by the Indian Council of Medical Research (ICMR, 1977, 1989).
2. To assess the nutritional status in the present population, using anthropometric variables.
3. To find out the relationship between various socio-economic conditions and dietary/nutritional status.
4. To find out the effects of other bio-social factors like age, sex, birth order, anthropometric variables, age at marriage, economic condition, religion, education, etc. on some demographic parameters like fertility, mortality, etc.
5. To understand the effects of diet/nutrition and other bio-social factors on child growth, adult body dimensions and haemoglobin content, etc.

6. To find out the frequency of nutritional defficiencies, if any, in this population.

1.3. AREA OF STUDY

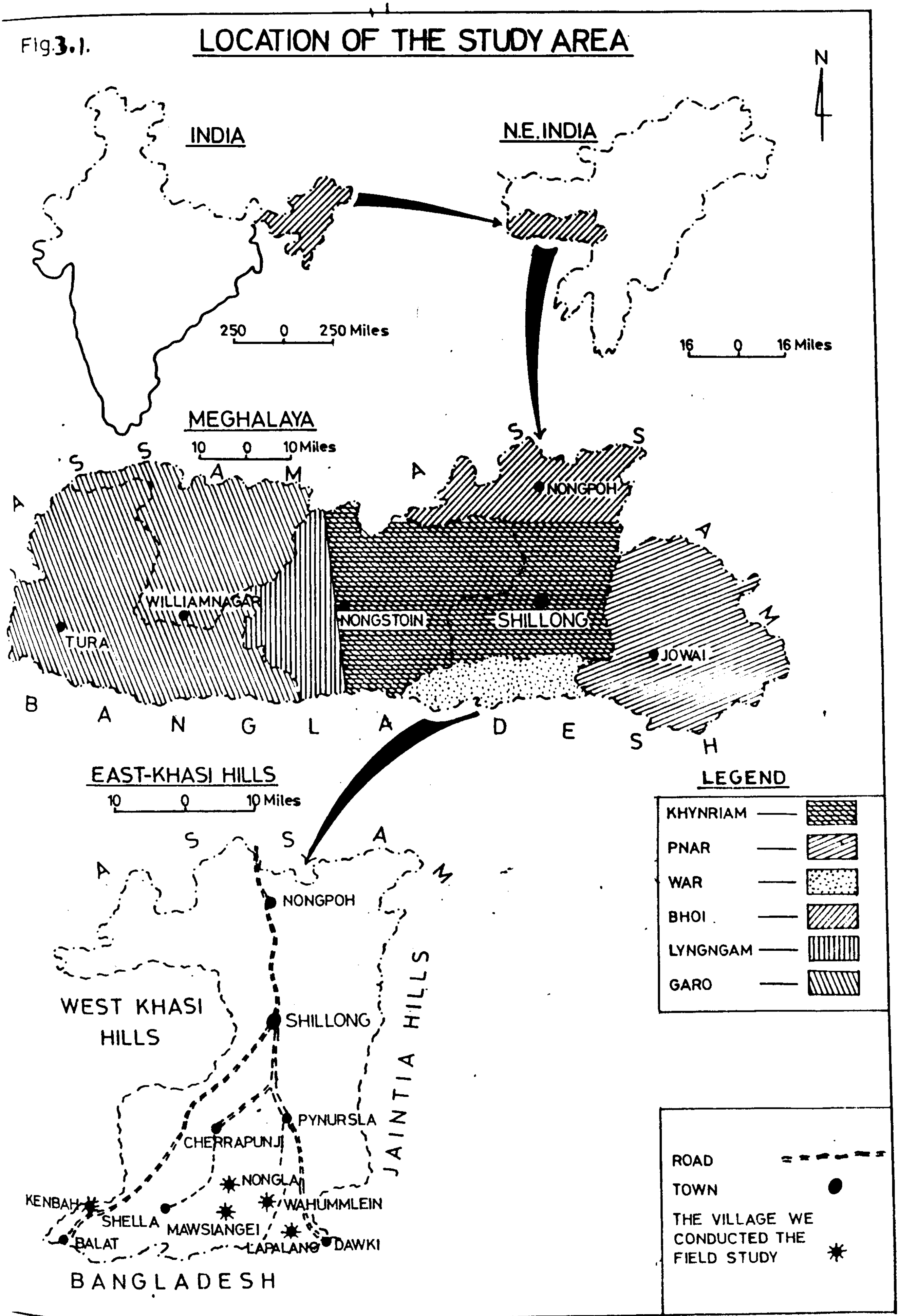
Location and Topography

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°45′ and 92°47′ E longitude. The state covers an area of about 22429 Km^2. It is bounded by Assam on the north, east and north-west ,and by Bangladesh on the south and south-west (Fig. 3.1).

Initially, Meghalaya was a part of Assam, which was composed of only two districts, namely, the United Khasi and Jaintia Hills district and the Garo Hills district. It was bifurcated from Assam as an autonomous state on April 2, 1970, and subsequently a full-fledged statehood was achieved on January 21, 1972. Prior to 1992, there were five districts in the state, namely, the Jaintia Hills, East Khasi Hills,West Khasi Hills, East Garo Hills and West Garo Hills districts. At present, there are altogether seven districts with the creation of two more districts in 1992, viz, the Ribhoi and South Garo Hills districts. Till now, no official map has been published by the State Government,which indicates the boundaries of the newly created districts.

The War Khasi mostly live in the southern slope of the East Khasi Hills district of Meghalaya. They are also found in the east-southern slope of the West Khasi Hills district as well as in the southern slope of the Jaintia Hills district. The East Khasi Hills district covers an

Fig. 3.1. LOCATION OF THE STUDY AREA



Drawn by Binod

area of 5196 Km^2. It is bounded by the Ri Bhoi district on the north, Bangladesh on the south, Jaintia Hills district on the east and West Khasi Hills district on the west. The headquarters of the East Khasi Hills district is Shillong, which is situated about 1510 metres above sea level, and it is also the capital of the state.

The southern slope of Khasi hills is also known as 'Ka Ri War'(War country). It extends roughly from Dawki on the east to Balat on the west. It is situated between the central upland region and the plains of Bangladesh. The area is characterised by the hill slopes and precipices, beautiful platforms and waterfalls. The famous platforms are Cherrapunji platform (1337 metres), Mawsynram (1305 metres) and Pynursla (Zimba, 1983).

The important rivers in the War area are Umngot, Khasmar, Umiam, Umrew, Umngi, Khuba, etc. These rivers have created the deep valleys through cretaceous sandstones and hard rocks while flowing towards Bangladesh.

Geological Composition

Meghalaya may be broadly divided into five geological formations, namely, Archean Gneissis Complex, Shillong Group of Rocks, Lower Gonduana Rocks, Cretaceous Tertiary Sediments and Sylhet Traps (Bhaktia,1992). The central and northern parts of the state are covered by the Archean Gneissis Complex. The important rocks of this geological formation are quartzite, gneissis, schist, etc. The Shillong Group of Rocks occupies the central and eastern parts of the state. The major rocks found in this formation are quartzite, granite, schist, etc. The Lower Gonduana Rocks lying in the western parts of the Garo hills are composed of pebble-beds, sandstones, shales, etc. The southern part of the state is formed by the Cretaceous Tertiary Sediments. It is said that these sediments are a continuation of the Cretaceous Tertiary Sediments of the Bengal plains.

The Sylhet Traps, comprising basalt, rhyolites, etc., occur in narrow belt and extend in the east-west direction along the southern slope of the West Khasi Hills district. These traps are closed to the Dawki-Shella fault. Zimba (1983) describes that the cretaceous or shalky rocks of this area, containing coal fields and limestones in the alternating strata of the compact rocks, are the result of transitional nummulities.

The War area is very rich in limestone and coal deposits. Limestones are found to exist in the whole area of southern slope from the Lubha river on the west to the Umngot river and southern parts of the Jaintia Hills district on the west. The Commorrah Quarry near Bholaganj is very famous for its supply of limestone to Assam Bengal Factory at Chattak, now in Bangladesh. Coal deposits of the War area are found in Mawlong, Mustoh, Mawsynram, Mawdon, Langrin, Langkyrdem, Pynursla, etc. Petroleum is also reported to have existed in the valley of the Khasimara river on the west of Shella village (Das Gupta, 1984).

Climate

The climate is wet and warm during summer and dry and cold during winter. The average temperature ranges from 30° to 34° C during summer, but it drops to as low as 12° C during winter. The average annual rainfall in the East Khasi Hills district is about 7090 mm (Simba,1983). According to annual record of rainfall in 1974, Sohra (Cherrapunji) experienced about 976 inches or 24, 554 mm, thereby having the heaviest rainfall in the world. But according to the Indian Meteorological Department (Sachdeva, 1993), Mawsynram, which is located about 16 Km. west of Cherrapunji, is now having the highest rainfall in the world. The average annual rainfall in Mawsynram exceeds that in both Cherrapunji in Meghalaya and Waileale in Hawaii.

Flora and Fauna

The important flora of the War Khasi area include teak(teotona grandis), pooma (cedrela toona), rubber plant (figus religiosa), palm tree (fenic dactilifera), bay leaf (belula acuminata), upas (rhus succedanea), arecanut (areoa catohu), simul tree (bombax malabarica), orrange (citrus aurantium), mango (mangifera indioa), jackfruit (artocarpus integrifolia), chestnut (castonopsia indioa), pan leaf (buclandia populnea), pine apple (bromelia ananas), quava (psidium quajiva), Indian plum (flacourtia jangomas), broom-stick (thysamolanena maxinus),Soh phie' (myroa esculenta), 'diengngan' (Khasiana dyer),'dieng pyrsit'(eurya japonica), 'dieng Sohum' (eugenia tetragona), etc. Other species like cinanamomium zeilandium, quercus spicata, citriodora, bacaria, sapeda, sapindus mukorosi, species of orchids, ferns, mosses, fungi, lichens, etc. are also found in the War area.

The area was once a sanctuary of various types of wild animals.

But owing to the practice of shifting or jhum cultivation and merciless killings of animals, most of the fauna have now become extinct. The fauna, which are found at present, include leopard, bear, deer, mongoose, small rodent, wild pig, fox, otter, monkey, squirrel, wild fowl, crow, myna, pheasant, owl, etc.

1.4. THE PEOPLE

Distribution

According to 1991 Census, the total population of Meghalaya is 17,60,626, of which males are 904,308 and females 856,318. The overall sex ratio is 94.7 females per 100 males. The density of population is approximately 78 persons per square kilometre.

The people of Meghalaya are mostly tribals, among which the Khasi and the Garo are the most dominant tribal groups. The other tribal populations like the Hajong, Naga, Mizo, etc. along with some Hindu caste populations, Nepali, etc. have also settled in the state.

The Khasi tribe consists of five major sub-groups, namely, the War, Khynriam (upland Khasi), Jaintia (Pnar or Synteng), Bhoi and Lyngngam. The Khynriam are mostly found in the upland regions of the East and West Khasi Hills districts of the state. The Jaintia Hills district is dominated by the Jaintia. The Bhoi predominantly live in the Ri Bhoi district or northern parts of the Khasi hills. The Lyngngam are mainly confined to the southern and western parts of the West Khasi Hills district. The entire southern slope of Khasi hills is dominated by the War Khasi. They are also found in the southern part of Jaintia Hills district.

Physical Characteristics and Affinity

From the anthropological point of view, the Khasi (or Khynriam, Pnar, Bhoi, War and Lyngngam) belong to the Indo-Mongoloid group of the Mongoloid racial stock (Das, 1981). Das (1987) has described that the "Khasi have brown skin colour. Their head hair is dark brown with a reddish tinge in colour, straight or flat, wavy in form and coarse in texture. They have scanty beard and moustache. The colour 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 mesocephalic and nose is mesorrhine". Regarding the four sub-groups of the Khasi, Das (1978) says that these four divisions (i.e. Khynriam, Pnar, Bhoi and War) do not deviate much from the average Khasi in relation to stature and trunk height. He, however, points out that the "Pnar and the Bhoi show most often deviation in higher magnitude and that these two populations are standing opposite to one another in relation to average Khasi". It may be mentioned that the people have so far treated the Khynriam, Pnar, Bhoi, War and Lyngngam 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 on 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 Khasi follow the matrilineal system of 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 is concerned, it is believed to be spoken by the earliest inhabitants of the country, particularly the Australoids and their descendants. At present, besides the Khasi, other peoples like the Kol, Munda, 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 Khasi in spite of their linguistic isolation among the peoples of Assam, are racially closely related to the majority of the Tibeto-Burman 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 Khasi . Linguistically, Chatterjee (1951) says "... in Burma and Indo-China lived speakers of Austric language, who are largely of Proto-Australoid race from India". Accordingly, Das (1978) has proposed that one of the possibilities is that the " Khasi are an Australoid population speaking 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". In view of these circumstances, we may also say that although the present day Khasi are not Australoid, they might be the autouchthonous population of this part of the country, or they might have been the small divergent group of the Proto-Australoids, who migrated to Burma and Indo-China from India.

The other possibility is that the Khasi are a Mongoloid people, who came from south-east Asia as suggested by many scholars like Gurdon (1907), Chatterjee (1951), Bareh (1967), Das (1978), and others. According to Gurdon (1907), " ... the Khasi 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 south from the 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 (Rman) or Mon people of central and southern Burma, the Palaungs and Was of Upper Burma, as well as the Khmers, the Chams, the Stiengs, the Bahnars and other Austric or Austro-Asiatic speakers of Siam and Indo-China". It may be mentioned here that the Proto-Australoids are known by different names like Pre-Dravidian, Australoid, Veddid and Nishada. The Proto-Australoids are similar to Caucasoids in respect of many characteristics. Sometimes, they are also considered a sub-division of the Caucasoid known as Archaic Caucasoid (Das, 1970). In view of the above suggestions, it appears that the Khasi are a Mongoloid people, who might have learned their language from the Australoids (or Proto-Australoids) on their way to India or they might be one of those peoples resulting from the admixture between the Mongoloids and Proto-Australoids (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 main occupation of the War Khasi is agriculture and horticulture. They mainly produce paddy, arecanut, bay leaf, betel leaf, pepper, lemon, orange, broom-stick (thysamolanena), banana, pine-apple, guava, ginger, tumeric, etc. It may be mentioned that the people, who cultivate paddy are those who live mostly in the plain regions, bordering Bangladesh. A large number of people, possessing no land property, are working as day labourers. Some people are also engaged in business and services. Some others have trade and commerce relation with the Khynriam and others mainly at the centres like Ranikor, Balat, Shella, Sohra(Cherrapunji), Langkyrdem, Pynursla, Dawki, Shillong, etc.

Rule of Inhertance

Among the War Khasi, the rule of inheritance is not exactly identical, though similar to that in other Khasi sub-populations. It is gerally believed that both son(s) and daughter(s) inherit the parental property (Gurdon, 1907; Bareh, 1967; Das Gupta, 1984; and others). It may, however, be mentioned that this practice is mainly prevalent among the War Shella and some parts of the War Cherrapunji. The other War Khasi, living in Balat, Pynursla and Dawki areas, except one or two villages, do not follow this pattern of inheritance; but they have adopted the customs, followed by the Khynriam,. which mean that the daughters, but not the sons,inherit the parental property (the youngest daughter gets the lion's share). So, among the War Khasi, there are two types of the rule of inheritance : (i) The War Shella customs and (ii) the general customs followed by the other Khasi groups, viz., the Khynriam, Pnar, Bhoi and Lyngngam, though there slight variations in certain respects.

Religion

The War Khasi have been in contact with a different people of different religious faiths from time to time (Das Gupta, 1984). The arrival of the Christian and Hindu missionaries, particularly in Shella and some parts of Cherra areas, has brought about a tremendous change in religion and belief of the people. At present, there three main religious sections in the War Khasi. These are : (1) **Ka Niam Khasi** - believer of Khasi traditional religion, (2) the Christian War Khasi - believer of Christianity, and (3) the Hindu War Khasi - believer of Hinduism. Of these religious groups, **Ka Niam Khasi** (Khasi religion) and the Christian War Khasi are the most predominant sections in the War Khasi. The spread of Hinduism among the War Khasi is mainly restricted in Shella and some parts of Cherra area. The Christian War Khasi are divided into different sects like the Presbyterian, Roman Catholic, Church of God and Fellowship.

The people, who are still following their traditional religion, are monotheistic, though the others are of the opinion that the Khasi religion may be described as animism (Gurdon, 1907; Bareh, 1967; Bhowmick, 1971) and demon worship (Nataranjan, 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". Nevertheless, the War Khasi, like the other Khasi sub-groups, believe in one God, the Supreme Planner and Creator (**U Blei Nongbuh Nongthaw**). It may not simply be assumed that the Khasi are polytheistic since they used to speak of many gods. Mawrie (1981) says, "Khasis are not polytheists. Occasionally, talk of many gods is rather to be understood as talk about multiciplicity of the manifestations of one and the same God. To a Khasi, God is one and many because of attribute of being present in all the world above and the earth below" . The breaking of eggs and sacrifice of birds and animals like fowl, pig, cow, goat, etc. are their important riligious 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 rivivalism of the traditional religion (**Ka Niam Khasi**), under the leadership of the Seng Khasi Organisation, established first on August 23, 1899, has already started among the War Khasi.

Marriage and Clan Exogamy

Monogamy is the general practice of the War Khasi. According to Gurdon (1907), this pattern of marriage is prevalent among the Khasi owing matriarchal system of the society. Though the War Khasi do not strictly prohibit intermarriages with other Khasi sub-groups, like the Khynriam, Pnar, Bhoi and Lyngngam, yet village endogamy is very much prevalent. A recent study has revealed that the frequency of inter-village marriages is only about 6.51 %. Besides, there is also a strong tendency towards religious endogamy even within a single village (Khongsdier, 1994a). Nevertheless, marriages with other communities like the Garo, Mizo, Naga, Assamese, Bengali, Nepali, etc. also take place at times. Cousin marriage like mother's brother's daughter (MBD) or father's sister's daughter (FSD) is generally prohibited (Gurdon, 1907). However, marriage with mother's brother's daughter is not theoretically prohibited, especially after the death of the maternal uncle (Das Gupta, 1984). In a recent study, a few cousin marriages among the War Khasi have been noticed(Khongsdier, 1991).

Relation with other Neighbours

The War Khasi are surrounded by the Khasi proper (Khynriam), peoples of Bangladesh, Pnar and Lyngngam on the north, south, east and west, respectively. Social contacts with these neighbours are always through trade and business transactions mainly at the centres like Balat, Shella, Cherrapunji, Pynursla, Majai, Nongjri, Hatthymmai, Lyngkhat, Dawki, Shillong, etc. It may be noted that the War Khasi, who are always in contact with the Pnar or Jaintia, are those who live in Pynursla and Dawki areas. Similarly, the people, who are in constant contact with the Lyngngam, are those, who live in the western part of the War country or Balat area. The War Khasi are dependent on the Muslim and Hindu of Bangladesh for the supply of fish, egg, fowl, utensils, etc. In turn, they sell to the neighbours some agricultural produce like arecanut, bay leaf, betel leaf, orange, lemon, guava, ginger, tumeric, etc. These local produce are also sold at Cherrapunji, Shillong, Pynursla, Langkyrdem, Laitlyngkot, Dawki,etc., where they frequently meet with the Khynriam, and others. It is also from these centres that they purchase rice, cloth, and other essential commodities.

Food Habits

Rice is the staple food of the War Khasi. It is taken by the people for all seasons in a year. Actually, rice is locally produced by a few sections of the people living on the border of Bangladesh or plain area. Since the War Khasi mainly depend on rice, a large quantity of it is procured from other state to meet the requirement. The principal pulse taken by the people is lenttil, which is available in local market. They also consume different types of bean especially during winter season. Common vegetables include onion, potato, brinjal, pumpkin, gourd, plantain flowers, yam, arum, green banana, cucumber, papaya, etc. Tomatoes are also taken frequently during the months between December and April. Different types of leafy vegetables, mushroom and bamboo shoots are collected from the jungles and consumed during the rainy season (April to September). There are also different types of fruits, especially during the rainy season. The most common fruits include orange, jackfruit, banana, pine-apple, papaya and different types of lemon.

The War Khasi are fond of meat and fish. They usually take fishes which may be either fresh or dry ones. Pork is taken frequently, particularly during the market days. Except the Hinduised War Khasi, beef is also consumed by a large number of people. They also use to take the flesh of other animals like mangose, seal, roddent, otter, monkey, wild pig, bear, deer, etc. Besides, the people are fond of chicken and different types of birds. Egg is also taken frequently. In general, besides vegetables, the people always take their rice along with either meat, or fish, or egg. It may be noted that nowadays, tea is another important ingredient of the breakfast and tiffin (Das Gupta, 1984). Along with tea, they take cold rice (Ja Jah), or boiled arum or yam, bread and biscuits. The War Khasi are not fond of milk, though they do consume little milk with tea.

CHAPTER II

REVIEW OF RELATED LITERATURE

In this chapter, we shall make a review of literature on the relationship between certain biological characteristics, nutritional and socio-economic conditions. It may, however, be mentioned that the review is not very exhaustive. The main purpose of this review is to show some trends of research work on related topics that have been carried out by the earlier works.

2.1. NUTRITION

There is a general agreement that nutritional status has been greatly influenced by a myriad of socio-environmental factors such as seaso-nal differences, economic conditions, types of occupation, nature of land productivity, etc. (Keys et al., 1950; Devadas and Eswaran, 1967; Wray and Aquirre, 1969; Tulpule and Rao, 1972; Ballweg, 1972; Gupta and Mwambe, 1976; Greene, 1977; Rao, 1978; Grivetti, 1981; Shukla, 1982; Roy and Roy, 1982; Chong et al., 1984; Edmundson and Sukhatme, 1990, 1992). However, only a few of these studies have revealed the parameters that are positively associated with malnutrition.

Economic Condition

Several studies have indicated the effect of economic condition on nutritional status (Tanner et al., 1966; Baker et al., 1967; Ziffer et al., 1967; Cook et al., 1973; Owen et al., 1974; Rao, 1978; Gopalan, 1992 ; Edmundson and Sukhatme, 1992; and others)

It is generally believed that nutrition and poverty are closely related. Economists are always concerned with the framework of measuring poverty, and in their attempt to understand this problem, they have taken into consideration the nutritional status of a population (Osmani, 1992). Osmani says, "Many elementary aspects of being poor, such as hunger, inadequate health care, unhygienic living conditions, and the stress and strain of precarious living tend to impair a person's nutritional status". Martorrel and Ho (1984) have observed that the basic cause of malnutrition in most of the developing countries is socio-economic condition. According to them, "Ignorance of the special needs of children and inappropriate cultural beliefs and practices often causes families to give their children diets that are less in quantity and quality than those they could provide".

Ferro-Luzzi et al. (1979) have reported that the Italian children, who have higher socio-economic status, generally get better diet than those belonging to the lower socio-economic condition. Wray and Aquirre,(1969) have also observed that the Columbian of low income families have higher rate of malnutrition than those of higher income families. Data from Sri Lanka, Brazil, Madagascar and Tunesia have also revealed a positive relationship between calorie intake and family income (FAO, 1977). Paswal (1972) , Perisse and Kamoun (1981), and Chong et al. (1984) have also made a similar observation in Phillippines, Tunesia and Malaysia, respectively.

In urban Peru, Graham et al. (1981) have reported that the overall dietary intake as well as the proportion of energy consumed as fat and animal protien increases with the rise in per capita expenditure for food. Brown (1984) , in a review on the determinants of dietary intake of infants and children, has suggested that the parental occupation is the major determinant of dietary consumption because of the fact that the availability of food to the family is highly influenced by this factor. She has also pointed out that the children, belonging to the higher economic strata,have higher intake of calcium, riboflavin, carotene and vitamin C because of their increased consumption of cow's milk, fruits and vegetables. Similarly, Groenewold and Tilahun (1990) have shown that income and occupation of the father in a household are the major factors influencing the nutritional status of children.

In India also, studies have indicated that the dietary intakes are associated with the socio-economic conditions (Devadas and Easwaran, 1967; Sukhatme et al., 1969; Gopalan et al., 1971; FAO, 1977; Thimmayamma et al., 1982; Majumdar et al., 1985; Basu et al., 1987; Bharati and Basu, 1988; and others).

Data collected from different states of India by the National Sample Survey Organisation (NSS, 1982) reveal that the per capita intake of protien, calories and fat increases consistently with the rise in per capita expenditure. Mitra (1942) has shown that among the Ho there is a positive relationship between family income and calorie intake. Devadas et al. (1967) have also reported that the consumption of different nutrients is positively associated with family income. Gopalan et al. (1971) have observed that the school children, belonging to the higher economic status, have higher intake of protien and calories than those children, belonging to the lower economic strata. Similar observation has been made by Thimmayamma et al. (1973), Kaur et al. (1982). Data from West Bengal have also revealed that the consumption of all nutrients, except that of vitamin C, increases significantly with the rise in the level of economic condition. In fact, the Indian children in poor rural communities have suffered not only from calorie deficiency but also from other nutrient deficiencies such as iron, vitamin A, Iodine, etc.(Gopalan, 1992). With regard to adults, Rao et al. (1990) have shown that both male and female adults of higher economic groups have lower rate of undernutrition and higher rate of overnutrition than those of lower economic groups.

Some studies also indicate that the per capita consumption as well as the daily consumption per consumption unit of different food items tends to increase with the rise in per capita income of household (Ramana and Kadar, 1976; National Institute of Nutrition, 1982; Bharati, 1983).

DEMOGRAPHY

The effects of various bio-social variables on fertility and mortality have been suggested by many workers (Pearl, 1939; Davis and Blake, 1956; Hauser, 1959; Nag, 1962; Chase, 1962; Mitra, 1966a, 1966b; Dumond, 1975; Rao, 1976; Kohli, 1977; Nag, 1977; Chang et al., 1979; Howell, 1979; Lee, 1979; Nag, 1981; Martorrel, 1982; Isely, 1984; Gray, 1988; Bharati and Basu, 1990; UNICEF, 1991; Kost and Amin, 1992; Redaiah and Kapoor, 1992; Freeney and Feng, 1993; and others)

2.2 FERTILITY

Many studies have revealed the relationship between fertility and socio-environmental factors like nutrition, income, education, religion, etc.(Gopalan and Naidu, 1972; Frisch and McArthur, 1974; Lee, 1979; Bharati, 1981; Ghosh et al., 1983; Bentley, 1985; Kono, 1986; Balakrishnan and Chen, 1990; Bharati and Dastider, 1990; Mukhopadhyay, 1990; Rajan and Rao, 1991; etc.).

(a). Nutrition

It has been suggested that nutrition has a great influence on fertility rate (Gopalan, 1973; Dumond, 1975; Howell, 1979; Lee, 1979; Sen Gupta, 1979; Bongaarts, 1980; Population Research Leads, 1981; Handwerker, 1983; Bentley, 1985; Roth, 1985; Mahadevan et al., 1986; Bharati and Basu, 1990; Ellison, 1990; and others).

de Castro (1952) has suggested that protien deficiencies in developing countries have increased fertility rate. Bongaarts (1980) is of the opinion that in western industrialised nations, women have less number of children because of the highest nutritional intake, whereas the highest prevalence of malnutrition in developing countries is associated with high completed fertility rate.

However, it has also been reported that menstruation and ovulation can stop when a woman suffers from a severe weight loss (Frisch and McArthur, 1974; Lev Pan, 1974 ; Bentley, 1985). A study, which has been carried out in Matlab area of Bangladesh, also shows that the total ferlity rate declines by 34 % during the 1974-75 famine (Razzague, 1986), but it increases again after the famine (Chowdhury and Cen, 1977). Pennington(1992) has also reported that there is no association between fertility and and nutrition among the !Kung of Southern Africa. So, it shows that the fertility rate varies with the variation in food supply (Chen et al.,1974).

In India, a relationship between low fertility and malnutrition has been reported by Gopalan and Naidu (1972). Sen Gupta (1970) has suggested that adequate dietary intake has brought about a high fertility rate, if family planning methods are not practised in a population. But Bharati and Basu (1990) have observed that the fertility rate is higher in women with low calorie intake than in those women with high calorie intake.

(b). Economic Condition

The effect of economic condition on fertility has been revealed in many studies (Sinha, 1957; Mitra, 1966a, 1966b; Dutta and Seal,1974; UN, 1976; Frisancho et al., 1976; Chang et al., 1979; Bharati, 1981; Smith and Ward, 1984; Gulati, 1988; Choudhary, 1988; Mukhopadhyay, 1990; and others).

It has been 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 (World Bank, 1974). Rao

(1976) has observed that many countries in in south east Asia like China, Sri Lanka, Phillippines, etc. have experienced a rapid decline if fertility rate owing to changes in economic structure.

In the United States of America, Freeman (1963) has described that the lower fertility rate is highly associated with higher economic condition. A similar observation is also made by Westoff(1986) and UN(1976).

In India, some studies have also revealed the inverse relationship between fertility and economic condition (Mitra, 1966a, NSS,1967; Agarwala, 1970; Chaterjee et al., 1980; Bharati, 1981; Ghosh et al., 1983; Gulati, 1988; and others)

Many studies have revealed that fertility rate is higher among the lower income groups than that among the higher ones (Sinha, 1957; Driver , 1963; Agarwala, 1972; Mukhopadhyay, 1981; Basu et al., 1981; Bharati, 1981; Ghosh et al., 1983; etc.).

Choudhary (1988) has observed that the rate of live-births is higher among the Santal with better economic condition than that among the Pahariya, who belong to the lower economic status. It may, however, be mentioned that Jorapur's (1967) study among the Dhurwar has revealed that the high income groups have higher fertility rate than those belonging to the lower economic strata. Agarwala (1970) has also reported that the fertility rate in rural areas near Delhi does not vary with the income levels. So, Jain (1975) is of the opinion that the effect of income, particularly that of occupation, on fertility is "fragmentary and inclusive" . He has suggested that further studies should be carried out with a view to understanding the effect of occupation on fertility, particularly among the agricultural groups.

(c). **Education**

The effect of education on fertility has been revealed in many studies (UN, 1961; Driver, 1963; Mitra, 1966b; NSS, 1967, 1970; Kiser, 1971; Stanhope and Hornabrook, 1974; Ghosh et al., 1983; Bharati and Dastider, 1990; De Wit and Rajulton, 1992; and many others).

Caldwell and McDonald (1981) have suggested that education of the mothers is a very important tool for breaking some of the traditional norms and thereby enables them to have more independence in taking decisions with the family situation. Thus, education has been regarded as one of the most important factors for bringing down the birth rate in most of the western countries (Westoff, 1986). Data from South Africa have also indicated the inverse relationship between fertility and educational level (Lotter, 1977).

Kasarda et al. (1986) have observed that education exerts its influence on a wide spectrum of social-psychological orientation in women, including freedom from tradition, greater faith in science and technology, heightened aspirations for themselves and their children, attitudes and sentiments towards smaller family size. De Wit and Rajulton (1992) have also supported this point of view that education does exert a substantial positive influence on birth timing for women of all age groups. In fact, the importance of education for limiting the family size has been revealed in many studies (Caldwell, 1980; Dodoo, 1992; and others).

In India, Hussain (1970) has found that the parents with higher educational background are more inclined to limiting their family size than the parents with lower educational background. The inverse relationship between fertility and education has also been reported by many authors (Dutta and Seal, 1974; Chatterjee et al., 1980; Ghosh et al.1983; Bharati and Dastider, 1990; and others). But Agarwala (1972) has suggested that the negative relationship between fertility and education is clearly significant only when the mothers are educated up to matriculation or more.

Among the Khasi, it has also been reported that the fertility rate tends to decrease with the increase in educational level of both husband and wife (Baruah and Das, 1982).

(d). **Age at Marriage**

Several studies have revealed a negative relationship between fertility and age at marriage (Bumpass, 1969; Busfield, 1972; Mandelbaum,1974 ; Mahadevan, 1979; Patnaik, 1981; Choudhury, 1984; Bharati and Dastider, 1990; and others).

Peel (1970) has reported that there is an inverse relationship between age at marriage and fertility. A similar observation has also been made by Dore (1953), Freeney and Feng (1993), etc. Kono (1986) has suggested that in Japan socio-economic factors play a great role in bringing about changes in age at marriage. Zathar (1988) is of the opinion 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 fecondability and other factors which seem to lead to very spacing between consecutive births".

In India, studies have also revealed that the decline in fertility rate occurs concomitantly with the increasing mean age at marriage (Balakrishna, 1951; Majumdar, 1960; UN, 1961; Mukherjee, 1962; Agarwala, 1962; Driver, 1963; Agarwala, 1964; Gulati, 1969; Raman, 1975; Patnaik, 1981; and many others).

Hussain (1970) observes that age at marriage has an inverse effect on fertility, but educational status exerts, in turn, a great influence on age at marriage. Similarly, Bharati and Dastider (1990) have made a similar observation in their study among the Mahishya of West Bengal. Some studies also show that age at marriage is associated with socioeconomic conditions, thereby it is difficult to assess its direct impact on fertility (Gulati, 1969, 1978).

(e). Religion

Several studies have indicated a relationship between fertility and religion (Davis, 1951; Kiser, 1962; Nag, 1962; Westoff, 1962; Driver, 1963; Goldberg, 1967; Mandelbaum, 1974; Rele and Kanitkar, 1977; Mahadevan, 1979; Sebastian, 1981; Chaudhury, 1982; Rajan and Rao, 1991; and others).

It has been reported that the Muslims have higher fertility rate in comparison with their non-Muslim neighbours in many countries of Asia and Middle East (Davis, 1951; Sinha, 1957; UN, 1961; Nag, 1962; Driver, 1963; Kirk, 1966; Rele and Kanitkar, 1977; Chaudhury, 1982). Kirk (1966) has reported that in most parts of the world, the fertility rate among the Muslims is higher than that among the non-Muslims. Balakrishnan and Chen (1990) have observed that more religious women are less likely to use contraceptives, thereby having higher fertility rate.

In India also, many studies have revealed that among the religious groups, the Christians have the lowest fertility rate, which is followed by the Hindus and then by the Muslims (UN, 1961; Rele, 1963; Agarwala, 1964; Dandekar, 1967; Kirk, 1968; Mandelbaum, 1974; Ghosh et al. ,1983; Rajan and Rao, 1991).

Srinivasan (1967) has reported 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. The Mysore study (UN, 1961) has shown that the fertility rate among the relatively well educated Christians of Bangalore city is lower than that among the married women of other religions. A study, conducted by the National Saple Survey (NSS, 1977), has also clearly indicated that among the religious groups in India, the Christians have the lowest birth rate, which is followed by the Sikhs. 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 Mathen, 1970).

(f). **Other factors**

Besides the factors mentioned above, there are many other factors that are responsible for reducing fertility rate like adoption of family planning (Michel, 1967; Mitchell, 1972; Ramakumar and Gopal, 1972; Cheng and Rajulton, 1992), breast feeding (Brown, 1982; Prema and Rabindranath, 1982; Rahman and Phillips, 1988), participation of women in labour force, etc. (UN, 1961; Heer, 1964; Namboodiri, 1964; Heer and Turner, 1965; UN, 1967; Gandell et al., 1970; and many others).

2.3. MORTALITY

Several studies have documented that the infant and child mortality rates are associated with a large number of bio-socioenvironmental factors such as nutrition, economic condition, education, religion, maternal age, sex, birth order, etc. (Wills and Waterlow, 1958; Yanakara, 1959; UN, 1961; Stockwell, 1962; WHO, 1970; Ekanen, 1972; Puffer and Serano, 1973; Newman, 1975; Ayeni and Oduntan, 1978; Basu et al., 1980a; D'Souza and Bhuiya, 1982; Farah and Preston, 1982; Frenzen and Hogan, 1982; Martin et al., 1983; Martorrel and Ho, 1984; Teckce and Shorter, 1984; Rustien, 1984; Rao, 1987; Bharati and Dastidor, 1990; UNICEF, 1991; Redaiah and Kapoor, 1992; Kost and Amin, 1992; and many others).

(a). **Nutrition**

The attribution of nutrition to infant and child mortality has been reported by many authors (Morley, 1969; Dumont and Rosier, 1969; Wringley, 1969; Flinn, 1970; Wray, 1978; Chen et al., 1980; Martorrel and Ho, 1984; Tekoe and Shorter, 1984; Fogel, 1986; Rao, 1987; Fogel, 1992).

It is suggested that malnutrition increases the rate of morbidity, thereby resulting in a high mortality rate (McDernott, 1986). The studies, carried out in many African countries, have also shown that the high death rate may be associated with malnutrition and infection (Snyder and Merson, 1982). A similar observation has also been made in many countries in south Asia (Basu et al., 1980a).

A study, carried out by Scrimshaw et al.(1957) in four Guatemalan villages, shows that the nutritional factors, especially protien-calorie malnutrition, are contributory to at least 50 % of infant mortality. In Java, Timmer (1961) has found that malnutrition causes deaths not only in infant stages but also in successive ages. Goenewold and Tilahun (1990) have also reported that the degree of malnutrition is positively related to the risk of mortality. In Kenya, Ewbank et al. (1980) have also found that malnutrition is a major factor, which is responsible for high infant and child mortality rates. A study, carried out by the Pan American Health Organisation (1971) in ten American countries, shows that mortality of children under five years of age is positively associated with malnutrition. Huffman and Lamphere (1984) have suggested that "child survival depends upon adequate nutrient intake and the availability of a child to resist or recover from infections". Tekce and Shorter (1984) have also pointed out that the children of " low nutritional status appear to be at approximately double the risk of dying when compared with other children ...."

In his paper on the nutritional deficiency and susceptibility to infection, Chandra (1979) has pointed out that undernutrition and infection, either one or both, are major contributors to morbidity and mortality, especially in the case of the 'under previledged children'. Gravioto and Delicardie (1976) have also shared the view that the nutritional factors may be directly or indirectly contributory to the higher child mortality rate in Mexico than in the USA. Puffer and Serano (1973) have made it clear that though malnutrition in Latin America is not a direct cause of death, it is a contributory factor to about 50 % of infant and child mortality. One of the conclusions derived by Martorrel and Ho (1984),on the basis of their review of literature on nutritional status and child survival, is that "Infections are more frequent in malnourished populations but this is best attributed to differences in the quality of the environment between rich and poor. Clinical evidence shows that infections are generally more severe in children from developing countries." They are also of the opinion that the improvement in dietary intakes during infancy and early childhood is highly associated with the decrease in mortality rate. On the contrary, some studies, conducted in New Guinea and Latin America, have revealed that the mortality rate is not significantly associated with the nutritional status of the survivors (Malcolm, 1974; Solimano and Vine , 1980). In Sri Lanka also, Gajanayake (1988) has reported that changes in total food supply do not seem to be associated with infant mortality. Similarly, Wrigley and Schofield (1981) have reported that they are not able to find out even a weak correlation between food supply and mortality rate in England.

Turning to the Indian situation, Kohli(1977) is of the opinion that malnutrition is associated with infant mortality rate. Sen Gupta (1979) has also suggested that the major causes of still-births and infant mortality are poverty and undernutrition. A similar observation has been made by Bharati and Basu (1990) in their study among the Mahishya caste community in West Bengal. Rao (1987) has also found that the mortality rate is high among the children having the marasmic Kwashiorkor along with gastrointestinal disorders. A study, carried out by Mohanty and Sahu (1991), has also revealed that mortality rate is high among the malnourished children.

In the north-eastern region of the country, no study has so far been carried out to find out the effect of nutrition on health status of a community. Barua (1984) has pointed out that the infant mortality rate in this part of the country may also be associated with nutrition and others factors.

(b). Economic Condition

The effect of economic condition on infant and child mortality has been revealed in many studies (UN, 1962; NSS, 1962; Stockwell, 1962; NSS, 1970; Frisancho et al., 1976; Markides and Barness, 1977; Mitra, 1978; Rodgers, 1979; Hashmi, 1980; Bharati, 1981; Blaxter, 1981; D'Souza and Bhuiya, 1982; Stockwell and Wicks, 1984; Mahadevan, 1984; Tekce and Shorter, 1984; Brown, 1984; Amin, 1988; Holian, 1988; Kost and Amin, 1992; and others).

It is reported that higher the infant mortality rate lower is the father's earning (Woodbury, 1925; Srivastava and Saksena, 1981). Greenby and Lewis-Fanning (1967) have reported that in 15 areas of England and Wales during 1950s, the infant mortality is high in those families which belong to the low economic status and poor hygienic conditions. Similarly, Mosley and Chen (1984) have suggested that "consequences for infant health and mortality depend largely upon the general economic circumstances of the household". Supporting the above observation, Ewbank et al. (1986) have reported that Kenya has experienced a sharp decline in mortality rate, owing to socio-economic development and cultural changes. 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 improvement in the fields of public health and disease control measures.

In India also, Misra (1970) has found that the infant mortality rate is high in those families, belonging to the low economic strata of the society. A survey, conducted by the National Sample Survey (NSS,1970), has also revealed that the infant mortality rate is high, when per capita income is low. A similar observation has also been made by Verma (1977), Bharati (1981), Mukhopadhyaya (1981), Choudhary (1988), and many others.

(c) **Education**

Several studies have indicated the effect of education on infant and child mortality (Ruzicka and Kanitkar, 1972; Stockwell and Hutchinson, 1975; UN, 1980; Meegama, 1980; Arriaga, 1980; Cochrane, 1980; Hashmi, 1980; Gandotra et al., 1982; India Registrar General, 1983; Davanzo, 1984; Ware, 1984; Mahadevan, 1984; Lindenbaum et al., 1985; Amin, 1988; Bharati and Dastider, 1990; Pant, 1991; UNICEF, 1991; Ahmad et al., 1991; Radalah and Kapoor, 1992; and many others). Ware (1984) has, however, pointed out that "No studies demonstrate that poor but educated women with limited access to effective sanitation or medical facilities nevertheless achieve significant reduction in child mortality".

Flegg (1982) has suggested that literacy has the greatest impact on child mortality in societies with a relatively equitable distribution of income. In rural Egypt, it has been found that the infant mortality rate tends to decline with the rise in educational level of the mothers (Khalifa, 1976). A similar observation has been made in both rural and urban areas of Indonesia (Hull and Hull, 1976b). In Nigeria, Caldwell (1979) has reported that the women with primary education have experienced a lower rate of child mortality by 42 % in comparison with those women, who have no formal education.

In Latin America, Palloni (1981) has reported that literacy has much greater impact on child mortality than on infant mortality. In Costa Rica, Haines and Avery (1982) have found that the infant mortality rate as well as the child mortality rate tends to vary with the varying educational standards of the mothers. O'Toole and Wright (1991) have documented that parental education is a key factor for explaining the child mortality differentials in Burundi. They have also observed that the effect of maternal education on child mortality is stronger than that of the paternal education.

On the basis of some data from ten developing countries, Caldwell and McDonald (1981) have, however, reported that the effect of education can be significantly perceptible only, when the mother's education is above primary level. It may also be noted that some studies have indicated a weak or insignificant effect of education on child survival (Kelley et al., 1982; Goldberg et al., 1984; Casterine et al., 1989).

In India, Dwivedi et al. (1990) have reported that the 'relative importance of literacy rate in reducing infant mortality rate is extraordinary'. Mandelbaum (1974) has suggested that an educated girl is likely to keep more of her children alive. Kost and Amin (1992) have reported that in rural areas of Ludhiana district the maternal education has a strong and significant effect on early infant mortality rate. Srivastava and Saksena (1981) and Bharati and Dastider (1990) have also found that the infant mortality rate is largely influenced by the educational standard of the mother. A similar view has been expressed in some other studies (Ruzicka and Kanitkar, 1972; Ladislav and Kanitkar, 1973; Singh, 1974; Khan et al., 1978; etc.).

(d). Religion

Only a 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 Muslims 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 in urban areas, the death rate among the Hindus is found to be similar to that among the Muslims, and also that among the Christians is similar to that among the Sikhs. Chandrashekhar(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, owing to better child care and higher standard of education.

In the north-eastern region of the country, a study conducted by Das and Das (1982) among the rural Assamese has revealed that the mortality rate varies even within the same religious group, i.e. the Hindu religion.

(e). Biological factors

Besides its association with different socio-economic parameters, infant mortality is also known to have a correlation with maternal age, sex and number of offspring, birth order, birth weight, etc. (Woodbury, 1926; Morris and Heady, 1955; Chase, 1962; WHO, 1970; Shah and Abey, 1971; Puffer and Serano, 1973; Frisancho et al., 1976; Ayeni and Oduntan, 1978; Amin, 1988; Majumdar, 1988; Chatterjee et al., 1991; and others).

It has been reported that the offspring of the very yound and elderly mothers are prone to greater risk of death (Puffer and Serano, 1973; NCHS, 1973; Dott and Fort, 1975; Ayeni and Oduntan, 1978). Strandskov and Einhorn (1948) have found that the frequency of still-births is higher in the case of elderly mothers, aged 45 years and above.

Newcombe (1965) has suggested that the early mortality, whether still-birth, infant or child mortality is common in higher birth order. Several studies have also demonstrated the correlation between infant mortality and birth order (Pearl, 1939; Morris and Heady, 1955; Chase, 1962; WHO, 1970; NCHS, 1973; Ayeni and Oduntan, 1978; Majumdar, 1988). In India, Poddar (1975) has observed that the reproductive wastages (Still-births and abortions) in the Dule Bagdi of 24 Parganas is high in both lower and higher birth orders. Barua (1982) has reported that among the Hajong of Meghalaya, the infant mortality rate is very high in the first birth order, but it decreases gradually with the increasing birth order.

It has also been suggested that the infant mortality rate in males is higher than that in females (Yerushalmy, 1967; Chase, 1969). But the studies like those conducted by Ayeni and Oduntan(1978), Barua(1982), etc. do not confirm this observation. Sharma and Khan (1990) have also found that among the Kairwar tribal women of Madhya Pradesh, the female death rate is higher than the male death rate.

2.4. ANTHROPOMETRIC VARIABLES AND REPRODUCTIVE PERFORMANCE

Several studies have been carried out to find out the relationship between anthropometric variables and fertility as well as mortality (Davenpot, 1923; Clark and Spuhler, 1959; Bressler, 1962; Furusho, 1964; Damon and Thomas, 1967; Mitton, 1975; Vetta, 1975; Bailey and Garn, 1979; Mueller, 1979; Martorrel et al., 1981; Eugenie et al., 1982; Brush et al., 1983; Devi et al., 1985; Sadhu, 1987).

Davenport (1923) has reported that the American stocky women have higher fertility rate than the lean ones. Similarly, a study, conducted in Denmark (Stern, 1960), has revealed that the parents of normal phy-sique tend to be more fertile than the chondrodystrophic dwarfs. Clark and Spuhler (1959) have shown that the tall statured mothers are less fertile than the short statured mothers, though the differences between these two groups of mothers in respect of live-births is not statistically significant. They have also found a positive relationship between body weight and fertility rate. Bailey and Garn (1979) have also made a similar observation that there is a strong tendency for the heavier women to have higher fertility rate. They have also found a negative relationship between stature and number of live-births.

Martorrel et al. (1981) have reported that among the Guatemalan Indians there is a positive significant relationship between stature and number of surviving children. They have also found that the infant mortality rate is significantly higher for the children of the shorter women. Brush et al. (1985) have also found positive linear regressions between reproductive variables and body weight, triceps skinfold thickness and head breadth. They have also found negative quadratic regressions between reproductive performance and height, sitting height and bizygomatic diameter.

In India, studies on the relationship between anthropometric variable and reproductive performance are very few in number. Devi et al. (1985) have found that among the Jalari of the Coastal belt of Visakhapatnam the mean number of live-births as well as the mean number of surviving children is significantly higher among the shorter women. However, the difference between the shorter and taller groups of women in respect of mortality rates, is not statistically significant. Another study, conducted among the Kashmiri Pandit and Muslims (Sadhu, 1987), has also revealed that the shorter women are more fertile than the taller ones . Sadhu (1987) has also found a negative relationship between body weight and fertility rate.

2.5. PHYSICAL GROWTH

Several studies have revealed that the pattern of growth and development is greatly influenced by nutrition and other socio-economic factors (Tanner, 1962; Downs, 1964; Garn, 1966; Scrimshaw and Gordon, 1968; Winick, 1968; Goldstein, 1971; Rea, 1971; Prasad et al. , 1972 ; ICMR, 1972; Pereira and Sundararaj,1975; Eveleth and Tanner, 1976; Frisancho, 1978; Tanner, 1978; Garn, 1980; Bandyopadhyay et al.,1981; Garn et al., 1984; Maletnlema, 1986; Musaiger et al., 1989; Mohanty et al., 1990; Lakshmanudu and Rao, 1990; Bharati and Basu, 1990; Terrell and Mascie-Taylor, 1991; Gopalan, 1992; Hauspie et al., 1992; Nestel et al., 1992; and others).

Nutrition

Adequate nutrient 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). It has also been suggested that inadequate intake of protien and other nutrients during pre school age period may not only result in growth retardation (Tanner, 1978; Shephard, 1978; Gopalan, 1992),but may also affect mental development (Brown, 1965; Gravioto et al., 1976; Spurr et al., 1982; Jamison, 1986; Moock and Leslie, 1986). Martorrel and Ho (1984) have pointed out that 'race and climate', which were previously considered to be the two major determinants of variations in body size of children, are now-a-days believed to have no or little importance. They have noted that small body size of children in developing countries is largely due to effects of poor diet and frequent infection.

Eveleth and Tanner (1976) have observed that populations,living under chronic poor dietary intake, develop a pattern of growth, which is characterised by (a) slow growth rate and (b) late adolescent growth spurt. Dettwyler (1991) has shown that in rural Mali malnutrition among children is a major factor, which is responsible for growth retardation and high rates of childhood morbidity and mortality.

Greulich's(1957) study on physical growth and development of the American born and the native Japanese children has revealed that, those who had been brought up in the United States are taller and heavier than those who had been in Japan, owing to improved standard of nutrition and physical environment. Data from Malaysia (Chong et al., 1984) have also revealed a positive effect of protien-energy malnutrition on growth pattern of the pre-school and primary school children. Similarly, Hodge and Dufour (1991) have observed that malnutrition is one of the important factors, which is responsible for growth retardation among the young Shipibo Indian children of Eastern Peru. Lampl et al. (1978) have reported that among the New Guinean school children, protien supplement has contributed largely to a faster growth and maturation.

Besides the above observation on the relationship between physical growth and nutrition, it may be mentioned that there are also studies, which reveal the contradictory results regarding the effect of nutrition on child growth and development. Mora et al. (1981) have reported that "Simple provision of food supplements without effective prevention of infections ... is likely to have limited effect on prevention of growth retardation" . Beaton and Ghassemi (1982) have made a review of literature on the effect of nutritional interventions on growth pattern of children. Their main conclusion is that food distribution programmes are rather "expensive for the measured benefit". They have also pointed out that "close scrutiny of the results of the total experience suggested that anthropometric improvement was surprisingly small". In this connection, it may also be noted that Durnin et al. (1974) have shown that the 14 year old children of Glassgow, who have had energy intake below the recommended level of the FAO/WHO, were neither lighter nor shorter than the mean values for the British children.

Turning to the Indian situation, Rao (1961) has suggested that the pattern of growth is strongly influenced by dietary intakes. Gopalan (1992) has observed that, "The speed and intensity of growth retardation and the consequent duration over which a given order of growth retardation results will differ depending on the nature and extent of dietary inadequacy and superadded infections". He has also reported that the Indian children with adequate nutrient intakes have shown a growth pattern, which is similar to the Harvard standards. Easwaran et al. (1974) have also shown that both boys and girls with better dietary intakes are heavier and taller than those with poor nutritional status. A study, carried out by Satyanarayana et al. (1980), has also indicated that one of the main causes of growth retardation among the pre-school boys in rural Hyderabad is nutritional deficiencies.

Bhattacharya et al. (1978) have suggested that better growth rate among infants in Minocoy island of Lakshwadeep has resulted from their supplementary foods in comparison with those in Agathi island. Rajalakshmi (1981) has also pointed out that the children belonging to poor economic condition can grow well as those belonging to the better economic status, provided they are given with food supplements. Similarly, other studies like those conducted by Mukherjee et al. (1986), Pakrasi et al. (1987), Mohanty and Sahu (1991), etc. have also revealed the effect of nutrition on physical growth.

Besides the above observations, it may also be mentioned that Mohanty et al. (1990) have reported that the tribal boys of Orissa, staying in Hostel, are heavier and taller than those, living with their parents, though the dietary intakes of the Hostel boys are far from being adequacy. Satyanarayana et al. (1989) have found that the severely malnourished children, from birth to age of 5, have gained a height at puberty which is equal to that of the normally nourished children.

Economic Condition

Physical growth of children has been reported to have associated with some socio-economic factors (Hamill et al., 1972; Bogin and MacVean, 1978; Smith et al., 1980; Bielicki et al., 1981; Johnston, 1986; Malhotra and Singh, 1988; Lasker and Mascie-Taylor, 1989; Rao et al., 1990; Terrell and Mascie-Taylor, 1991; Hauspie et al., 1992;and others).

There has been a general agreement, on the basis of data from different parts of the world, that variations in growth pattern of children in the 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 attributable to differences in their socio-economic status, and not to genetic differences (Habicht et al., 1974; Stephenson et al., 1983; Eveleth and Tanner, 1990; Gopalan, 1992). According to the World Bank (1986), about 730 million people in developing countries do not have adequate energy intakes and nearly 340 million of them are at the risk of stunted growth and serious health problems. Having based on the results of 56 height studies and per capita income estimates for twenty countries, Steckel (1983) has found that there is a close relationship between height and per capita income.

Verghese et al. (1969) have reported that head and 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. 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). Rona et al. (1978) have shown that the British children of the unemployed fathers are shorter on average than those of the employed ones. Lasker and Mascie-Taylor (1989) have also shown that there is a relaship between occupation of the fathers and height and weight of the British children. In Ethiopia also, Groenewold and Tilahun (1990) have found the effect of income and father's occupation on weight for age and weight for height of the children.

Habicht et al. (1974) have presented some data from Columbia, which show that the children (up to 7 years of age) with better economic condition are heavier and taller than those with low economic status. Amirhakimi (1974) and Lampl et al. (1978) have also made a similar observation among the Iranian and New Guinean school children, respectively.

Data from Malaysia show that the mid arm circumference of the higher income group children are greater than those of children with lower economic status Mckay, 1969). Fry et al. (1965) have found that the Chinese children, belonging to the higher economic groups, have thicker skinfold thickness than those, belonging to the lower economic strata. However, Rona and Chin (1982) have observed 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. In this connection, it may be noted that Sukkar et al. (1979) have also found that weight and height of the children have hardly changed, owing to improvement in economic condition. Similarly, Malina and Himes (1978) have reported that the rural Zapotec children, living in the valley of Oaxaca (Mexico), have similar height and weight to the well nourished U.S. children. Lindgren (1976) has also reported that in Swedish urban area, the 'girls from the lowest socio-economic status have more weight for height than the higher strata'. For boys there are no significant difference among different socio-economic groups. A similar observation has also been made by Hiernaux (1964) between the Tulsi children with better economic condition and the Huto children with lower socio-economic status. Therefore, some studies have also revealed that there are less differences between socio-economic groups in respect of growth rate (Tanner, 1962, 1992).

With regard to the Indian situation, some studies have shown that children from high economic section of the community are heavier and taller than those, belonging to the lower economic strata (Chatterjee, 1938; Mitra, 1939; Mitra, 1941; Mukherjee, 1951; Udaini, 1963; Datta Banik et al., 1970; Bharati and Basu, 1990).

The Indian Council of Medical Research (ICMR, 1972) has reported that height, weight, subcutaneous tissue and other anthropometric variables are significantly assoiated with socio-economic status. Rajyalakshmi (1981) has also found that the children of higher economic groups are heavier and taller than those of lower income groups. Similarly, Singh and Malhotra (1988) have reported that the Patiala girls, belonging to the higher social class, are heavier and taller than those, belonging to the lower social class. Arm circumference and fat fold at triceps have also been reported to be associated with socio-economic condition Vijayaraghavan, 1974). The effect of socio-economic condition on growth pattern of Indian children have also been revealed in other studies (Rao and Sastry, 1977; Satyanaraya 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; Duarah and Das,1978; Choudhury et al., 1992; Das and Choudhury, 1992; etc.). But there is hardly any study, which shows the effect of nutrition and other socio-economic factors on growth pattern of children. Besides, most of the studies have been carried among a different population of Assam only.

Other factors

Retardation of growth with increasing family size has been reported (Scott, 1961; Grant, 1964; Douglas and Simpson, 1964; Smith et al ., 1980: etc.). Goldstein (1971) and Rona et al. (1978) have observed that the children from larger sibships are shorter on average than those from smaller sibships. Billewicz et al. (1983) have found that the values of subscapular and triceps skinfold thicknesses as well as mid arm circumference decrease significantly with the increasing family size. Malina et al. (1980) have suggested that the lack of secular change in growth of school children may be also associated with some cultural factors. It has also been reported that the girls are more susceptible to growth disturbing influences in comparison with the boys (Greulich , 1951; Tanner, 1962).

Das and Devi (1982) have reported that the female babies of Hindu Assamese origin are heavier than those of their Muslim counterparts . It is also found that the mean value of head circumference is higher among the children of the Hindu caste community.

2.6. ADULT BODY DIMENSIONS

Several studies have revealed that adult body dimensions like height, weight, etc. are associated with nutrition, urbanisation and other socio-economic factors (Shapiro, 1939; Lasker, 1954; Roberts, 1969; Schreider, 1967; Harrison et al., 1977; Kobyliansky and Aurensburg , 1977; Rao and Sastry, 1977; Mimica et al., 1978; Tartakovasky et al., 1983; Eveleth, 1985; Roberts and Darn, 1985; Bharati, 1989; Rao et al., 1990; and others).

Nutrition

Calwick (1951) has suggested that the height and body weight are greatly influenced by nutrition. Zimmer et al. (1944) have also made a similar observation in France. Hiernaux (1968) has observed that the two ethnic groups of Rwanda are different from each other in respect of adult stature, owing to nutritional and hygienic conditions. Ulijaszek et al. (1989) have also suggested that the differences among the three populations of New Guinea (i.e. Wopkaimin, Ningerum and Awin), in respect of some anthropometric measurements, are due to differences in dietary intakes among these three populations. Harrison et al. (1969) have suggested that the nutritional factors play important roles in determining the differences in body dimensions between high and low altitude Ethiopeans. Sitalekhi et al. (1982) have suggested that the increase in weight and obesity among the relatively more westernised settlements are due to better dietary intakes.

In India, Malhotra (1966) has reported that stature has a positive correlation with nutritional level. Harrison et al. (1977) have suggested that the Sikhs of northern India are taller than the Madrasi of south India, since the former have higher intake of protien. Vijayaraghavan (1981) has suggested that the differences in body dimensions are related to differences in nutritional status. However, Basu et al. (1980b) have pointed out that the protien intake is not related to weight and height, rather they are related to calorie and fat intakes. Similarly, Roy and Roy (1982) have observed a positive correlation between calorie intake and anthropometric measurements. Bhattacharya et al. (1981) have suggested that the poor physique in the Christian population of Mirpur village may be due to inadequate "dietary intakes and heavy parasite infections". It may, however, be pointed out that Gupta and Basu(1981) have suggested that the differences in body dimensions between the high and low altitude Sherpa may be due to environmental stress, rather than due to nutritional condition.

Economic Condition

Rothhammer and Spielman (1972) have suggested that socio-economic condition may have a great influence on variations in adult body dimensions. Oliver and Tisser (1977) have also found that there is a positive relationship between anthropometric characters and socio-economic status. Schreider (1967) has, however, observed that the French peasants are heavier, though shorter, than the office workers. Again, Hornabrook et al. (1977) have found that in some Papua New Guinean populations, height is not related to socio-economic status, but weight shows a positive correlation.

In India, Vijayaraghavan (1981) has reported that the Indian adults of higher income groups are heavier and taller than those, belonging to the lower income groups. Similarly, Bharati (1989) has observed that in both sexes, the values of body side measurements, skinfold thickness, body fat and anthropometric indices increase with the increasing income level. Rao et al. (1990) have also found that both male and female adults, belonging to the upper middle income groups, are taller and heavier than those, belonging to the lower income groups. A similar observation has also been made by Bhatnagar (1975) among the Brahmins, living in Lucknow city.

It may, however, be mentioned that Majumdar et al. (1986) have found no discernible effect of occupation on adult body dimensions among the Himalayan populations.

2.7. HAEMOGLOBIN CONTENT

A number of studies have revealed that the differences in haemoglobin levels are associated with socio-economic conditions, nutrition , age, sex, etc. (Napier and Das Gupta, 1936, 1940; Rao et al., 1954; Alekseeva, 1973; Owen et al., 1973; Parra et al., 1976; Garn et al., 1977; Das and Mukherjee, 1977, 1978; WHO, 1979; and others).

Basta et al. (1974) have reported that the low income and poor dietary intakes are responsible for aneamia among the Indonesian workers. Owen et al. (1974) have found that the pre-school children of the United States with better economic condition have higher haemoglobin content than those with low economic condition. Hornabrook et al. (1977) have also made a similar observation in the two Papua New Guinean populations.

In India, Prasad and Choudhuri (1943) have found a positive relationship between haemoglobin content and socio-economic condition. Similarly, Pai and Theophilus (1974) have reported that the girls, belonging to the higher economic status, have higher value of haemoglobin content than those, belonging to the low socio-economic strata. A similar observation has also been made by Vijayalakshmi and Dwaki (1976) and Kaur et al. (1982). Bharati (1983) has also observed the same trend in the case of males, but in the case of females, the lower economic groups have higher haemoglobin content than those, belonging to the high economic groups.

Parra et al. (1976) have reported that the girls have higher haemoglobin levels than the boys between 9.5 and 10.5 years of age, but lower than the boys from the age of 11.5 to 13.5 years. This sex difference in haemoglobin content is reported to be associated with body composition (Mellits and Check, 1968), owing to greater and faster increase in lean body mass of boys (Reba et al., 1968; Brasel , 1968; Parra et al., 1976).

Haemoglobin content is also reported to vary with age(Parra et al., 1976; Das and Mukherjee, 1978). Das and Mukherjee (1978) have reported that there is a gradual rise in haemoglobin level with the rise in age up to 30 years in males and 20 years in females. Rao et al. (1954) have also shown that haemoglobin content tends to increase with the advancing age.

Parra et al. (1976) have reported that there is no significant difference in haemoglobin content in respect of age among the girls, but among the boys there is a first increase from 10.5 to 11.0 years and a second increase starts from 12.5 to 13.5 years.

With this brief review of literature on the related aspects of our study, we shall deal with our findings in the subsequent chapters.

CHAPTER III

MATERIALS AND METHODS

In the present chapter, we shall deal with the nature and volume of data collected for the purpose of the present study. We shall also describe the methods, which have been adopted for the collection and analyses of data.

3.1. DURATION OF FIELD WORK

The field work for the present study was conducted in five villages, falling under the War area during the period between 1990 and 1994 in different instalments. Dietary survey was conducted during the period between October, 1993 and January, 1994, i.e. post-harvesting period.

3.2. SYSTEMATIC RANDOM SAMPLING

The War Khasi are distributed in about 250 villages in the southern slope of the East Khasi Hills district of Meghalaya. For the porpose of the present study, a 2 % systematic random sampling of the War Khasi villages was made, since it was very difficult to collect data from all the villages. It may be mentioned that some difficulties were arising at the time when we prepared the list of sample villages(including hamlets), because we were not ascertained which villages could be considered as falling under the War area. Consequently, we had taken the

the aid of the State Government List of villages, falling under the border area mainly in the East Khasi Hills district, along with the help of other information. The list of villages was prepared randomly according to the geographical distribution of villages under the War area. The 2 % systematic random sampling of the listed villages was determined and drawn by a statistician, and as a result, five villages, namely, Nongkenbah, Mawsiangei, Nongla, Wahumlein and Lapalang were selected for the present study. The locations of these five villages have been shown in the map (Fig. 3.1).

Table 3.1. Number of households according to villages

Village	Number of households	%
Nongkenbah	58	15.85
Mawsiangei	41	11.20
Nongla	24	6.56
Wahumlein	33	9.02
Lapalang	210	57.38
Total	366	100.01

The total number of households in these five villages is altogether 366, i.e. 58 in Nongkenbah, 41 in Mawsiangei, 24 in Nongla, 33 in Wahumlein and 210 in Lapalang (Table 3.1). It may be mentioned that, as far as demographic data are concerned, we have made a complete enumeration in each of these five villages. For the other investigations, complete enumeration was not possible, owing to operational difficulties in the field. All those, who agreed to cooperate, were included in the sample.

As regards the dietary survey, efforts were being made to cover 50 % of the total households in each of the selected villages. It may also be noted that there are no other people from some other communities like the Garo, Mizo, Naga, Nepali, Bengali, etc. who have settled parmanently in these five villages, except those who have come through matrimonial alliances. So, data were collected from only the War Khasi - both Christians and Non-christians.

3.3. NATURE OF DEMOGRAPHIC DATA

The nature of demographic data collected for the present study was based on those parameters, suggested by the WHO Working Group (1964, 1968a). These are 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 woman, present age of mother, approximate age at each conception, total number of live-births, birth order; age, sex and marital status of each offspring, etc.

Mortality records: These include total number of conception, number of dead children, sex, date of birth, age at death, number of reproductive wastages (abortion and still-birth), etc.

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

3.4. METHODS OF DATA COLLECTION

Demographic Data:

The entire demographic data were collected through pedigrees and schedules from all the three hundred sixty six households in the five selected villages. The household schedule; designed for getting information on age, sex, marital status, tribe, religion, occupation, income, education, community affiliation, place of birth, place of residence, etc. ; was completed through indepth interview with the head of the household, or in his/her absence with other elderly member of the household, who was capable of furnishing all the relevant information.

The fertility schedule was completed by filling in information on the number of conceptions, number of live-births, number of reproductive wastages (abortion and still-birth), sex, present age, age at death, birth order, etc. from all the ever-married women. Pedigrees were also collected for cross-checking of data on reproductive history of the mothers. Sometimes, information given by the mothers were cross-checked from their respective husbands. It may be mentioned that great difficulties were experienced in the assessment of age, particularly that of the elderly women, since many of them were not aware of their real age. Consequently, in such cases, age was estimated with reference to some important events and also with the help of other persons in the household/village. So, there could be some mistakes, in some cases, in the estimation of age.

Dietary Data

One day dietary survey was conducted in each of 184 households, i.e. about 50 % of the total households covered under the present study, which may be described as follows:

For one day, 6 or 7 numbers of households, depending upon the cluster of the households in a village, were visited during the day time. Each of these households was asked to show all the food items which were available in the stock of the household. Then, each of the different food items was weighed on a spring type salter balance, keeping the record for each of them separately. For rice, since it is their staple food, the housewife was asked to show any specific tool/utensil which had been used by her for measuring rice before cooking. Among the War Khasi, almost all the households used to measure rice on a 'milkmaid' tin for the requirement of the household before cooking. A sample of tin or a bowl of rice was then asked and weighed on the weighing machine. The total amount of rice consumed per meal was obtained by multiplying the weight of rice per tin, or bowl by the number of tin or bowl of rice consumed by the household. The same method was followed for all households. In the evening time, each of the households,covered during the day time, was visited again to get information whether the household was procuring new food item(s) from either market or jungle. If new food items were procured by the household, the weight of each of them was taken and recorded. The housewife was then asked to let us know on the next day, if any member of the household consumed food outside home, or any guest coming and consumed food in the household.

On the next day, during the day time or before the people preparing their dinner, each of the households covered on the day before was again visited, asking each of them to show all the remaining food items that we had recorded. The weight of each of food items was again taken and recorded. Before leaving the household, the following dietary information for the whole day was completed in a schedule :

1. Name, age, sex of each member of the household.
2. Name, age, sex of each member of the household, who consumed food outhome.
3. Age, sex of each guest consumed food in the household.
4. Name and approximate amount of food items consumed by member(s) outside home.
5. Name and approximate amount of food items given to neighbour, if any.
6. Name of food items consumed by the household during the day
7. Other information, if any.

The amount (weight) of each food item, except rice, which was consumed by a given household for one day, was worked out as follows:-

$$T = (A - D) + (B - C);$$

where,

T = Total amount of any food item consumed for one day;

A = Weight of the food item recorded on the day before;

B = Approximate amount (weight) of the food item consumed by member(s) outside home during the day;

C = Approximate amount (weight) of the food item given to neighbour, etc., if any;

D = Weight of the food item recorded on the next day.

It may be mentioned that no correction was made for the inter and intra personal variation in the amount of food/nutrient consumed as well as for the loss or wastage of food or nutrient on account of cooking. So, there is a possibility of slight overestimate of the nutritional status of the population.

The nutrient values as well as the edible portion were computed from the Food Composition Tables, prepared by the Indian Council of Medical Research (ICMR, 1977, 1989), considering the War Khasi as moderate by their nature of work. For food items that were not available in the Food Composition Tables, the average values of nutrients for a particular food group, were taken into consideration. The consumption unit (C.U.) per household was calculated, following the method suggested by Bhattacharya et al.(1981), which is as follows : -

For a certain household consisting of (say) the following seven members : Males aged 55, 24 and 14 years, and females aged 52, 23, 18 and 17 years. Thus, the total consumption unit for this household will be calculated as shown in the following : -

Individual	Age (years)	Calories as per ICMR recommended allowance	Consumption unit
Male	55	2875	2875/2875 = 1.00
Male	24	2875	2875/2875 = 1.00
Male	14	2875	2450/2875 = 0.85
Female	52	2225	2225/2875 = 0.77
Female	23	2225	2225/2875 = 0.77
Female	18	2060	2060/2875 = 0.72
Female	17	2060	2060/2875 = 0.72
Total household consumption unit			= 5.83

Anthropometry (Adults)

Some selected anthropometric measurements from the basic list of measurements, recommended by the international Biological Programme(Weiner and Lourie, 1981), were taken into consideration for the purpose of the present study. Following are the anthropometric measurements, taken on 434 adult (aged between 20 and 55 years), of both sexes wearing light apparel :-

1. Weight (kg)
2. Height vertex (cm)
3. Sitting height (cm)
4. Biacromial diameter (cm)

5. Bi-iliac diameter (cm)
6. Mid upper arm circumference (left) (cm)
7. Chest girth (inhale) (cm)
8. Chest girth (exhale) (cm)
9. Biceps skinfold thickness (left) (mm)
10. Triceps skinfold thickness (left) (cm)

Besides the above measurements, following are the ratios/indices and/or estimates computed for the adult males and females of the present study :-

1. Weight/height ratio
2. Weight/height^2 index
3. Weight for height (%)
4. Ponderal index
5. Cormic index
6. Chest (exhale)/height ratio
7. Log of skinfold thickness at :
   (a) Biceps
   (b) Triceps
8. Surface area(S.A.):
   (a) $S.A. = W^{0.425} \times 74.66$ (For male)
   (b) $S.A. = W^{0.425} \times 78.28$ (For female)
9. S.A./weight ratio
10. Body fat (kg) = $\dfrac{F(\%) \times \text{Weight (kg)}}{100}$, (Sen, 1979);
    where, $F(\%) = (4.201/D - 3.813) \times 100$, and $D = 1.0890 - 0.0028 \times$ Triceps skinfold thickness (mm).

11. Total upper arm area (TUA) = $C^2/(4 \times \pi)$, where C stands for the mid upper arm circumference (Frisancho, 1990).

12. Upper arm muscle area(UMA) = $[C - (\text{Triceps skinfold thickness} \times \pi)]^2/(4 \times \pi)$.

13. Upper arm fat area (UFA) = TUA - UMA

14. Upper arm fat index (AFA) = (UFA/TUA) x 100

Anthropometry (Children)

The present study of physical growth was based on a cross-sectional sample of 514 War Khasi boys and girls (aged 3 - 15 years). Following are the anthropometric measurements taken on the War Khasi children, wearing light apparel :-

1. Weight (kg)
2. Height vertex (cm)
3. Sitting height (cm)
4. Biacromial diameter (cm)
5. Bi-iliac diameter (cm)
6. Head circumference (cm)
7. Mid upper arm circumference (left) (cm)
8. Chest girth (cm)
9. Biceps skinfold thickness (left) (mm)
10. Triceps skinfold thickness (left) (mm)

Besides the above measurements, the following ratios/indices and /or estimates were computed for the children of the present study. For computation of the total upper arm area, upper arm muscle area, upper arm fat area and upper arm fat index, we have followed the method by Frisancho(1990) :

1. Weight/height ratio
2. Weight/height^2 index
3. Ponderal index
4. Cormic index
5. Chest/height ratio
6. Weight for height (%)
7. Weight for age (%)
8. Height for age (%)
9. Total upper arm area (TUA)
10. Upper arm muscle area (UMA)
11. Upper arm fat area (UFA)
12. Upper arm fat index (AFA)

It may be mentioned that the age grouping of children is done by the average, viz., 5 year group includes 4.50 to 5.49 years (Sen, 1994).

Methods of Taking the Measurements

The methods, followed for taking the anthropometric measurements on both adults and children, may be briefly described as follows (Attempts were made to follow,as far as possible, the standard techniques proposed by Weiner and Lourie, 1981; Singh and Bhasin, 1989; Sen, 1994) :-

Weight: The body weight was taken on 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 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 (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 centimetre and its fractions was then 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. The 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. Reading was taken.

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 found by palpating along the outside edge of the scapular spine, the measuring points of the left and right hand bars were pressed firmly 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 iliac crests were palpated with the forefingers, 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 naked skin (Sen, 1994), while the arms are hanging at the sides of the body.

Chest girth (inhale and exhale): The measurement was taken with a steel tape from the front of the subject at the level of the fourth pair of ribs (In the case of adult females, it was taken from the back). Reading was recorded separately at the time of exhalation and inhalation. For the children, only one reading was taken at the time between inhalation and exhalation.

Head circumference (Children only): The measurement was taken with a steel tape in such a way that the zero pint of the tape was held on the glabella by a left hand, and then the tape was applied around the whole projecting surface on the back of the head by a right hand. After joining the two ends at the glabella region, reading was recorded.

Skinfold thickness(left): Ponderax skinfold caliper graduated in cm and mm was used for the measurement of skinfold thickness at biceps and triceps, as suggested by Sloan and Koeslag (1973).

Triceps:

The fold of the subject was picked up at the dorsal side of the left upper arm, above the level of the upper arm girth, taking care that the fold should be in a line along the length of the arm.

Biceps:

The fold was taken in front of the upper arm at the same level as in the case of biceps region, taking care that the fold should be paralled to the length of the arm.

Haemoglobin Estimation

Haemoglobin content of 434 adults (aged 20 - 55 years) was estimated, using Sahli's Haemometer. The estimation was immediately done after the collection of blood samples, following the standard techniques(WHO, 1980), which are as follows:

Firstly, N/10 HCL was taken in the clean graduated tube up to the 20 mark (or the mark 3 g/dl).

Secondly, the blood sample was taken directly from the subject, up to the 0.02 ml mark of the Sahli's pipette. The outside of the pipette was then wiped with the absorbent or filter paper, making sure that the blood was still on the mark.

Thirdly, the blood was blown from the pipette into the graduat-ed tube containing N/10 HCL. The mixture was then shaken thoroughly, and allowed to stand for five minutes or so in the Haemometer.

Fourthly, after five minutes or so, two or three drops of distilled water were added to the mixture with the help of dropping pipette. Special care was taken that the blood should be thoroughly diluted by stiring it with the glass rod.

Fifthly, after seeing that the blood had changed its colour, care was taken by adding drop by drop of distilled water, and thorough stiring was done till the colour of the blood matched with those of the reference tube. Reading was then recorded.

Precautions: (i) All apparatus were cleaned thoroughly.

(ii) Attempt was made not to take the first drop of blood from the finger.

(iii) Care was taken not to allow air bubbles to enter Sahli's pipette, before sucking the blood from the finger of the subject.

3.5. ANALYSES OF DATA (CLASSIFICATIONS)

Mortality

For analysing the data on mortality, two parameters have been taken into consideration. These are : (a) Infant mortality, i.e. those infants who died before one year of age, and (b) Juvenile mortality, i.e. deaths before fifteen years of age.

Economic Condition:

Considering some aspects of economic conditions like housing condition, occupation, land holding, etc., the given household having a per capita monthly income of Rs. 300.00 seems to be appropriate for being a minimum of the subsistence income level and to delineate poverty line in the present population. This per capita monthly income of Rs. 300.00 is found to be more or less equivalent to $\bar{X} - 4SD$. Accordingly, the War Khasi of the present study are broadly classified into three economic groups with the help of the following interval estimation based on standard deviation, which is as follows:-

$$\text{Above } (\bar{X} + 4SD) = \text{High income group}$$

$$(\bar{X} - 4SD) \text{ to } (\bar{X} + 4SD) = \text{Middle income group}$$

$$\text{Below } (\bar{X} - 4SD) = \text{Low income group}$$

In the present study, the average per capita monthly income of 366 households was found to be Rs. 342.53 with a standard deviation of Rs. 195.26. Applying the above method, we get,

$$(X - 4SD) = \text{Rs.}342.53 - \frac{4 \times \text{Rs. } 195.26}{\sqrt{366}} = \text{Rs. } 301.70$$

$$(X + 4SD) = \text{Rs. } 342.53 + \frac{4 \times \text{Rs.}195.26}{\sqrt{366}} = \text{Rs. } 383.36$$

The above economic classification is certainly arbitrary. It may, however, be noted that the main purpose of such classification is to make out the effect of economic condition on some biological or health traits of the present population.

Educational Level

The individuals who were not able to read and write have been grouped as **Illiterate.** Those who could write and read and those who have had education up to standard III have been placed under the category of **Primary level.** All other academic, vocational and professional types of education are included in the category of Secondary level, since the number of persons, having such educational standards is very few in the present sample. Though this classification is also arbitrary, it has been done with a view to finding out the effect of education on some demographic parameters like fertility and nortality. It may be noted that for the calculation of literacy rate, we have taken into consideration only the number of persons aged 7 years and above as per the 1991 Census.

3.6. STATISTICAL ANALYSES

The statistical analyses, which have been adopted in the present study, may be briefly described as follows:

Mean: The mean is also known as arithmetic average. It is defined as a 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:

$$\text{Mean } (\bar{X}) = \frac{\sum X_i}{N} = \frac{X_1 + X_2 + \dots + X_n}{N},$$

Where,

$\sum$ = Symbol for summation,

X_i = Value of the ith item X_i , $i = 1, 2, \dots, n$

N = Total number of items

It may be noted that in the case of frequency distribution, the mean is calculated as under :

$$\bar{X} = \frac{\sum f_i X_i}{\sum f_i} = \frac{f_1 X_1 + f_2 X_2 + \ldots + f_n X_n}{f_1 + f_2 + \ldots + f_n = N}$$

<u>Standard deviation (SD):</u> Standard deviation is defined as the square root of the mean of the squares of the deviations of observations from their arithmetic mean. It is computed as follows:

$$SD = \sqrt{\frac{\sum (X_i - \bar{X})^2}{N - 1}} \text{ , or } \qquad SD = \sqrt{\frac{\sum f_i (X_i - \bar{X})^2}{\sum f_i - 1 \text{ (i.e. } N - 1)}}$$

The divisor was taken as (N - 1) but not N as we did not know the true mean and standard deviation of the population. So, the mean and standard deviation are estimated, and in doing so we lost what is known as a degree of freedom (Parker, 1973).

<u>Standard error of mean (S.E.):</u> It is calculated as follows:

$$S.E. = \frac{SD}{\sqrt{N}}$$

<u>Difference between means:</u> In the present study, the number of observations in the two sample means are almost more than 50. Therefore, the statistical difference between two means is worked out firstly by calculating the standard error of the difference between two means (Chambers,

1958; Parker, 1973; Kothari, 1985). **Secondly, the ratio of the difference between two means to the standard error of the difference (z) is then worked out to determine the level of significance, using Table 3.2, which** shows the different values of z or d **at different levels of** probability. It may be mentioned here that **we have used this test instead of t-test** because the t-value, with more than 30 or 50 **degrees of freedom,** corresponding to a particular probability level is **approaching to d or z- value,** as shown in Table 3.2.

So, we evaluate :

$$z = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\left(\frac{SD_1^2}{N_1} + \frac{SD_2^2}{N_2}\right)}}$$

where,

$\sqrt{\left(\frac{SD_1^2}{N_1} + \frac{SD_2^2}{N_2}\right)}$ **is the standard error of the** difference between two means, i.e. $\bar{X}_1$ and $\bar{X}_2$.

Table 3.2. Normal distribution

Probability (P)	0.100	0.050	0.025	0.010	0.005	0.001
Value of z or d	1.645	1.960	2.241	2.576	2.807	3.291

Difference between proportions: The method of testing the significance of difference between two proportions is similar to the test for the difference between two means, Firstly, the standard error of the difference between two proportions is calculated. Secondly, the ratio of the difference between two proportions to the standard error of the difference(d) is computed to determine the level of significance, using Table 3.2. The test is worked out as follows:

	Sample 1	Sample 2
No. of individuals	N_1	N_2
No. of particular case	a_1	a_2
Proportion	$p_1 = \frac{a_1}{N_1}$	$p_2 = \frac{a_2}{N_2}$

Total number of cases in sample 1 and sample 2 $\quad n = N_1 + N_2$

Overall proportion $\quad P = \frac{a_1 + a_2}{n}$

Standard error of difference between two proportions(S.E.) $\quad \sqrt{P \times Q \left(\frac{1}{N_1} + \frac{1}{N_2}\right)}$, where

$$Q = 1 - P$$

$$\text{So, } d = \frac{p_1 - p_2}{\text{S.E.}}$$

The Chi-square (χ^2) test: The Chi-square is used in the investigation of a number of different problems. It can be used whenever we wish to dtermine whether or not the observed frequencies in a particular category differ significantly from those which would be expected to fall in that category under a certain set of theoretical assumptions, or hypotheses. In the present study, the Chi-square is used for testing the difference among different sample proportions, or percentages (Blalock, 1972; Parker, 1973). The form of statistics is as follows:

$$\chi^2 = \sum \frac{(O - E)^2}{E} = \frac{(O_1 - E_1)^2}{E_1} + \frac{(O_2 - E_2)^2}{E_2} + \ldots + \frac{(O_n - E_n)^2}{E_n}$$

where, O is the observed frequency and E the corresponding expected one.

The value obtained is then compared with that given in the Table of Chi-square with (N - 1) degree of freedom(DF).In the case of 2 x C contingency Table, the number of (DF) is (R - 1)(C - 1), where R and C are the number of rows and columns, respectively. The expected frequency is calculated as (Row Total)(Column Total)/(Grand Total).

<u>Analysis of Variance</u>: One-way analysis of variance is used for testing the difference between the means of more than two samples (Parker, 1973; Snedecor and Cochran, 1967). The basic procedure consists in examining the amount of variation 'Within the Samples' in relation to the amount of variation 'Between Samples'. Following are the steps for computing this test :-

1) Correction factor (C) = $(\sum X_i)^2/N$, 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 the squares (TSS) $= \sum X_i^2 - C$, 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

$n_1, n_2, \ldots, n_k$ = No. of items in samples 1, 2, ...,k.

4) Sum of squares for variance within samples(SSW) = TSS - SSB

5) Mean square for variance between smaples(MSB) = SSB/(K - 1), where (K - 1) is the degree of freedom between sample (i.e. K = No. of samples).

6) Mean square for variance within samples (MSW) = SSW/(N - K), where (N - K) is the degree of freedom.

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.

<u>Correlation and Regression:</u> Regression analysis has many applications. The main purpose in 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 have been made for the effect of X-variable. The regression of Y on X is worked out as follows:

$b = \sum xy/\sum x^2$, where $\sum xy = \sum XY - (\sum X)(\sum Y)/N$, and $\sum x^2 = \sum X^2 - (\sum X)^2/N$.

The regression equation of Y on X is expressed as :

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

Correlation coefficient(r): The correlation coefficient is computed as follows:

$r = \sum xy/\sqrt{[(\sum x^2)(\sum y^2)]}$, where $y^2 = \sum Y^2 - (\sum Y)^2/N$.

The correlation coefficient is usually taken when there is no reason to think of one variable as dependent variable and the other as the independent variable. It is taken as a simple measure of the degree of relationship, but not to make out the nature of relationship between two or more variables.

Analyses of Co-variance and multiple regression:

So far as the analyses of co-variance and multiple regression are concerned, we have followed the methods suggested by Snedecor and Cochran(1967).

3.7. DEFINITION OF TERMS

Christians and Non-christians:

In the present study, the term 'Christians' has been used to refer to those individuals who are by faith christian. Christianity includes Presbyterian, Roman Catholic, Church of God and Fellowship denominations. On the other hand, 'Non-christians' refer to those people who believe in Ka Niam Khasi or Khasi religion, and those who are the believers/followers of other religions.

Health traits:

The health traits include fertility, mortality, nutritional status, physical growth, adult body dimensions and haemoglobin content.

Bio-social factors:

They include age, sex, birth order, anthropometric variables, economic condition, religion, education, etc.

Nutritional status:

It refers to "the physical expression of the relationship between an individual's dietary intakes, the bioavailability of these ingested nutrients and his or her physiological requirements". In the present study, it is defined in terms of dietary intakes, nutritional anthropometry and haemoglobin level.

3.8. LIMITATIONS OF THE PRESENT STUDY

Some of the major limitations of the present study are as follows:

Estimation, Approximation, etc.: The present study is not entirely free from estimation and/or approximation. We had to estimate information, whenever difficulties were experienced to get a direct information from the informant(s) like income of household, age of individual, foods and drink consumed outside home, etc.

Limited Parameters: The present study has dealt with limited parameters on nutrition and health status of the War Khasi, thereby it is far from being exhaustive.

Inadequacy of Sample Size: Except in the case of demographic parameters, a complete enumeration was not possible, owing to operational difficulties in the field. So, an attempt was made to include all those individuals who agreed to cooperate to the present study.

Dietary Intakes: The present study has not made any correction regarding the inter and intra variation in the nutrient intakes, or loss of nutrient values during cooking, etc. Owing to operational difficulties, seasonal difference in dietary intakes could not also be obtained. Similarly, we use the Table Food Composition, prepared by the ICMR(1989), ignoring the difference in nutrient values of food according to geographical area, or climatic conditions. However, as far as the present study is concerned, dietary intake is taken as one of the parameters, but not as the only parameter to understand the nutritional status of the present population.

Above all, whatever we have found and/or pointed out here, really based on our field observations. We do hope that some future studies with more parameters will throw much more light on the bio-social aspects of the War Khasi population.

3.9. IDENTIFICATION AND NOMENCLATURE

Each household and subject was given a unique identification number and the same was used for all kinds of data collection.

The following abbreviations were used in the following chapters:

CH : Christians

NCH : Non-christians

LA : Lapalang

MA : Mawsiangei

NA : Nongla

WA : Wahumlein

LIG : Low Income Group

MIG : Middle Income Group

HIG : High Income Group

In the subsequent chapters, we shall present the findings of the present study and finally we shall try to evaluate the health status of the War Khasi population.

CHAPTER IV

NUTRITIONAL STATUS AND SOCIO-ECONOMIC CONDITION

In this chapter, we shall present some of the basic socio-economic conditions of the War Khasi, for both the Christians(CH) and Non-christians (NCH). We shall also discuss the relationship between nutritional status and economic condition in respect of dietary intakes and nutritional anthropometry.

4.1. SOCIO ECONOMIC CONDITION

Distribution of CH and NCH Households:

Table 4.1.1 shows the distribution of the CH and NCH households in each of the five villages, covered under the present study. The number of households belonging to the NCH section is higher (i.e. 58.47 %) than that belonging to the CH section (41.53 %). It is, however, seen that in Nongkenbah and Nongla villages, the number of households is higher among the CH than that among the NCH. So, it shows that the spread of Christianity is faster in these two villages.

Table 4.1.1. **Number of households by religious groups**

Village	Number of households		
	CH	NCH	Total
Nongkenbah	50 (86.21)	8 (13.79)	58 (100.00)
Mawsiangei	10 (24.39)	31 (75.61)	41 (100.00)
Nongla	19 (79.17)	5 (20.83)	24 (100.00)
Wahumlein	8 (24.24)	25 (75.76)	33 (100.00)
Lapalang	65 (30.95)	145 (69.05)	210 (100.00)
Total	152 (41.53)	214 (58.47)	366 (100.00)

Figures within parentheses indicate percentage.

Table 4.1.2. **Family size by religious groups**

Family size(N)	CH (N = 152)		NCH(N = 214)		Total(N = 366)	
	N	%	N	%	N	%
1 - 2	14	9.21	24	11.22	38	10.38
3 - 4	17	11.18	32	14.95	49	13.39
5 - 6	24	15.79	46	21.50	70	19.13
7 - 8	50	32.89	56	26.17	106	28.96
9 - 10	35	23.03	39	18.22	74	20.22
11 +	12	7.89	17	7.94	29	7.92
Average family size	$6.97 \pm 2.77^{*}$		$6.45 \pm 2.95^{*}$		6.67 ± 2.89	

* $z = 1.72$, $P > 0.05$

Family Size

The mean family size among the War Khasi is shown in Table 4.1.2 for both the CH and NCH. It is found that the mean family size in this population is large (6.67 ± 2.89) in comparison with some other tribal populations (Rajyalakshmi, 1991), but it is similar to that among the Muklom (6.69) of Arunachal Pradesh (Sarkar, 1995). The Table also shows that the mean family size is slightly higher among the CH (6.97 ± 2.77) than that among the NCH (6.45 ± 2.95), though the difference between them is not statistically significant ($z = 1.72$, $P > 0.05$). Further, it is found that about 63.82 % of the families among the CH and about 52.34 % of them among the NCH, have had a family size of 7 +. So, it shows that the majority of the households in both the CH and NCH have got a large family size.

Table 4.1.3. Occupational distribution by religious groups

Occupation	CH (N= 152)		NCH(N = 214)		Total(N=366)	
	N	%	N	%	N	%
Agriculture	53	34.87	68	31.78	121	33.06
Agricultural labour	41	26.97	74	34.58	115	31.42
Both agriculture and agricultural labour	43	28.29	57	26.64	100	27.32
Business	10	6.58	12	5.61	22	6.01
Services	5	3.29	3	1.40	8	2.19

Table 4.1.4. **Land holding by religious groups**

Types of land possessed	CH (N = 152)		NCH (N = 214)		Total(N =366)	
	N	%	N	%	N	%
Dry Land	102	67.11	134	62.62	236	64.48
Wet Land	6	3.95	8	3.74	14	3.83
No Land	44	28.95	72	33.64	116	31.69

Occupation

Table 4.1.3 shows the distribution of households according to occupation of the heads of households for both the CH and NCH. It is found that agriculture is the primary occupation of the families in both the religious groups, whereas agricultural labour is their secondary occupation . In fact, about 28 % and 27 % of the CH and NCH households, respectively,depend largely on both agriculture and agricultural labour. In other words, more than one fourth of the families, which had not been engaged in agriculture for the whole year, have also performed the agricultural labour. Table 4.1.3 shows that the percentage of the heads of households, depending on agricultural activity, is higher in the NCH (34.58 %) than that in the CH (26.97 %), though the binomial test shows that the difference between the two religious groups is not statistically significant ($d = 1.55$, $P > 0.05$). Besides agriculture and agricultural labour, about 6.58 % and 3.29 % of the CH families are engaged in business and services, respectively. Among the NCH, these frequencies are found to be 5.61 % and 1.40 %, respectively.

Table 4.1.4 shows the distribution of households according to land holdings for both the CH and NCH. It is found that about 67 % and 63 % of CH and NCH families, respectively, have possessed dry land, which includes lands for shifting cultivation and horticulture. Only 3.95 % of the CH families and 3.74 % of the NCH families are reported to have possessed wet land. It may be mentioned that none of the households is having irrigated land. Further, Table 4.1.4 shows that the frequencies of households having no land property are 28.95 % and 33.64 % among the CH and NCH, respectively. It shows that the frequency, possessing no land property, is higher among the NCH (33.64 %) than that among the CH (28.95 %), though the difference between them is not statistically significant (d = 0.95, $P > 0.05$).

Per Capita Income

Table 4.1.5 shows the distribution of households according to per capita monthly income. The frequencies of low, middle and high income groups among the CH are 34.21 %, 45.39 % and 30.39 %,respectively , whereas among the NCH, these frequencies are 42.06 %, 41.12 % and 16.82 %, respectively (The classification of income groups has already been given in Chapter III). So, it shows that the number of households, belonging to the low income Group (LIG), is higher among the NCH than that among the CH. It indicates that the overall economic condition seems to be better among the CH than that among the NCH. However, the X^2 value shows that there is no significant difference between the CHand NCH in respect of per capita monthly income ($X_1^2 = 2.41$, $P > 0.05$).

Table 4.1.5. **Income levels of households by religious groups**

Section of population	Low	Middle	High	Total
	Below Rs.301.70	Rs.301.70 to Rs.383.36	Above Rs.383.36	
Christians	52	69	31	152
%	34.21	45.39	30.39	99.99
Non-christians	90	88	36	214
%	42.06	41.12	16.82	100.00

$X^2 = 2.41$, d.f.= 2, $P > 0.05$

Table 4.1.6. **Literacy rate by religious groups**

Educational level	Christians		Non-christians	
	Male	Female	Male	Female
Illiterate	189	196	273	257
%	44.78	46.89	46.04	48.95
Primary	144	158	214	178
%	34.12	37.80	36.09	33.90
Secondary	89	64	106	90
%	21.09	15.31	17.88	17.14
Total literacy rate (%)	55.21	53.11	53.96	51.05
Total number of persons*	422	418	593	525

* Children aged 0 - 6 years are excluded (Census, 1991).

Literacy

Table 4.1.6 shows the total literacy rate by religious groups among the War Khasi. It is found that the total literacy rate is higher among the CH (54.17 %) than that among the NCH (52.59 %). So, it indicates that the CH are slightly more literate than the NCH, the difference between them is not statistically significant ($d = 0.77$, $P > 0.05$). Table 4.1.6 further shows that the literacy rate is higher in males than in females for both the CH and NCH. These sex differences, in respect of literacy rate, are also not statistically significant for both the CH ($d = 0.68$, $P > 0.05$) and NCH ($d = 0.97$, $P > 0.05$).

Table 4.1.7. Educational levels of the heads of households

Section of population	Illiterate	Primary	Secondary	Total
Christians	74	51	27	152
%	48.68	33.55	17.76	99.99
Non-christians	112	77	25	214
%	52.34	35.98	11.68	100.00

Table 4.1.7 shows the educational levels among the heads of households for both the CH and NCH. About 52 % of the heads of households in the NCH are illiterate, whereas among the CH, the frequency of illiteracy is found to be 48.68 %. So, as in the case of total literacy, the literacy rate among the heads of the CH households is higher than that among the heads of NCH households, despite the absence of statistical dif-

erence between them (d = 0.70, $P > 0.05$). It may, however, be mentioned that only a few of the heads of households have had educational standard up to the secondary and/or above secondary level. This holds good for both the CH and NCH.

4.2. DIETARY INTAKES

Consumption of foods

The daily consumption of different food groups per consumption unit (C.U.), according to economic condition, are shown in Tables 4.2.1A and 4.2.1B for both the CH and NCH. On the one hand, it is found that the CH have higher intakes of many food groups than the NCH, though the differences between them are significant only in respect of meat, fish and egg, and milk. On the other hand, the intakes of cereals and fats are higher among the NCH than those among the CH, and it is significant in respect of cereals ($z = 4.08$, $P < 0.001$). Tables further show that the consumption of different food groups, except other vegetables, is higher in the MIG (Middle income group) and HIG (High income group), when compared with that in the LIG (Low income group). With respect to other vegetables, it is found that the consumption tends to decrease with the increasing level of per capita monthly income in both the religious groups. The analysis of variance shows that the differences among the income groups are significant in respect of the consumption of different types of food, except in the case of other vegetables and fruits in both the religious groups. With respect to cereals and green leafy vegetables, there are no significant differences among the income groups, and it erence between them ($d = 0.70$, $P > 0.05$). It may, however, be mentioned that only a few of the heads of households have had educational standard up to the secondary and/or above secondary level. This holds good for both the CH and NCH.

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Table 4. .1A. Daily consumption of cereals, pulses, green leafy vegetables, roots and tubers, and other vegetables per C.U. by income groups

Income group		Cereals(g)	Pulses(g)	Green leafy vegetables (g)	Roots and tubers(g)	Other vegetables (g)
Christians:						
LIG(N = 28)	$\bar{X}$	516.24	36.40	65.00	108.32	88.63
	SD	95.02	17.04	57.27	58.17	68.29
MIG(N = 36)	$\bar{X}$	560.50	44.37	68.03	139.88	72.66
	SD	93.32	14.35	59.31	59.19	69.74
HIG(N = 20)	$\bar{X}$	573.38	43.82	125.24	142.74	80.55
	SD	102.15	8.42	87.92	33.71	52.78
Total(N=84)	$\bar{X}$	548.81	41.58	80.64	130.04	79.86
	SD	99.43	14.02	64.24	53.37	66.60
F-Statistics		2.25	3.50[a]	5.91[d]	3.31[a]	0.48
Non-christians:						
LIG(N = 39)	$\bar{X}$	550.55	33.64	63.64	92.82	97.66
	SD	101.95	25.86	50.74	67.44	70.02
MIG(N = 37)	$\bar{X}$	650.60	32.27	72.84	136.50	97.27
	SD	108.10	25.16	91.18	85.93	114.60
HIG(N = 24)	$\bar{X}$	663.52	57.27	75.93	164.13	75.75
	SD	102.66	46.46	76.48	135.55	100.98
Total(N=100)	$\bar{X}$	614.68	38.80	68.69	126.10	92.08
	SD	119.22	32.88	74.33	99.34	97.38
F-Statistics		12.44[e]	4.38[a]	0.26	4.73[a]	0.50
CH vs NCH(z-value)		4.08[e]	0.83	1.17	0.34	1.01
Recommended Allowances(ICMR,1977)		475.00	65.00	125.00	100.00	75.00

a. $P < 0.05$; d. $P < 0.005$; e. $P < 0.001$.

Table 4.2.1B. **Daily consumption of meat, fish and egg; sugar; fats and oils: milk and fruits per C.U. by income groups**

Income group		Meat, fish and egg(g)	Sugar(g)	Fats and oils(g)	Milk(g)	Fruits(g)
Christians:						
LIG(N = 28)	$\bar{X}$	69.12	40.28	21.04	20.96	12.69
	SD	27.51	15.59	11.08	29.28	19.85
MIG(N = 36)	$\bar{X}$	82.20	43.13	25.61	34.99	13.60
	SD	25.35	16.42	8.36	33.99	26.21
HIG(N = 20)	$\bar{X}$	141.15	51.80	42.38	50.55	17.35
	SD	47.78	7.11	17.70	17.30	23.39
Total(N=84)	$\bar{X}$	91.88	44.24	28.08	34.02	14.19
	SD	32.63	14.08	13.36	27.39	24.33
F-Statistics		8.45^{d}	4.04^{b}	20.84^{e}	6.03^{d}	0.28
Non-christians:						
LIG(N = 39)	$\bar{X}$	67.60	37.35	18.88	16.29	10.95
	SD	27.99	10.02	7.28	19.30	25.18
MIG(N = 37)	$\bar{X}$	78.42	44.96	40.91	20.85	14.06
	SD	32.78	23.22	28.96	17.82	26.34
HIG(N = 24)	$\bar{X}$	102.65	48.06	34.03	23.55	19.11
	SD	38.67	13.24	11.30	19.33	42.83
Total(N=100)	$\bar{X}$	80.02	42.74	30.67	19.72	14.06
	SD	34.15	17.42	18.36	20.48	34.45
F-Statistics		6.62^{c}	3.99^{a}	13.27^{e}	4.39^{a}	0.44
CH vs NCH(z-value)		2.41^{a}	0.65	1.11	3.95^{e}	0.03
Recommended Allowances (ICMR, 1977)		60.00	40.00	40.00	100.00	30.00

a. $P < 0.05$; b. $P < 0.025$; c. $P < 0.01$; d. $P < 0.005$; e. $P < 0.001$

holds true for both the CH and NCH.

Tables 4.2.1A and 4.2.1B further show that in both the CH and NCH, the intakes of pulses, green leafy vegetables, milk, fats and fruits are below the recommended allowances, suggested by the Indian Council of Medical Research (ICMR, 1977). It holds good for the LIG and HIG among the CH and for all the income groups in the NCH. But the consumption of cereals (mainly rice), roots and tubers (mainly potato), other vegetables, sugar and meat, fish and egg are above the recommended allowances in almost all the three income groups, and it holds true for both the CH and NCH.

Consumption of Nutrients

Table 4.2.2 shows the daily consumption of calories, protien, fat and minerals by income groups in the CH and NCH sections of the population . It is seen that the CH have higher consumption of protien, fat and iron, whereas, the NCH have higher intakes of calories and calcium. However, the differences between the CH and NCH are significant only in the case of calcium and iron intakes.

Table 4.2.2 further shows that in both the religious groups, the consumption of nutrients increases with the increasing income level, except among the NCH, which shows that the MIG and HIG have more or less similar intakes of iron. The analysis of variance also indicates that the differences among the three income groups in respect of the nutrient intakes are statistically significant in both the CH and NCH.

Among the CH, it is found that the consumption of all nutrients , except calories in the LIG, is above the recommended allowances(ICMR, 1989).

Table 4.2.2 . **Daily consumption of energy, protien, fat and minerals per C.U. by income groups**

Income group		Calories(kcal.)	Protien(g)	Fat (g)	Calcium (mg)	Iron(mg)
Christians:						
LIG(N = 28)	$\bar{X}$	2678.16	69.01	26.30	456.08	28.23
	SD	628.63	24.24	11.69	223.23	14.53
MIG(N = 36)	$\bar{X}$	2943.57	97.21	38.73	525.41	32.83
	SD	598.18	36.13	16.74	247.84	15.91
HIG(N = 20)	$\bar{X}$	3589.37	135.30	53.72	676.69	37.63
	SD	837.31	64.15	20.25	256.36	10.61
Total(N=84)	$\bar{X}$	3008.87	96.88	38.17	538.32	32.44
	SD	656.48	42.37	18.33	235.44	12.32
F-Statistics		11.12^{e}	15.30^{e}	14.57^{e}	5.10^{c}	3.21^{a}
Non-christians:						
LIG(N = 39)	$\bar{X}$	2696.57	68.74	24.90	506.95	24.06
	SD	559.01	27.80	11.98	243.33	7.20
MIG(N = 37)	$\bar{X}$	3146.97	90.41	38.04	594.20	32.37
	SD	821.84	39.39	20.01	168.89	14.27
HIG(N = 24)	$\bar{X}$	3477.56	110.90	47.28	834.20	32.33
	SD	711.57	45.99	14.70	308.09	7.97
Total(N=100)	$\bar{X}$	3050.66	86.88	35.13	617.77	29.12
	SD	736.22	39.45	16.42	248.35	8.70
F-Statistics		6.01^{d}	10.27^{e}	6.10^{e}	15.30^{e}	7.49^{e}
CH vs NCH(z-value)		0.41	1.64	1.17	2.22^{a}	2.08^{a}
Recommended Allowances (ICMR, 1989)		2875.00	60.00	20.00	400.00	28.00

a. $P < 0.05$; c. $P < 0.01$; d. $P < 0.005$; e. $P < 0.001$.

Table 4.2.3. Daily consumption of vitamins per C.U. by income groups

Income group		Vitamin A (β-Carotene) (μg)	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Vitamin B_{12} (mg)	Vitamin C(mg)	Niacin (mg)	Folic acid(mg)
Christians:								
LIG(N = 28)	$\bar{X}$	1169.83	1.38	0.93	2.01	25.81	22.01	80.75
	SD	1357.38	0.48	0.40	2.57	23.14	7.31	24.55
MIG(N = 36)	$\bar{X}$	1962.73	1.72	0.86	2.98	45.48	24.90	95.25
	SD	1082.22	0.68	0.41	2.30	31.97	6.52	42.66
HIG(N = 20)	$\bar{X}$	1973.83	1.92	1.27	2.99	61.59	31.77	101.70
	SD	1173.83	0.90	0.56	2.26	40.53	10.76	42.76
Total(N=84)	$\bar{X}$	1701.07	1.65	0.98	2.66	42.76	25.57	91.95
	SD	1286.48	0.69	0.46	2.03	32.20	9.20	39.48
F-Statistics		3.95^b	4.02^b	5.77^b	1.50	9.93^d	8.48^d	2.04
Non-christians:								
LIG(N = 39)	$\bar{X}$	1392.71	1.34	0.54	1.99	24.77	21.14	76.80
	SD	960.47	0.31	0.28	2.16	17.43	8.38	30.29
MIG(N = 37)	$\bar{X}$	1761.60	1.51	0.79	3.42	43.30	25.22	100.11
	SD	931.01	0.42	0.45	2.75	24.05	9.06	44.80
HIG(N = 24)	$\bar{X}$	1960.07	1.89	1.18	3.19	58.64	27.39	135.18
	SD	1228.79	0.51	0.54	3.12	33.91	8.23	66.74
Total(N=100)	$\bar{X}$	1665.37	1.53	0.79	2.81	39.75	24.15	99.44
	SD	1098.09	0.52	0.44	2.18	26.31	9.46	48.12
F-Statistics		2.35	14.81^e	18.76^e	2.89	15.33^e	4.52^b	12.34^e
CH vs NCH(z-value)		0.20	1.33	2.00^a	0.48	0.69	1.03	1.16
Recommended Allowances (ICMR, 1989)		2400.00	1.40	1.60	1.00	40.00	18.00	100.00

a. $P < 0.05$; b. $P < 0.025$; c. $P < 0.01$; d. $P < 0.005$; e. $P < 0.001$

among the NCH, the nutrient intakes like protien, fat and calcium are also above the ICMR recommended allowances,but the consumption of calories and iron the LIG is less than the requirement level.

The daily consumption of different vitamins per consumption unit by income groups is presented in Table 4.2.3. It is found that the CH have higher intakes of almost all vitamins, except in the case of vitamin B_{12} and folic acid, which are higher among the NCH. The differences between the CH and NCH with regard to consumption of vitamins are, however, significant only in the case of vitamin B_2 .

With respect to the income groups, it is found that the consumption of vitamins tends to increase with the increasing level of per capita monthly income, except in the case of vitamin B_2 among the CH and vitamin B_{12} among the NCH. The consumption of vitamin B_2 among the CH is found to be higher in the LIG than in the MIG, whereas the consumption of vitamin B_{12} among the NCH is higher in the MIG than in the HIG. Among the CH, the differences among the three income groups in respect of vitamin intakes are also significant,except in the case of vitamin B_{12} and folic acid. Among the NCH, on the other hand, the differences among the three income groups are statistically significant in respect of folic acid and other vitamins except in the case of vitamin A and vitamin B_{12}.

In comparison with the ICMR recommended allowances, it is found that the consumption of vitamin B_1 , vitamin B_{12} and niacin (nicotinic acid) is above the requiement level, whereas the intakes of vitamin B_2 and vitamin A fall below the recommended levels in all the income groups and it is true for both the CH and NCH. With respect to other vitamins like vitamin B_1, vitamin C and folic acid, the consumption levels among the LIG are found to be below the recommended aloowances, and it is true for both the CH and NCH.

Table 4.2.4. Distribution of households according to calorie intake per C.U. by income groups.

Income groups	Calorie intake		Total
	< 2875 kcal.	≥ 2875 kcal.	
Christians:			
LIG	22	7	29
%	75.86	24.14	100.00
MIG	20	16	36
%	55.56	44.44	100.00
HIG	6	14	20
%	30.00	70.00	100.00
Non-christians:			
LIG	24	15	39
%	61.54	38.46	100.00
MIG	16	21	37
%	43.24	56.76	100.00
HIG	10	14	24
%	41.67	58.33	100.00

Table 4.2.4 shows the distribution of households according to calorie intake by income groups for both the religious groups. Among the

Table 4.2.5. Distribution of the families (%) according to consumption of some vitamins

Vitamins	60 % of the requirement			60-80 % of the requirement			80-100 % of the requirement			100 % of the requirement		
	LIG	MIG	HIG	LIG	MIG	HIG	LIG	MIG	HIG	LIG	MIG	HIG
Christians:												
Vitamin A (Carotene)	53.57	27.78	35.00	17.86	11.11	5.00	7.14	16.67	15.00	21.43	44.44	45.00
Vitamin B_1 (Thiamine)	14.29	5.56	0.00	10.71	8.33	5.00	39.29	36.11	10.00	35.71	50.00	85.00
Vitamin B_2 (Reboflavin)	64.29	66.67	40.00	14.29	13.29	15.00	14.29	11.11	20.00	7.14	8.33	25.00
Vitamin B_2	53.57	27.78	10.00	21.43	22.22	10.00	17.89	16.67	15.00	7.14	33.33	65.00
Vitamin C (Ascorbic acid)	25.00	5.56	5.00	32.14	13.89	10.00	21.43	44.44	10.00	21.43	36.11	75.00
Non-Christian												
Vitamin A (carotine)	56.41	27.03	16.67	10.26	21.62	25.00	15.38	29.73	16.67	17.95	21.62	41.67
Vitamin B_1 (Thiamine)	5.13	2.70	0.00	20.51	8.11	8.33	41.03	32.43	8.33	33.33	56.76	83.33
Vitamin B_2 (reboflavin)	64.10	70.27	37.50	23.08	18.92	33.33	12.82	10.81	25.00	0.00	0.00	4.17
Vitamin B_{12}	30.76	27.03	20.33	2.56	16.22	8.33	35.90	10.81	29.17	30.77	45.95	41.67
Vitamin C (Ascorbic acid)	53.85	32.43	0.00	20.51	24.32	16.67	15.38	16.22	25.00	10.26	27.03	58.33

CH, about 75.86 %, 55.56 % and 30.00 % in the LIG, MIG and HIG, respectively, are found to have consumed energy below the ICMR recommended allowances, whereas among the NCH, these frequencies are 61.54 %, 43.24 % and 41.67 %, respectively. So, the frequency of households, which have calorie intake below the requirement level, is found to be higher among the CH (56.57 %) than that among the NCH (50.00 %), though the difference between them is not statistically significant (d = 0.97, P > 0.05). However, it is seen that the frequency of households with low energy intake is higher in the lower income groups for both the CH and NCH.

The distribution of households according to consumption of some vitamins by income groups is also shown in Table 4.2.5.. With respect to the consumption of vitamin A, it is found that the frequencies of households which consume less than 80 % of the requirement level among the CH are 71.43 %, 38.89% and 40.00 % in the LIG, MIG and HIG, respectively. Among the NCH, these frequencies are 66.67 %, 48.65 % and 41.67 %, respectively. The frequencies of families, which have consumed less than 80 % of the recommended allowance, for vitamin B_1, are found to be more or less same in both the CH and NCH income groups. But with respect to vitamin B_2, it is found that among the CH, about 78.58 %, 80.56 % and 45.00 % of the families in the LIG, MIG and HIG, respectively, have consumed less than 80 % of the requirement level. These frequencies are higher among the NCH, which are about 87.18 %, 89.19 % and 70,83 % in the LIG, MIG and HIG, respectively. Further, among the CH, the distribution of families, which have taken vitamin B_{12} less than 80 % of the recommended allowance, are 75.00 %, 50.00 % and 20.00 % in the LIG, MIG and HIG, respectively. Among the NCH, on the other hand, these frequencies are 33.32 %, 43.25 % and 20.83 %, respectively. With respect to vitamin C, it is observed that most of the households in the lower income groups have consumed less than 80 % of the recommended allowance, and it is by and large true for both the religious groups.

4.3. NUTRITIONAL ANTHROPOMETRY

Anthropometry is widely recognised as one of the most useful techniques to assess the nutritional status of an individual or a population (WHO Working Group, 1986; Rao, 1987). It is generally agreed that the mild and moderate forms of malnutrition are not easy to diagnose, the use of anthropometry is very much essential. In this section, an attempt will be made to show the nutritional status of children and adults for both the CH and NCH sections of the War Khasi. A special emphasis will be given on the problems regarding the use of international and/or national standards for the assessment of nutritional status.

Table 4.3.1. Expected height (cm) of boys by 3 years of age according to population references

Population reference	Median of population reference	Height for age (%)*			
		> 95 (Normal)	95 - 87.5 (Mild)	87.5 - 80 (Moderate)	< 80 (Severe)
NCHS	98.70	>93.77	93.77-86.36	86.36-78.96	< 78.96
Harvard**	96.00	>91.20	91.20-84.00	84.00-76.80	< 76.80
ICMR	88.60	>84.17	84.17-77.53	77.53-70.88	< 70.88

* Cut-off points taken from Waterlow (1972)

** Sexes were combined (Source: Jelliffe, 1966)

Table 4.3.1. shows the distribution of height for age according to the percentage of the median height of the population references. It is seen

that a boy or a group of boys, who may be regarded as having a normal growth in height, according to the ICMR (Indian Council of Medical Research, 1972) reference, may be considered as having a moderate growth retardation as per the NCHS (American National Centre for Health Statistics) reference standard (recently derived by Frisancho, 1990). In other words, a severe form of growth retardation as per the NCHS reference standard may be either mild or moderate as per the ICMR reference standard. Similar pattern of differences can be seen between the two international standards, i.e. NCHS and Harvard standards (though sexes are combined in Harvard standard). Consequently, the use of these standards will give a different result, as shown in Table 4.3.3 for the children of the present population in which the differences between the NCHS and ICMR standards, in respect of the mean values of height for age, are clearly perceptible for all ages. So, if we use the NCHS standard, most of the children in the present population may be regarded as having a growth retardation, whereas the results are just opposite when we use the ICMR reference standard. In this connection, it may be seen from Table 4.3.2 that the calorie and protien intakes in the present population are much better than those in many other Indian tribal populations.

In view of the above circumstances, it is considered essential to pay more attention to the methods of estimating the cut-off point (critical limit) and trigger level (distance or interval between two groups or grades of malnutrition and/or growth status) for assessing the growth and nutritional status of the children in the present study. In fact, systematic methods of determining the cut-off points and trigger levels are most important for identifying the different groups of individuals, particularly those who warrant a priority for immediate intervention. The WHO Working Group 'able 4.3.2. Average intakes of calories and protien per C.U. per day in some Indian tribes

ribe	Calories (kcal.)		Protien (g)		Source
	$\bar{X}$	SD	$\bar{X}$	SD	
(harwar	2565.00	690.00	88.30	24.50	Bhattacharya et al.,1972.
oya	2380.00	540.00	58.60	15.00	Roy and Roy, 1971.
aiga	2600.00	-	75.00	-	Roy and Rao, 1962.
uria	2760.00	-	80.00	-	" " " "
rali	2410.00	-	28.00	-	" " " "
anikkar	2200.00	-	13.00	-	" " " "
alapantharam	1850.00	-	13.00	-	" " " "
uthuvan	2640.00	-	44.00	-	" " " "
latan	2450.00	-	30.00	-	" " " "
ripuri	2600.00	-	63.00	-	" " " "
iang	3150.00	-	76.00	-	" " " "
adam Abor	2960.00	-	80.00	-	" " " "
nyong Abor	2650.00	-	68.00	-	" " " "
allong Abor	2950.00	-	70.00	-	" " " "
aniya	1975.00	-	52.70	-	" " " "
lla Kurumba	2730.00	-	56.30	-	" " " "
rali Kurumba	2300.00	-	61.50	-	" " " "
oda	3100.00	-	75.10	-	" " " "
ota	3060.00	-	88.90	-	" " " "
rula	1860.00	-	50.30	-	" " " "
icobarese	3050.00	-	130.00	-	Roy and Roy, 1967.
uria Gond	2958.00		73.92	8.50	Pingale(1973) cited in Rajyalakshmi, 1991.
ar Khasi	3031.57	751.78	91.44	34.03	Present study.

Table 4.3.3. Means and standard deviations of height for age (%) among the War Khasi children

Age	NCHS reference		ICMR reference	
	$\bar{X}$	SD	$\bar{X}$	SD
3 years:				
Boys (N = 25)	89.85	5.75	100.09	6.40
Girls(N = 20)	89.41	4.73	100.08	5.30
4 years:				
Boys (N = 22)	91.15	5.64	100.70	6.06
Girls(N = 20)	91.69	5.27	101.78	5.85
5 years:				
Boys (N = 23)	91.20	5.83	100.57	6.45
Girls(N = 19)	91.26	5.43	100.81	6.30

Table 4.3.4. Growth status of 3 year old boys according to height for age(%) (Example of classification on the basis of 95 % confidence limits of t-distribution)

Cut-off points and trigger levels*			Frequency (%)			Growth status
..S reference	ICMR reference	Sample mean**	NCHS	ICMR	Sample mean	
< 70.46	< 78.49	< 75.44	-	-	-	Very short
.97 - 70.46	87.97 - 78.49	84.49 - 75.44	-	-	-	Short
.48 - 78.97	97.45 - 87.97	93.54 - 84.49	40.00	40.00	40.00	Below Average
.48 - 95.99	97.45 -106.93	93.54 -102.60	40.00	40.00	40.00	Average
.99 -104.50	106.93 -116.41	102.60 -111.66	20.00	20.00	20.00	Above Average
.50 -113.01	116.41 -125.89	111.66 -120.72	-	-	-	Tall
> 113.01	>125.89	>120.72	-	-	-	Very tall

.wo cut-off points were estimated, i.e. $\bar{X}_1 - t_{0.05}SD_1/\sqrt{N_1}$ and $\bar{X}_2 + t_{0.05}SD_2/\sqrt{N_2}$,
where N_1 = Total sample size, and N_2 = Total sample of $\geqslant \bar{X}_1 - t_{0.05}SD_1/\sqrt{N_1}$.

The mean of the sample size N_2 is considered the standard mean.

(1986) has recommended to maintain the conventional cut-off point, - 2SD for "comparison of prevalences and for screening of populations". Accordingly , a similar method is used for the assessment of growth and nutritional status in the present population, for which the cut-off points are estimated using 95 % confidence interval based on the t-distribution, i.e. $\bar{X} - t_{0.05} \times SD$, or $- t_{0.05}SD$ (for large sample, it is equivalent to - 2SD). Since anthropological researches are mostly concerned with micro studies, it is felt necessary to use $- t_{0.05}SD$ as the cut-off point for screening the sample size of children into two groups, i.e. $\geqslant - t_{0.05}SD$ and $< - t_{0.05}SD$. Regarding the method of determining the trigger levels, the cut-off point $+ t_{0.05}SD$ derived from the group $\geqslant - t_{0.05}SD$ (i.e. normal sample size) is taken as another critical limit. As a result, the distance or interval between $- t_{0.05}SD$ of the total sample size and $+ t_{0,05}SD$ of the normal sample size is taken as the trigger level for subsequent groupings (Table 4.3.4). It may also be noted that the mean of sample size $\geqslant - t_{0.05}SD$ is considered the standard mean, provided we wish to express in percentage as an example in Table 4.3.4.

The same method is followed with respect to the assessment of the nutritional status of adults. The only difference is that we have taken - 4SD of the total sample size and + 4SD of the normal sample size for determining the cut-off points and trigger level, respectively. We have taken - 4SD as the cut-off point for screening the adult sample size, taking into consideration the fact that the variations in adult body dimensions, owing to various factors, are greater than those among the children.

Applying the above method, it is found that there is no difference between the international and the national/local reference standards in the assessment of growth and nutritional status of children, provided they have followed the same device of grouping and data analyses (Table 4.3.4). Therefore, the present method seems to take into account the approximate feature of the population concerned and thereby it is to some extent independent of the ethnic differences, owing to various factors. However, for the purpose of comparative studies of growth, but not for the assessment of growth and nutritional status, the use of NCHS/Harvard reference standard and that of Z-scores may be essential as recommended by the WHO Working Group (1986).

Nutritional Status of Children

Using the method suggested above, Table 4.3.5 shows the nutritional status of children aged 3-5 years according to weight for height (percentage of the Harvard reference standard) by income groups for both the CH and NCH. Among the CH, the frequencies of undernourished children are 36.36 %, 38.89 % and 20.00 % in the LIG, MIG and HIG, respectively, whereas among the NCH, these frequencies are 42.86 %, 38.46 % and 25.00 %, respectively. However, the χ^2 value shows that these variations in the frequencies of undernutrition, according to weight for height, among the three income groups are not statistically significant for both the CH (χ^2_2 = 1.62, $P > 0.05$) and NCH (χ^2_2 = 1.68, $P > 0.05$). It is also observed that the frequency of undernourished children is lower among the CH (32.37 %) than that among the NCH (36.49 %), though the difference between the two religious groups is not statistically significant (d = 0.44 , $P > 0.05$).

Table 4.3.5 further shows that most of the undernourished children are having only mild form of undernutrition in all the income groups for both the CH and NCH. Among the CH, the frequencies of mild grade of

Table 4.3.5. **Weight for height (%) of children aged 3 - 5 years by income groups**

Income group	Nutritional status							
	Normal		Mild		Moderate		Severe	
	N	%	N	%	N	%	N	%
Christians:								
LIG (N = 22)	13	59.09	5	22.73	2	9.09	1	4.55
MIG (N = 18)	12	66.67	6	33.33	1	5.56	0	0.00
HIG (N = 15)	12	80.00	3	20.00	0	0.00	0	0.00
Total(N = 55)	37	67.27	14	25.45	3	5.45	1	1.82
Non-christians:								
LIG (N = 28)	16	57.14	7	25.00	3	16.67	2	7.14
MIG (N = 26)	16	61.54	8	30.77	2	7.69	0	0.00
HIG (N = 20)	15	75.00	5	25.00	0	0.00	0	0.00
Total(N = 74)	47	63.51	20	27.03	5	6.76	2	2.70

Table 4.3.6. **Weight/height^2 of children aged 3-5 years by income groups**

Income group	Nutritional status							
	Normal		Mild		Moderate		Severe	
	N	%	N	%	N	%	N	%
Christians:								
LIG (N = 22)	14	63.64	5	22.73	3	13.64	0	0.00
MIG (N = 18)	12	66.67	6	33.33	0	0.00	0	0.00
HIG (N = 15)	12	80.00	3	20.00	0	0.00	0	0.00
Total(N = 55)	38	69.09	14	25.45	3	5.45	0	0.00
Non-christians:								
LIG (N = 28)	17	60.71	6	21.43	3	10.71	2	7.14
MIG (N = 26)	16	61.54	8	30.77	2	7.69	0	0.00
HIG (N = 20)	15	75.00	5	25.00	0	0.00	0	0.00
Total(N = 74)	48	64.86	19	25.68	5	6.76	2.	2.70

undernutrition are 22.73 %, 33.33 % and 20.00 % in the LIG, MIG and HIG, respectively. Among the NCH, these frequencies are 25.00 %, 30.77 % and 25.00 %, respectively.

Table 4.3.6 shows the degree of undernutrition according to weight/height by income groups for both the CH and NCH. As in the case of weight for height, most of the undernourished children according to weight/height^2 have mild grade of undernutrition. It is seen that the frequency of undernutrition (i.e. including mild, moderate and severe forms of undernutrition), as per this index, is higher in the lower income groups than that in the high income group, and it is true for the CH and NCH. It is, however, found that thse differences in the frequency of undernutrition among the three income groups are not statistically significant for both the CH (χ^2_2 = 1.51, P > 0.05) and NCH (χ^2_2 = 1.23, P > 0.05). Further, it is also found that the difference between the two religious groups in respect of the frequency of undernourished children is not significant (d = 0.50, P > 0.05), though it is higher among the NCH.

Nutritional Status of Adult Males

Table 4.3.7 shows the nutritional status of adult males according to weight for height by income groups. It is found that among the CH, the frequencies of undernutrition (combining together the mild, moderate and severe forms) are 36.36 %, 41.30 % and 11.54 % in the LIG, MIG and HIG, respectively. Among the NCH, these frequencies are found to be 46.67 %, 23.81 % and 30.00 % in the LIG, MIG and HIG, respectively. It

Table 4.3.7. **Nutritional status of adult males according to weight for height by income groups**

Income group	Nutritional status: Normal N	Normal %	Mild N	Mild %	Moderate N	Moderate %	Severe N	Severe %
Christians:								
LIG (N = 33)	21	63.64	7	21.21	4	12.12	1	3.03
MIG (N = 46)	27	58.70	13	28.26	3	6.52	3	6.52
HIG (N = 26)	23	88.46	3	11.54	0	0.00	0	0.00
Total(N = 105)	71	67.62	23	21.90	7	6.67	4	3.81
Non-christians:								
LIG (N = 45)	24	53.33	16	35.56	3	6.67	2	4.44
MIG (N = 42)	32	76.19	4	9.52	6	14.29	0	0.00
HIG (N = 30)	21	70.00	9	30.00	0	0.00	0	0.00
Total(N =117)	77	65.81	29	24.79	9	7.69	2	1.71

Table 4.3.8. **Nutritional status of adult males according to weight/height^2 by income groups**

Income group	Nutritional status: Normal N	Normal %	Mild N	Mild %	Moderate N	Moderate %	Severe N	Severe %
Christians:								
LIG (N = 33)	19	57.58	10	30.31	3	9.09	1	3.03
MIG (N = 46)	28	60.87	11	23.91	4	8.70	3	6.52
HIG (N = 26)	23	88.46	3	11.54	0	0.00	0	0.00
Total(N = 105)	70	66.67	24	22.86	7	6.67	4	3.81
Non-christians:								
LIG (N = 45)	24	53.33	17	37.78	2	4.44	2	4.44
MIG (N = 42)	33	78.57	6	14.29	3	7.14	0	0.00
HIG (N = 30)	21	70.00	9	30.00	0	0.00	0	0.00
Total(N = 117)	78	66.67	32	27.35	5	4.27	2	1.71

can, however, be seen that most of the undernourished adult males have suffered from mild form of undernutrition (Table 4.3.7). Nevertheless, the Table shows that the frequency of undernutrition is higher in the lower income groups than that in the high income group, and it is true for both the religious groups. The χ^2 values show that the differences among the the three income groups are statistically significant among the CH(χ^2_2 =6.55, P$<$ 0.05), but not significant among the NCH (χ^2_2 = 5.36, P$>$ 0.05). As far as religion is concerned, it is found that there is no significant difference between the CH and NCH in respect of the frequency of undernutrition according to weight for height (d = 0.28, P $>$ 0.05).

The weight/height^2 index by income groups for the CH and NCH males is given in Table 4.3.8. It is seen that the frequencies of undernutrition among the CH are 42.42 %, 39.13 % and 11.54 % in the LIG, MIG and HIG, respectively. Among the NCH, these frequencies are found to be 46.67 %, 21.43 % and 30.00 %, respectively. The differences among the three income groups in respect of the frequency of undernutrition according to weight/height^2 are found to be significant for both the CH (χ^2_2 = 7.47,P$<$0.05) and NCH (χ^2_2 = 6.44, P$<$0.05). As far as religion is concerned, it is found that there is no difference between the CH and NCH in respect of the frequency of undernutrition according to weight/height^2.

Nutritional Status of Adult Females

The nutritional status of adult females according to weight for height by income groups is presented in Table 4.3.9 for both the CH and NCH. It shows that, except among the CH in which the frequency of under-

Table 4.3.9. **Nutritional status of adult females according to weight for height by income groups**

Income group	Nutritional status							
	Normal		Mild		Moderate		Severe	
	N	%	N	%	N	%	N	%
Christians:								
LIG (N = 31)	12	38.71	14	45.16	5	16.13	0	0.00
MIG (N = 40)	33	82.50	7	17.50	0	0.00	0	0.00
HIG (N = 28)	20	71.43	8	28.57	0	0.00	0	0.00
Total(N = 99)	65	65.66	29	29.29	5	5.05	0	0.00
Non-christians:								
LIG (N = 40)	14	35.00	19	47.50	7	17.50	0	0.00
MIG (N = 43)	36	83.72	7	16.28	0	0.00	0	0.00
HIG (N = 30)	26	86.67	4	13.33	0	0.00	0	0.00
Total(N = 113)	76	67.26	30	26.55	7	6.19	0	0.00

Table 4.3.10. **Nutritional status of adult females according to weight/height^2 by income groups**

Income group	Nutritional status							
	Normal		Mild		Moderate		Severe	
	N	%	N	%	N	%	N	%
Christians:								
LIG (N = 31)	12	38.71	14	45.16	5	16.13	0	0.00
MIG (N = 40)	34	85.00	6	15.00	0	0.00	0	0.00
HIG (N = 28)	20	71.43	6	21.43	2	7.14	0	0.00
Total(N = 99)	66	66.67	26	26.26	7	7.07	0	0.00
Non-christians:								
LIG (N = 40)	14	35.00	21	52.50	5	12.50	0	0.00
MIG (N = 43)	38	88.37	5	11.63	0	0.00	0	0.00
HIG (N = 30)	26	86.67	4	13.33	0	0.00	0	0.00
Total(N = 113)	76	67.26	30	26.55	5	4.42	0	0.00

nutrition is lower in the MIG than that in the HIG, the frequency of undernutrition tends to decrease with the increasing level of per capita income. These variations in the frequency of undernutrition among the three income groups are highly significant for both the CH (χ^2_2 = 15.43, P < 0.001) and NCH (χ^2_2 = 29.31, P < 0.001). The difference between the CH and NCH in respect of the frequency of undernutrition is, however, not significant(d=0.25, P > 0.05).

Table 4.3.10 shows the nutritional status of adult females according to weight/height^2 by income groups for both the religious groups. The frequency of undernutrition (i.e. including mild, moderate and severe forms), according to this index, is not quite different from that found according to weight for height. It is seen that the frequencies of undernutrition are higher in the lower income groups for both the CH and NCH. The variations in the frequency of undernutrition among the three income groups are found to be highly significant for both the CH (χ^2_2 = 17.24, P < 0.001) and NCH (χ^2_2 = 33.55, P < 0.001). The comparison between the two religious groups in respect of the frequency of undernutrition is found to be not significant (d = 0.37, P > 0.05).

On the basis of the above findings, it is obvious that it is not religion, which really plays a significant role in influencing the nutritional status in the present population. Moreover, it is also observed that most of the undernourished individuals in this population have suffered from a mild grade of undernutrition.

CHAPTER V

EFFECTS OF BIO SOCIAL FACTORS ON HEALTH TRAITS

In the present chapter, an attempt will be made to show the relationship between bio-social factors like age, sex, birth order, anthropometric traits, religion, education, per capita income, etc. on health traits like fertility, mortality, physical growth, adult body dimensions and haemoglobin content.

5.1. FERTILITY

Table 5.1.1 shows the number of live-births and surviving children by age groups of the mothers. It is found that there is a significant-positive correlation between age of mothers and number of live-births as well as number of surviving children(Table 5.1.2). It can also be seen from Table 5.1.1 that the number of live-births and surviving children tends to increase with the increasing age of mothers. The coefficient of regression (b) on the effect of maternal age (independent variable) on number of live-births and surviving children (dependent variables) also show that there is a significant-positive relationship between them (Table 5.1.2). These

Table 5.1.1. **Live-births and surviving children by age groups of mothers**

Age groups (years)	No. of mothers	No. of live-births	No. of surviving chil	Mean No. of live-births (± S.E.)	Mean No of surviving children (± S.E.)
Christians:					
≤ 24	26	42	40	1.62 ± 0.26	1.54 ± 0.27
25 - 29	34	100	93	2.94 ± 0.29	2.74 ± 0.30
30 - 34	23	109	100	4.74 ± 0.41	4.35 ± 0.47
35 - 39	22	150	139	6.82 ± 0.47	6.32 ± 0.59
40 - 44	15	90	83	6.00 ± 0.54	5.53 ± 0.66
45 +	61	391	37	6.41 ± 0.35	5.52 ± 0.36
Total	181	882	792	4.87 ± 0.21	4.38 ± 0.21
Non-christians:					
≤ 24	28	65	59	2.32 ± 0.30	2.11 ± 0.28
25 - 29	39	107	99	2.74 ± 0.29	2.54 ± 0.30
30 - 34	34	160	147	4.71 ± 0.37	4.32 ± 0.39
35 - 39	32	178	160	5.56 ± 0.38	5.00 ± 0.41
40 - 44	22	139	125	6.32 ± 0.58	5.68 ± 0.64
45 +	83	516	430	6.22 ± 0.33	5.18 ± 0.34
Total	238	1165	1020	4.90 ± 0.19	4.29 ± 0.18

Table 5.1.2. **Regression of live-births and surviving children on maternal age**

Variable	Estimated number (a)	Regression coefficient (b ± S.E.)	F- value	r^2 (%)
Christians:				
Live-births	-2.14	0.20 ± 0.05	16.00[a]	81.00[a]
Surviving children	-1.54	0.17 ± 0.05	12.86[a]	75.69[a]
Non-christians:				
Live-births	-1.47	0.18 ± 0.03	39.90[c]	90.91[b]
Surviving children	-2.03	0.19 ± 0.02	76.39[d]	94.31[b]

a. $P < 0.05$; b. $P < 0.01$; c. $P < 0.005$; d. $P < 0.001$.

findings hold true for both the religious groups. Further, Table 5.1.1 shows that the mean number of live-births per ever-married woman is slightly lower among the CH (4.87 ± 0.21) than that among the NCH (4.90 ± 0.19). But the mean number of surviving children is slightly higher among the CH(4.38 ± 0.21) than that among the NCH (4.29 ± 0.18). These differences between the CH and NCH are not statistically significant in respect of both the number of live-births ($z = 0.11$, $P > 0.05$) and number of surviving children ($z = 0.32$, $P > 0.05$).

Table 5.1.3. **Age-specific fertility rate**

Age groups (years)	No. of married women		No. of live-births		Age-specific fertility rate	
	CH	NCH	CH	NCH	CH	NCH
15 - 19	181	238	87	120	0.48	0.50
20 - 24	177	236	258	341	1.46	1.44
25 - 29	158	212	218	297	1.38	1.40
30 - 34	126	173	167	200	1.33	1.16
35 - 39	102	139	93	120	0.91	0.86
40 - 44	76	105	52	59	0.68	0.56
45 +	61	83	7	28	0.11	0.34
Total fertility rate (TFR)					6.35	6.26

Table 5.1.3 shows the age-specific fertility rate among the CH and NCH. It is found that the total fertility rate(TFR) is slightly higher among the CH (6.35) than that among the NCH(6.26). It is also seen that the age-specific fertility rate (ASFR) reaches it peak, when the mothers are in the age group 20 - 24 years, then it starts decreasing with the rise in age of the mothers (Fig. 5.1.1). This holds good for both the religious groups.

FIG.5.1.1. AGE-SPECIFIC FERTILITY RATE

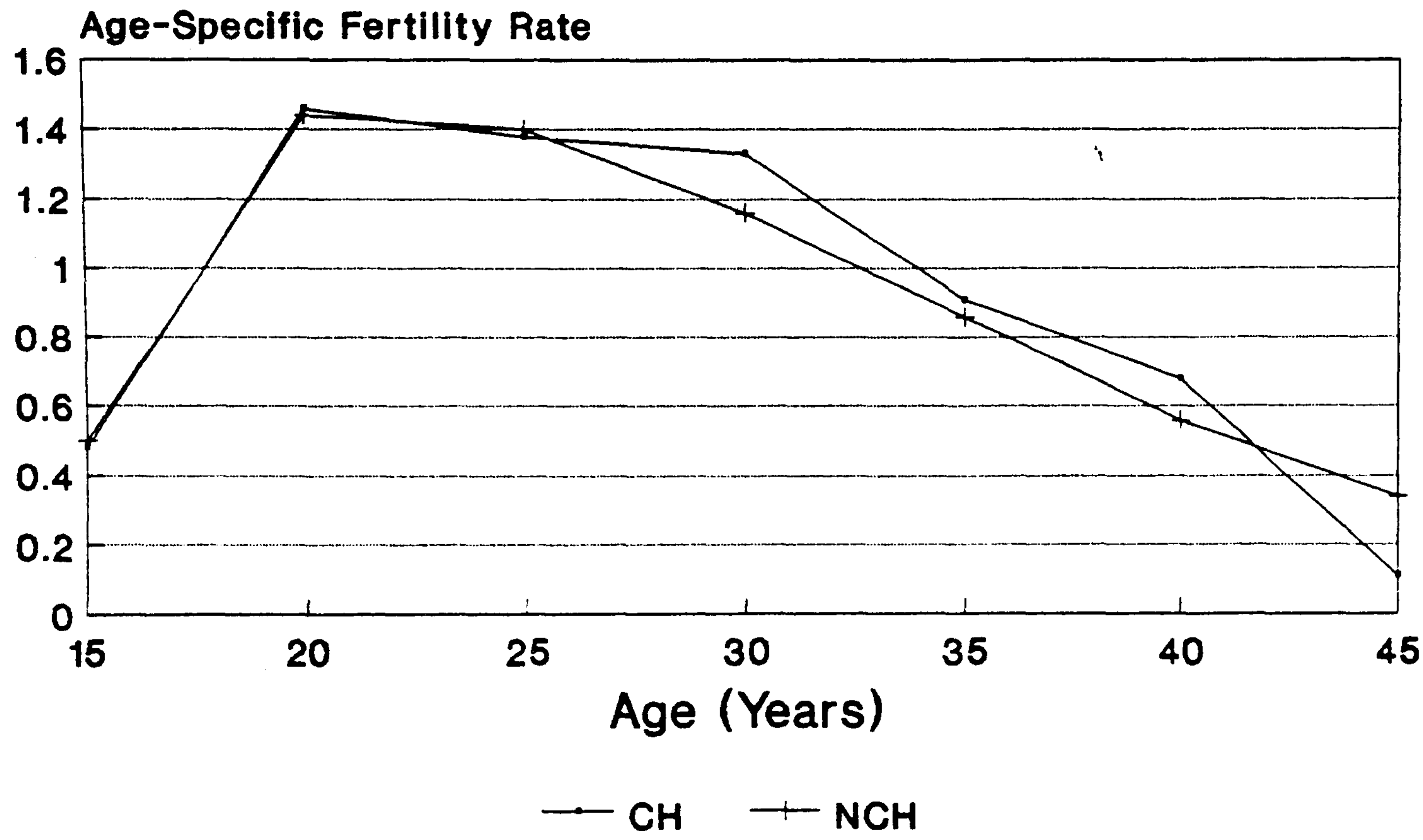


Table 5.1.4. Number of live-births by age at marriage

Age at marriage (years)	No. of mothers		No. of live-births		Mean No. of live-births ± S.E.	
	CH	NCH	CH	NCH	CH	NCH
≤ 19	87	140	519	729	5.97 ± 0.28	5.21 ± 0.24
20 - 24	66	72	258	343	3.91 ± 0.31	4.76 ± 0.29
25 - 29	22	20	85	72	3.86 ± 0.57	3.60 ± 0.47
30 +	6	6	20	21	3.33 ± 0.84	3.50 ± 0.39
F-Statistics					9.78[b]	2.80[a]
Correlation coefficient (r)					- 0.89[a]	- 0.93[a]

a. $P < 0.05$, b. $P < 0.005$

Table 5.1.4 shows the mean number of live-births per ever-married woman by age at marriage. It is found that the mean number of live-births decreases with the rise in age at marriage, and it is true for both the religious groups. The coefficient of correlation (r) also shows that there is negative relationship, and it is statistically significant for both the CH ($r = -0.89$, $P < 0.05$) and NCH ($r = -0.93$, $P < 0.05$). The differences among the age groups at marriage in respect of live-births are also found to be statistically significant for both the CH ($F = 9.78$, D.F. = 3,178, $P < 0.005$) and NCH ($F = 2.80$, D.F. = 3, 235, $P < 0.05$).

Table 5.1.5 shows the mean number of live-births per ever-married woman by income groups for both the CH and NCH. It is seen that the mean number of live-births (unadjusted for age) decreases with the rise in per capita monthly income of the households. It holds good for both the

Table 5.1.5. **Analysis of variance and covariance on maternal age and number of live-births by income groups**

Parameters	LIG	MIG	HIG	F-value
Christians:				-
No. of mothers	69	75	37	-
Mean age(years) of mothers ± SD	36.22 ± 11.47	39.69 ± 12.90	37.54 ± 12.41	1.43
No. of live-births	390	348	144	-
Mean No. of live-births[a] (Unadjusted)	5.65	4.64	3.89	5.23*
Non-christians:				
No. of mothers	98	102	38	-
Mean age(years) of mothers ± SD	39.86 ± 11.29	37.82 ± 10.71	31.42 ± 9.43	8.39**
No. of live-births	545	475	145	-
Mean No. of live-births (Unadjusted)	5.56	4.66	3.82	6.03**
Mean No. of live-births (Adjusted)	5.20	4.63	4.82	1.77

* $P < 0.05$; ** $P < 0.005$

[a] No adjustment for age was made as there is no significant difference in age of mothers.

religious groups of the population. The analysis of variance and covariance also shows that the differences among the the three income groups in respect of the mean number of live-births (unadjusted for age) are significant for both the CH ($F = 5.23$, D.F.= 2,178, $P < 0.05$) and NCH ($F = 6.03$, D.F. = 2, 235, $P < 0.005$). Among the CH, it is found that there is no significant difference among the three income groups in respect of the mean ages of mothers ($F = 1.43$, D.F. = 2, 178 , $P > 0.05$). Therefore, no adjustment for age was made while analysing the variance on the effect of the per capita income on the mean number of live-births. On the other hand, it is found that in the CH the differences among the three income groups, in respect of the mean ages of mothers, are statistically significant ($F = 8.39$, D.F. = 2, 235, $P < 0.005$). So, an attempt has been made to control the effect of age with the help of analysis of covariance. As a result, it is found that the effect of per capita income on the mean number of livebirths is not statistically significant ($F = 4.82$, D.F. = 2, 235, $P > 0.05$), i.e. after controlling the effect of maternal age. So, it shows that the maternal age has a greater role than the per capita income in regulating the fertility rate. Nevertheless, the effect of per capita income on the mean number of live-births is also quite perceptible, especially among the CH section of the present population.

Table 5.1.6. **Analysis of variance and covariance on the effect of maternal education on live-births**

Parameters	Illiterate	Primary	Secondary	F-value
Christians:				
No. of mothers	100	51	30	-
Mean age (years) of mothers ± SD	40.70 ± 12.30	36.10 ± 11.28	33.47 ± 10.84	5.37**
No. of live-births	528	240	114	-
Mean No. of live-births (Unadjusted)	5.28	4.71	3.80	4.56*
Mean No. of live-births (Adjusted)	4.90	5.03	4.51	0.98
Non-christians:				
No. of mothers	121	93	24	-
Mean age (years) of mothers ± SD	39.31 ± 11.11	37.47 ± 10.99	29.83 ± 7.30	7.69**
No. of live-births	647	428	90	-
Mean No. of live-births (Unadjusted)	5.35	4.60	3.75	4.01*
Mean No. of live-births (Adjusted)	5.08	4.63	5.00	1.03

* $P < 0.05$, ** $P < 0.01$

The relationship between fertility rate and educational levels is shown in Table 5.1.6. It is found that the mean number of live-births(unadjusted for age of mothers) decreases significantly with the increasing level of maternal education. This is true for both the CH and NCH. After controlling the effect of maternal age, the differences among the educational groups of mothers in respect of the mean number of live-births are not statistically significant for both the CH and NCH (Table 5.1.6). So, it clearly indicates that maternal age is more important than education for regulating the fertility rate in the present population. It may, however, be seen that the mean age of mothers also decreases significantly with the rise in educational level. In other words, the married women who could not read and write are much older than those belonging to the primary and secondary levels of education. As a result, most of the married women in the illiterate group might have completed their reproductive period, taking into consideration their mean age (Table 5.1.6), whereas the mothers belonging to the primary and secondary levels of education are mostly younger, thereby they are still to complete their reproductive performances. This may hold good for both the religious groups of the present population.

5.2. INFANT AND JUVENILE MORTALITY

Table 5.2.1A shows the frequencies of infant and juvenile mortality according to sex. It is found that the infant as well as the juvenile mortality rate is higher in males than in females. However, the binomial test for equality of proportions shows that the sex differences in infant and juvenile mortality rates are not statistically significant for both the CH and NCH (Table 5.2.1B). It is also found that the infant mortality rate is higher among the NCH (8.67 %) than that among the CH (7.03 %), though the difference between the two religious groups is not statistically significant ($d = 1.36$, $P > 0.05$). Similarly, the juvenile mortality rate is higher in the NCH (3.78 %) than that in the CH (3.17 %), despite the absence of significant difference between them ($d = 0.74$, $P > 0.05$).

Table 5.2.1A. Infant and juvenile mortality rate according to sex

Sex	Number of live-births	Number of deaths		Mortality rate(%)	
		< 1 year	< 15 years	Infant	Juvenile
Christians:					
Male	460	34	15	7.39	3.26
Female	422	28	13	6.64	3.08
Total	882	62	28	7.03	3.17
Non-christians:					
Male	607	54	24	8.89	3.95
Female	558	47	20	8.42	3.58
Total	1165	101	44	8.67	3.78

Table 5.2.1B. Value of d (Binomial test of proportions between sexes)

Section of population	Infant mortality rate	Juvenile mortality rate
Christians	4.30×10^{-1}, $P > 0.05$	1.50×10^{-1}, $P > 0.05$
Non-christians	2.60×10^{-1}, $P > 0.05$	3.30×10^{-1}, $P > 0.05$

Table 5.2.2A. Infant and juvenile mortality rates by birth order

Birth order	No. of live-births		Infant mortality rate (per 100 live-births)		Juvenile mortality rate (Per 100 live-births)	
	CH	NCH	CH	NCH	CH	NCH
1	180	212	4.44	9.91	2.67	3.15
2	198	253	6.06	5.53	2.02	3.56
3	160	206	6.88	6.31	3.75	2.91
4	118	173	5.08	6.94	3.38	2.89
5	101	153	7.93	9.80	1.98	4.58
6	66	98	12.12	14.29	4.55	6.12
7 +	59	70	12.25	17.14	6.78	5.71
Coefficient of correlatio (r)			0.88**	0.76*	0.71	0.83**

* $P < 0.05$, ** $P < 0.01$

Table 5.2.2B. Regression of infant and juvenile mortality rates on birth order

Variable	Estimated rate (a)	Regression coefficient (b ± S.E.)	F- value	r^2 (%)
Christians:				
Infant mortality	1.73	1.63 ± 0.39	17.47**	77.44**
Juvenile mortality	1.35	5.60×10^{-1} ± 0.24	5.44*	50.41
Non-christians:				
Infant mortality	3.87	1.52 ± 0.58	5.52*	57.76*
Juvenile mortality	2.05	5.20×10^{-1} ± 0.16	10.56*	68.89**

* $P < 0.05$, ** $P < 0.01$

Table 5.2.2A shows the frequencies of infant and juvenile mortality by birth orders. It is found that there is a significant-positive correlation between infant mortality rate and birth order for both the CH ($r = 0.88$, $P < 0.01$) and NCH ($r = 0.76$, $P < 0.05$), which shows that the infant mortality rate increases with the increasing birth order. The coefficient of regression (b) on the effect of birth order (independent variable) on infant mortality rate (dependent variable) also shows a significant-positive relationship between the two variables for both the religious groups (Table 5.2.2B). The form of relationship between infant mortality rate (IMR) and birth order (BO) is expressed by the following equations:

$$CH : IMR = 1.73 + 1.63 \times BO$$

$$NCH: IMR = 3.87 + 1.53 \times BO$$

The correlation between juvenile mortality and birth order is also found to be positive, but it is not significant among the CH (Table 5.2.2A). The coefficient of regression shows that the juvenile mortality rate increases with the increasing birth order for both the religious groups, though it is not significant among the CH (Table 5.2.2B). The relationship between juvenile mortality rate (JMR) and birth order in both the religious groups is expressed by the following equations:

$$CH : JMR = 1.35 + 0.56 \times BO$$

$$NCH : JMR = 2.05 + 0.52 \times BO.$$

Table 5.2.3A shows the frequencies of infant and juvenile mortality by age groups of the mothers. The coefficient of correlation shows that there is a positive relationship between infant mortality rate and maternal age, though it is not significant among the NCH (CH: $r = 0.93$, $P < 0.05$; NCH:

Table 5.2.3A. **Infant and juvenile mortality rates by age groups of mothers**

Age groups (years)	No. of live-births		Infant mortality rate (Per 100 live-births)		Juvenile mortality rate (Per 100 live-births)	
	CH	NCH	CH	NCH	CH	NCH
≤ 24	42	65	4.76	6.15	0.00	3.08
25 - 29	100	107	5.00	4.67	2.00	2.80
30 - 34	109	160	5.50	5.63	2.75	2.50
35 - 39	150	178	6.00	6.74	1.33	3.37
40 - 44	90	139	6.67	7.19	1.11	2.88
45 +	391	516	8.70	11.82	5.12	4.85
Coefficient of correlation (r)			0.93*	0.79	0.65	0.64

*$P < 0.05$

Table 5.2.3B. **Regression of infant mortality rate on age group of mothers**

Section of population	Estimated rate (a)	Regression coefficient (b ± S.E.)	F-value	r^2 (%)
Christians	1.28	$1.44 \times 10^{-1} \pm 0.03$	21.78**	86.49*
Non-christians	2.70×10^{-1}	$2.12 \times 10^{-1} \pm 0.08$	6.69	62.46

* $P < 0.05$, ** $P < 0.01$

Table 5.2.4. **Infant and juvenile mortality rates by income groups**

Income group	No. of live-births	Infant mortality rate (Per 100 live-births	Juvenile mortality rate(Per 100 live-births)
Christians:			
LIG (N = 69)	390	7.44	3.59
MIG (N = 75)	348	6.90	2.87
HIG (N = 37)	144	6.25	2.78
Non-christians:			
LIG (N = 98)	545	10.28	3.85
MIG (N = 102)	475	7.37	3.79
HIG (N = 38)	145	6.90	3.45

Table 5.2.5. **Infant and juvenile mortality rates by educational levels**

Educational level	No. of live-births	Infant mortality rate (per 100 live-births)	Juvenile mortality rate(per 100 live-births)
Christians:			
Illiterate (N=100)	528	7.77	3.79
Primary (N= 51)	240	6.67	2.50
Secondary (N= 30)	114	4.39	1.75
Non-christians:			
Illiterate (N=121)	647	10.20	4.02
Primary (N= 93)	428	7.01	3.50
Secondary (N= 24)	90	5.56	2.63

$r = 0.79$, $P > 0.05$). It shows that the infant mortality rate tends to increase with the increasing age groups of mothers for both the religious groups, though it is higher in the first age group among the NCH. The regression analysis (Table 5.2.3B) shows that there is a significant linear relationship between infant mortality rate and maternal age among the CH ($b = 0.14 \pm 0.03$, $P < 0.01$), which is expressed by the equation: IMR= 1.28 + 0.14 x Maternal age. Among the NCH, on the other hand, this pattern of relationship is not statistically significant ($b = 0.21 \pm 0.08$, $P > 0.05$).

The relationship between juvenile mortality rate and maternal age is not clearly perceptible in the present population. Table 5.2.3A shows that there is a positive correlation between juvenile mortality and maternal age, but the coefficient of correlation is not statistically significant for both the CH ($r = 0.65$, $P > 0.05$) and NCH ($r = 0.64$, $P > 0.05$). So, it indicates that the maternal age has an insignificant effect on juvenile mortality rate, though the oldest mothers (i.e. aged 45 + years) have experienced higher rate than those in any other age groups (Table 5.2.3B).

The frequencies of infant and juvenile mortality by income and educational levels are presented in Tables 5.2.4 and 5.2.5, respectively . It is seen from Table 5.2.4 that both infant and juvenile mortality rates are higher in the lower income groups than those in the high income group. This is true for both the religious groups. The regression of infant and juvenile mortality on income level is shown in Table 5.2.6. Among the CH, it is found that there is no significant relationship between per capita income and infant as well as juvenile mortality. On the other

Table 5.2.6. **Regression of infant and juvenile mortality on income level adjusted for maternal age**

Variable	No. of mothers	b (Unadjusted)	t-value	b_1 (Adjusted)	t_1-value
Christians:					
Infant mortality	181	$- 9.01 \times 10^{-2}$	1.28	$- 6.80 \times 10^{-2}$	0.97
Juvenile mortality	181	$- 5.03 \times 10^{-2}$	1.26	$- 4.13 \times 10^{-2}$	1.00
Non-christians:					
Infant mortality	238	$- 1.45 \times 10^{-1}$	2.00*	$- 5.92 \times 10^{-2}$	0.84
Juvenile mortality	238	$- 4.06 \times 10^{-2}$	0.81	$- 2.66 \times 10^{-2}$	0.58

* $P < 0.05$

Table 5.2.7. **Regression of infant and juvenile mortality on educational level adjusted for maternal age**

Variable	No. of mothers	b (Unadjusted)	t-value	b_1 (Adjusted)	t_1-value
Christians:					
Infant mortality	181	$- 1.19 \times 10^{-1}$	1.99*	$- 1.17 \times 10^{-1}$	1.67
Juvenile mortality	181	$- 6.97 \times 10^{-2}$	1.74	$- 7.64 \times 10^{-2}$	1.91
Non-christians:					
Infant mortality	238	$- 1.88 \times 10^{-1}$	2.35*	$- 1.75 \times 10^{-1}$	2.92*
Juvenile mortality	238	$- 4.80 \times 10^{-2}$	0.96	$- 4.25 \times 10^{-2}$	0.85

* $P < 0.05$

hand, the coefficient of regression on the effect of per capita income on infant mortality, without controlling the effect of maternal age, is found to be negatively significant among the NCH ($b = -0.15$, $P < 0.05$). It is, however, not significant after removing the effect of age. So, it indicates that the maternal age is more important than the per capita income of the households for regulating the mortality rates in the present population.

Table 5.2.7 shows the regression of infant and juvenile mortality on educational levels of the mothers. It is seen that there is no significant relationship between juvenile mortality and educational level. It is true for both the CH and NCH. On the other hand, the effect of education on infant mortality, unadjusted for age, is found to be negatively significant for both the religious groups ($P < 0.05$). After controlling the effect of maternal age, the regression coefficient shows that the negative relationship between education and infant mortality is not statistically significant for both the CH and NCH (Table 5.2.7). Thus, it indicates that both education and per capita income have a very little effect on infant and juvenile mortality. This holds good for both the religious groups of the present population.

It may be mentioned here that the other demographic characteristics such as age and sex composition, marital status, marriage pattern, fertility, mortality, reproductive wastages, etc. have already been reported for this population (Khongsdier, 1991). So far as the present study is concerned, we are mainly confined to the effects of some bio-social factors like age, sex, birth order, religion, economic condition, education, age at marriage, anthropometric variables on fertility and mortality rates.

5.3. ANTHROPOMETRIC VARIABLES AND REPRODUCTIVE PERFORMANCES

Table 5.3.1 shows the means and standard deviations of live-births, infant and juvenile mortality, and anthropometric variables for both the CH and NCH. It is seen that there are 99 and 113 mothers among the CH and NCH, respectively. The mean age is found to be 36.19 ± 7.77 years for the CH mothers and 37.76 ± 9.92 years for the NCH mothers. Among the CH the mean number of live-births is 4.61 ± 3.06 and among the NCH 5.09 ± 3.47. The mean numbers of infant and juvenile mortality are found to be 0.36 ± 0.63 and 0.17 ± 0.45, respectively, in the CH and 0.43 ± 0.71 and 0.25 ± 0.49, respectively, in the NCH. The means and standard deviations of selected anthropometric variables for the present study like height,weight, bi-iliac diameter, body mass index (i.e. weight/height^2) and body fat for both the CH and NCH mothers are also presented in Table 5.3.1.

Table 5.3.1. Means and standard deviations of key variables for regression analyses

Variables	Christians.	Non-christians
Number of mothers	99	113
Number of live-births	456	575
Number of infant deaths	36	49
Number of juvenile deaths	17	28
Mean age(years) of mothers ± SD	36.19 ± 7.77	37.76 ± 9.92
Mean number of live-births ± SD	4.61 ± 3.06	5.09 ± 3.47
Mean number of infant deaths ± SD	0.36 ± 0.63	0.43 ± 0.71
Mean number of juvenile deaths ± SD	0.17 ± 0.45	0.25 ± 0.49
Mean value of stature ± SD (cm)	147.81 ± 4.22	147.56 ± 4.68
Mean value of weight ± SD (kg)	46.33 ± 4.66	46.48 ± 5.30
Mean value of bi-iliac diameter ± SD (cm)	26.29 ± 0.89	26.55 ± 0.96
Mean value of body mass index ± SD	2.12 ± 0.17	2.13 ± 0.19
Mean value of body fat ± SD	6.44 ± 1.41	6.39 ± 1.41

Maternal Stature and Reproductive Performances

The relationship between stature and reproductive performances of mothers for both the religious groups is shown in Table 5.3.2. In both the religious groups, the number of live-births, infant and juvenile mortality are regressed separately with the maternal stature. Among the CH, it is found that there is no significant relationship between stature (independent variable) and infant as well as juvenile mortality (dependent variable). However, it is found that the relationship between maternal stature and number of live-births is negatively significant, even after controlling the effect of age. This pattern of relationship between maternal stature and live-births is found to be negatively significant among the NCH also. The form of relationship is expressed by the following equations:

CH : Live-birth = 56.66 - 0.3976 x Stature + 0.1875 x Age

NCH : Live-birth = 21.49 - 0.1315 x Stature + 0.2514 x Age.

Table 5.3.2. Regression of live-birth, infant and juvenile mortality on maternal stature adjusted for age

Variable	No. of mothers	b (Unadjusted)	t-value	b_1 (Adjusted)	t_1-value
Christians:					
Live-births	99	$- 4.42 \times 10^{-1}$	7.55^{***}	$- 3.98 \times 10^{-1}$	8.32^{***}
Infant mortality	99	$- 1.97 \times 10^{-2}$	1.32	$- 1.11 \times 10^{-2}$	0.82
Juvenile mortality	99	$- 1.39 \times 10^{-2}$	1.30	$- 1.26 \times 10^{-2}$	1.15
Non-Christians:					
Live-births	113	$- 1.76 \times 10^{-1}$	2.57^{*}	$- 1.32 \times 10^{-1}$	2.44^{*}
Infant mortality	113	$- 4.46 \times 10^{-1}$	3.23^{**}	$- 3.72 \times 10^{-1}$	3.21^{**}
Juvenile mortality	113	$- 1.69 \times 10^{-1}$	1.72	$- 1.47 \times 10^{-1}$	1.47

* $P < 0.05$; ** $P < 0.005$; *** $P < 0.001$

Among the NCH, Table 5.3.2 shows that there is a significant negative relationship between maternal stature and infant mortality, even after controlling the effect of age. This form of relationship is expressed by the following equation:

$$\text{Infant mortality} = 4.3180 - 0.0372 \times \text{Stature} + 0.0425 \times \text{Age}.$$

As in the case of the CH, the relationship between maternal stature and juvenile mortality among the NCH is not statistically significant.

Maternal Body Weight and Reproductive Performances

The relationship between body weight and reproductive performances of the CH and NCH mothers are tested with the help of regression analyses. Table 5.3.3 shows that among the CH the relationship between live-births (dependent variable) and maternal body weight (independent variable) is negatively significant, even after removing the effect of age. Similarly, the coefficient of regression (b) among the NCH, unadjusted for age, shows that the relationship between live-births and maternal body weight is also negatively significant. After adjusting for age, the relationship between these two variables is, however, not statistically significant. Nevertheless, it indicates that the number of live-births has also associated, to a certain extent, with the maternal body weight. The form of relationship is expressed by the following equations :

CH : $\text{Live-birth} = 3.5041 - 0.1265 \times \text{Weight} + 0.1925 \times \text{Age}$

NCH : $\text{Live-birth} = -0.6978 - 0.0724 \times \text{Weight} + 0.2424 \times \text{Age}.$

Table 5.3.3. **Regression of live-birth, infant and juvenile mortality on maternal body weight adjusted for age**

Variables	No. of mothers	b (Unadjusted)	t-value	b_1 (Adjusted)	t_1-value
Christians:					
Live-births	99	-2.15×10^{-1}	3.41***	-1.27×10^{-1}	2.22*
Infant mortality	99	-3.25×10^{-2}	2.46**	-1.68×10^{-2}	1.34
Juvenile mortality	99	-1.52×10^{-2}	1.57	-1.33×10^{-2}	1.32
Non-christians:					
Live-births	113	-2.18×10^{-1}	3.54***	-7.24×10^{-2}	1.55
Infant mortality	113	-9.78×10^{-2}	11.11***	-7.98×10^{-2}	9.95***
Juvenile mortality	113	-1.43×10^{-2}	1.67	-7.22×10^{-3}	0.78

* $P < 0.05$; ** $P < 0.025$; *** $P < 0.001$

As regards the infant mortality, Table 5.3.3 shows that the regression coefficient, unadjusted for age, is highly significant for both the religious groups of the population. It shows that the number of infant deaths decreases with the rise in maternal body weight. Among the NCH, the negative relationship between infant mortality and maternal body weight is found to be statistically significant, even after removing the effect of age. On the other hand, the coefficient of regression, adjusted for age, shows that the relationship between these two variables among the CH is not statistically significant. After all, it indicates that the infant mortality is also associated with maternal body weight. The form of relationship is expressed by the following equations:

CH : Infant mortality = $-0.0958 - 0.0168 \times \text{Weight} + 0.0342 \times \text{Age}$

NCH : Infant mortality = $3.0073 - 0.0798 \times \text{Weight} + 0.0307 \times \text{Age}$.

As far as juvenile mortality is concerned, Table 5.3.3 shows that the coefficient of regression is not statistically significant for both the religious groups.

Maternal Bi-iliac Diameter and Reproductive Performances

Table 5.3.4 shows the relationship between bi-iliac diameter and reproductive performances of both CH and NCH mothers. It is found that the relationship between bi-iliac diameter and number of live-births is positively significant, even after removing the effect of age for both the religious groups. In other words, the coefficient of regression shows that the number of live-births increases with the increase in bi-iliac diameter. The regression equations are expressed as follows:

CH : Live-birth = − 21.0700 + 0.6968 x Bi-iliac diameter + 0.2034 x Age

NCH : Live-birth = − 47.9758 + 0.9502 x Bi-iliac diameter + 0.2499 x Age.

Table 5.3.4. Regression of live-birth, infant and juvenile mortality on maternal bi-iliac diameter adjusted for age

Variables	No. of mothers	b (Unadjusted)	t-value	b_1 (Adjusted)	t_1-value
<u>Christians:</u>					
Live-births	99	9.25×10^{-1}	9.45***	6.97×10^{-1}	2.39*
Infant mortality	99	1.62×10^{-1}	2.30*	1.22×10^{-1}	1.91
Juvenile mortality	99	3.98×10^{-2}	0.77	3.32×10^{-2}	0.64
<u>Non-christians:</u>					
Live-births	113	1.04	3.20**	9.50×10^{-1}	3.92***
Infant mortality	113	1.96×10^{-1}	2.71*	4.62×10^{-2}	0.74
Juvenile mortality	113	5.46×10^{-2}	0.54	9.60×10^{-3}	0.18

* $P < 0.025$; ** $P < 0.005$; *** $P < 0.001$

With respect to infant mortality, the regression coefficient, unadjusted for age, also shows that the number of infant deaths increases significantly with the increase in maternal bi-iliac diameter. This is true for both the religious groups of the population. However, after controlling the effect of age, this significant positive relationship between the two variables disappears in both the groups.

As in the case of stature and body weight, the relationship between juvenile mortality and bi-iliac diameter is not significant for both the CH and NCH.

Maternal Body Mass Index and Reproductive Performances

Table 5.3.5 shows the relationship between body mass index and reproductive performances of the mothers for both the religious groups. It is found that there is no significant relationship between live-birth and body mass index, though the coefficient of regression, unadjusted for age, is statistically significant among the NCH. Further, the coefficient of regression, unadjusted for age, shows that there is a significant-negative relationship between body mass index and infant mortality for both the CH and NCH, This negative relationship is, however, not significant after removing the effect of age. It holds good for both the religious groups. Table 5.3.5 also shows that the relationship between body mass index and juvenile mortality is not significant in both the religious groups.

Maternal Body Fat and Reproductive Performances

The relationship between body fat and reproductive performances of the CH and NCH mothers is shown in Table 5.3.6. It is found that the rela-

Table 5.3.5. Regression of live-birth, infant and juvenile mortality on maternal body mass index adjusted for age

Variables	No. of mothers	b (Unadjusted)	t-value	b_1 (Adjusted)	t_1-value
Christians:					
Live-births	99	- 1.18	0.67	- 1.27	0.81
Infant mortality	99	$- 7.33 \times 10^{-1}$	2.05*	$- 3.44 \times 10^{-1}$	1.0[illegible]
Juvenile mortality	99	$- 2.36 \times 10^{-1}$	0.91	$- 1.77 \times 10^{-1}$	0.66
Non-christians:					
Live-births	113	- 4.77	2.80**	- 1.04	0.41
Infant mortality	113	$- 7.79 \times 10^{-1}$	2.19*	$- 1.36 \times 10^{-1}$	0.43
Juvenile mortality	113	$- 2.15 \times 10^{-1}$	0.87	$- 2.27 \times 10^{-2}$	0.86

* $P < 0.05$; ** $P < 0.01$.

Table 5.3.6. Regression of live-birth, infant and juvenile mortality on maternal body fat adjusted for age

Variables	No. of mothers	b (Unadjusted)	t-value	b_1 (Adjusted)	t_1-value
Christians:					
Live-births	99	$- 5.76 \times 10^{-1}$	2.72*	$- 2.91 \times 10^{-1}$	1.53
Infant mortality	99	$- 9.78 \times 10^{-2}$	2.23*	$- 4.82 \times 10^{-2}$	1.16
Juvenile mortality	99	$- 3.78 \times 10^{-2}$	1.18	$- 3.09 \times 10^{-2}$	0.95
Non-christians:					
Live-births	113	$- 6.73 \times 10^{-1}$	3.00**	$- 1.40 \times 10^{-1}$	0.80
Infant mortality	113	$- 2.82 \times 10^{-1}$	7.04***	$- 2.07 \times 10^{-1}$	5.62***
Juvenile mortality	113	$- 5.70 \times 10^{-2}$	1.75	$- 3.21 \times 10^{-2}$	0.92

* $P < 0.05$; ** $P < 0.005$; *** $P < 0.001$.

tionship between body fat and live-births is significant for both the CH and NCH. It shows that the number of live-births decreases with the increase in body fat. This negative relationship is, however, not significant after adjusting for the effect of age in both the religious groups.

With respect to infant mortality, it is found that the coefficient of regression, unadjusted for age, is negatively significant in both the religious groups. After controlling the effect of age, this pattern of relationship is found to be statistically significant only among the NCH. The regression equation is found to be as follows :

CH : Infant mortality = - 6.9757 - 0.0482 x Body fat + 0.0346 x Age

NCH : Infant mortality = - 2.2054 - 0.2075 x Body fat + 0.0348 x Age.

As in the case of other anthropometric variables, the relationship between body fat and juvenile mortality is not statistically significant in both the religious groups.

5.4. ADULT BODY DIMENSIONS

In this section, we shall deal with the variations in body dimensions of adult males and females of the present population. With this end in view, we have presented our findings according to villages and income groups based on the per capita monthly income of households. Religion was not taken into consideration as there were not much differences in body dimensions between the CH and NCH.

Variations in Adult Body Dimensions among Villages (MALES)

In order to understand the magnitude of variation in adult body dimensions among the War Khasi villages, i.e. Lapalang (LA), Mawsiangei (MA), Nongla (NA) and Wahumlein (WA), we have followed the T^2-square method suggested by Sanghvi (1953), which is as follows:

$$T^2 = \frac{100 \sum_{i=1}^{n} \left[\frac{(m_1 - m_2)^2}{(s_1^2 - s_2^2)^2} \right]}{n},$$

where, m_1 and m_2 , and s_1 and s_2 are the means and standard deviations of the of the same character between two groups, and n is the number of character taken into consideration.

Table 5.4.1 shows the means and standard deviations of ten selected anthropometric measurements by villages for the adult males of the War Khasi. It is seen from Table 5.4.2 that the LA males differ significantly from the MA males in respect of sitting height, bi-iliac diameter and mid upper arm circumference. The value of T^2 , which accounts the magnitude of variation between the LA and MA males in respect of all the measurements, is found to be 12.62. On the other hand, the differences between the LA and NA males are statistically significant in respect of weight, height, sitting height and bi-iliac diameter, and the value of T^2 is found to be 11.42. A more deviation is found when the comparison is made between the LA and WA males. It can be seen from Table 5.4.2 that the differences between the LA and WA adult males are statistically significant in respect of height, sitting height, biacromial diameter, bi-iliac diameter and chest girth (exhale). The sum total of differences between them in respect of all measurements taken for the

Table 5.4.1. Anthropometric measurements by villages (Males)

Body measurements	Lapalang (N = 77) Mean age (years) = 34.20 ± 7.32		Mawsiangei (N = 48) Mean age (years) = 35.33 ± 8.54		Nongla (N = 42) Mean age (years) = 33.23 ± 9.01		Wahumlein (N = 35) Mean age (years) = 35.10 ± 9.98	
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Weight (kg)	51.30	5.02	50.23	4.76	49.05	5.01	50.26	4.71
Height (cm)	158.67	4.81	157.51	4.32	156.58	4.44	155.09	5.41
Sitting height (cm)	83.78	2.80	82.00	2.78	81.45	2.96	80.78	2.87
Biacromial diameter (cm)	36.83	1.68	36.31	1.71	36.18	1.72	36.13	1.63
Bi-iliac diameter (cm)	27.65	1.13	26.12	1.30	26.67	0.98	27.15	0.78
Mid upper arm cir. (cm)(L)	24.68	1.70	24.09	1.20	24.29	1.77	24.45	1.52
Chest girth (inhale)(cm)	84.75	3.18	84.04	3.54	83.96	3.57	83.51	3.86
Chest girth (exhale)(cm)	80.83	3.09	80.08	3.53	80.55	3.49	79.20	2.55
<u>Log of skinfold thickness:</u>								
Biceps (left)	0.5393	0.1111	0.5422	0.1049	0.5415	0.1012	0.5385	0.1292
Triceps (left)	0.8201	0.0907	0.7945	0.0951	07868	0.1117	0.8115	0.1442

present study is found to be 11.71.

In comparison with the NA and WA males, the MA males do not show much deviation in body dimensions, except in respect of bi-iliac diameter. It is found that the sum total of differences in body measurements between the MA and NA males is 2.05, and between the MA and WA males 6.99. With respect to the differences between the NA and WA males, it is found that the value of T^2 is only 3.38. So, it shows that the three villages, i.e. MA, NA and WA do not show much variation in respect of body measurements taken for the present study. However, adult males of all these three villages show a greater magnitude of variation when compared with the LA males. These variations between villages in respect of anthropometric traits will be discussed in the following chapter.

Table 5.4.2. **Statistical differences between villages in respect of anthropometric measurements (MALES)[b].**

Anthropometric measurements	LA vs MA	LA vs NA	LA vs WA	MA vs NA	MA vs WA	NA vs WA
Weight	1.19	2.34*	1.06	1.14	0.03	1.09
Height	1.40	2.38*	2.42*	1.00	1.28	0.43
Sitting height	3.49**	4.18**	5.17**	0.90	1.94	1.01
Biacromial diameter	1.68	1.99	2.09*	0.36	0.49	0.13
Bi-iliac diameter	3.32*	4.93**	2.71*	2.28*	4.49**	2.40*
Mid upper arm circumference	2.27*	1.16	0.72	0.63	1.16	0.43
Chest girth(inhale)	1.13	1.20	1.66	0.11	0.64	0.53
Chest girth(exhale)	1.21	0.44	2.93*	0.64	1.32	1.96
<u>Log of skinfold thickness:</u>						
Biceps	0.15	0.11	0.03	0.04	0.14	0.11
Triceps	1.51	1.67	0.32	0.35	0.60	0.82
Sanghvi's T^2	12.62	11.42	11.71	2.05	6.99	3.38

* $P < 0.05$; ** P 0<001.

b. As suggested by Sanghvi(1953).

Table 4.3. Anthropometric measurements ... villages ... (fe)male ...

Body measurements	Lapalang (N = 65) Mean age (years) = 34.17 ± 7.66		Mawsiangei (N = 45) Mean age (years) = 34.80 ± 9.81		Nongla (N = 38) Mean age (years) = 33.80 ± 8.00		Wahumlein (N=45) Mean age (years) = 34.34 ± 7.82	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Weight (kg)	45.91	4.41	46.20	5.08	45.11	3.93	44.58	3.71
Height (cm)	148.15	4.48	147.58	4.81	147.01	4.09	146.70	3.53
Sitting height (cm)	78.15	2.83	77.00	3.04	77.09	2.07	76.27	2.13
Biacromial diameter (cm)	33.56	1.32	32.94	1.43	32.69	1.17	32.46	1.14
Bi-iliac diameter (cm)	26.80	0.79	26.29	0.88	26.32	1.00	26.28	0.55
Mid upper arm cir.(cm)(L)	22.85	1.93	23.49	2.02	23.38	2.15	22.95	1.90
Chest girth(inhale)(cm)	81.36	3.74	82.33	3.15	80.89	2.85	80.18	3.77
Chest girth(exhale)(cm)	78.82	3.63	79.03	3.14	77.40	2.79	77.51	3.67
<u>Log of skinfold thickness</u>:								
Biceps (left)	0.6349	0.1058	0.6378	0.0809	0.6586	0.1109	0.6525	0.1107
Triceps (left)	0.9389	0.1203	0.9736	0.0961	0.9471	0.1062	0.9375	0.1229

Variation in Adult Body Dimensions Between Villages (FEMALES)

The means and standard deviations of anthropometric measurements, taken for the purpose of the present study, for the adult females are shown in Table 5.4.3 according to villages.

Table 5.4.4 shows the values of statistical comparison according to Sanghvi's(1953) method of distance analyses. It is seen that the values of T^2, which show the sum total of differences in anthropometric measurements between the LA and other three villages (i.e. MA, NA and WA), vary from 3.71 to 9.25. The differences between LA and MA females are found to be significant in respect of sitting height, biacromial diameter and bi-iliac diameter, whereas the LA and NA females differ significantly from each other with regard to sitting height, biacromial diameter, bi-iliac diameter and chest girth(exhale). In comparison with the WA females, the LA females show a significant difference with regard to sitting height, biacromial diameter and bi-iliac diameter.

Table 5.4.4 further shows that the MA females differ significantly from the NA and WA females with regard to chest girths (inhale and exhale). The T^2 values are found to be 3.81 and 5.89 for the differences between MA and NA, and between MA and WA females,respectively. The diferences between NA and WA females are not statistically significant in respect of all anthropometric characters. The value of T^2 is found to be the lowest (1.61) of all the comparisons made between villages.

The distances between villages with regard to anthropometric traits taken for the present study have been shown in Tables 5.4.2 and 5.4.4 for males and females respectively. As far as the present findings are concerned,it shows that the variations between villages are not much striking in the case of females. In the case of males, it has been seen that the Lapalang(LA) males mostly deviate from all the other three villages, namely, Mawsiangei(MA), Nongla(NA) and Wahumlein(WA), in respect of certain anthropometric measurements (Table 5.4.2).

Table 5.4.4. **Statistical differences between villages in respect of anthropometric measurements (FEMALES)**

Anthropometric measurements	LA vs MA	LA vs NA	LA vs WA	MA vs NA	MA vs WA	NA vs WA
Weight	0.31	0.95	1.71	1.10	1.73	0.63
Height	0.63	1.32	1.89	0.58	0.99	0.37
Sitting height	2.01*	2.18*	3.97**	0.16	1.32	1.77
Biacromial diameter	2.31*	3.47**	4.66**	0.88	1.76	0.90
Bi-iliac diameter	3.13*	2.54*	4.08**	0.14	0.06	0.22
Mid upper arm Circumference	1.66	1.25	0.27	0.24	1.31	0.96
Chest girth(inhale)	1.51	0.72	1.62	2.24*	3.00*	0.98
Chest girth(exhale)	0.32	2.22*	1.85	2.50*	2.11*	0.15
Log of skinfold thickness:						
Biceps	0.18	1.06	0.66	1.04	0.60	0.25
Triceps	1.74	0.37	0.05	1.18	1.61	0.39
Sanghvi's T^2	3.71	4.89	9.25	3.81	5.89	1.61

* $P \leq 0.05$; ** $P \leq 0.001$.

Anthropometric Variables by Economic Condition(MALES)

The comparison between villages shows that LA village differs significantly from the other three villages with regard to some anthropometric measurements. Therefore, anthropometric data, collected from Lapalang, will be presented separately with a view to having a better understanding of the probable effect of economic condition on anthropometric variables. However, anthropometric data collected from the other three villages, namely, Mawsiangei (MA), Nongla(NA) and Wahumlein WA), are pooled together, since there are not much differences between these villages in respect of body measurements.

The effect of economic condition on anthropometric variables of adult males for the three villages, i.e. MA, NA and WA is shown in Table 5.4.5. It is found that the mean values of anthropometric measurements are higher in the HIG, when compared with those in the LIG and MIG. The analysis of variance shows that the income group differences in many anthropometric measurements are significant, except in the case of height, bi-iliac diameter and chest girth(inhale). Similarly, the mean values of anthropometric ratios and indices are higher in HIG, in comparison with those in the LIG and MIG. The analysis of variance also shows that the differences in anthropometric ratios and indices among the three income groups are highly significant,excepting cormic index and chest girth(exhale)/height ratio.

The differences between any two groups for the adult males are given in Table 5.4.6. It is found that the variations between the LIG and MIG are statistically significant only in the case of mid upper arm circumference ble 5.4.5. **Anthropometric** variables for **adult males by income groups**(MA+NA+WA)

nthropometric variables	LIG (N = 49) Mean age(years) = 35.12 ± 10.78		MIG (N = 51) Mean age(years) = 36.37 ± 7.39		HIG (N = 25) Mean age(years) = 36.42 ± 7.39		F-value
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	
solute measurements:							
ight (kg)	48.14	5.39	49.76	3.48	53.24	4.72	9.49**
ight(cm)	156.81	5.49	157.12	4.35	158.34	3.52	0.88
tting height(cm)	82.28	3.05	81.54	2.90	83.35	2.59	3.23*
acromial diameter(cm)	35.94	1.42	35.98	1.63	37.42	1.90	7.98**
-iliac diameter(cm)	27.00	0.83	27.17	1.17	27.54	1.39	1.99
d upper arm circum.(cm)	23.54	1.46	24.30	1.76	25.51	1.17	13.27***
est girth(inhale) (cm)	83.55	3.32	83.67	3.74	85.52	3.99	2.71
st girth(exhale) (cm)	79.27	3.22	79.98	3.44	81.64	3.96	3.79*
of skinfold thickness:							
ceps (left)	0.4958	0.1367	0.5533	0.0735	0.5856	0.1017	6.54**
iceps (left)	0.7456	0.1116	0.8174	0.1132	0.8673	0.0854	11.50**
dices and Ratios:							
ight/height	0.3066	0.0281	0.3172	0.0226	0.3369	0.0270	10.86**
ight/height^2	1.95	0.16	2.04	0.15	2.12	0.17	10.31**
ight for height	82.21	6.93	85.13	6.46	89.45	7.13	9.28**
nderal index	43.19	1.31	42.75	1.46	42.22	1.20	4.25*
ormic index	0.5236	0.0137	0.5175	0.0189	0.5237	0.0119	2.00
est girth(exhale)/height	0.5058	0.0193	0.5104	0.0251	0.5167	0.0234	2.00
urface area	1.51	0.10	1.53	0.06	1.59	0.08	6.71**
rface area/weight	3.17	0.20	3.09	0.14	2.99	0.21	8.24**
dy fat	5.02	1.24	5.63	1.05	6.46	1.29	12.48**
tal upper arm area(TUA)	44.26	5.56	47.01	6.79	51.89	4.76	13.23***
er arm muscle area(UMA)	37.68	4.70	39.12	6.11	42.75	4.34	7.55**
per arm fat area(UFA)	6.72	1.96	7.80	2.31	9.13	2.04	10.66**
per fat index (AFA)	15.06	3.61	16.61	4.29	17.60	3.44	3.95*

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

Table 5.4.6. **Differences between two means (For adult males of MA, NA and WA).**

Anthropometric variables	LIG vs MIG	LIG vs HIG	MIG vs HIG
	Difference ± S.E.	Difference ± S.E.	Difference ± S.E.
<u>Absolute measurements</u>:			
Weight	1.62±0.91	5.10±1.22***	3.48±1.06**
Height	0.31±0.99	1.53±1.05	1.22±0.93
Sitting height	0.74±0.60	1.07±0.68	1.81±0.66*
Biacromial diameter	0.04±0.31	1.48±0.43***	1.44±0.44**
Bi-iliac diameter	0.17±0.20	0.54±0.30	0.37±0.32
Mid upper arm circum.	0.76±0.32*	1.97±0.31***	1.21±0.34***
Chest girth(inhale)	0.12±0.98	1.97±0.93*	1.85±0.93*
Chest girth(exhale)	0.71±0.67	2.37±0.92*	1.66±0.93
<u>Log of skinfold thickness:</u>			
Biceps	0.0575±0.0221*	0.0898±0.0282**	0.0323±0.0228
Triceps	0.0718±0.0225**	0.1217±0.0234***	0.0499±0.0233*
<u>Indices and Ratios</u>:			
Weight/height	0.0106±0.0051*	0.0303±0.0067***	0.0197±0.0063**
Weight/height^2	0.09±0.03**	0.17±0.04***	0.08±0.04*
Weight for height	2.92±1.34*	7.24±1.74***	4.32±1.69*
Ponderal index	0.44±0.28	0.97±0.30**	0.53±0.32
Cormic index	0.0061±0.0033	0.0001±0.0031	0.0062±0.0036**
Chest girth(exh.)/height	0.0046±0.0045	0.0109±0.0054*	0.0063±0.0059
Surface area	0.02±0.02	0.08±0.02***	0.06±0.02**
Surface area/weight	0.08±0.03*	0.18±0.05***	0.01±0.05
Body fat	0.61±0.23*	1.44±0.31***	0.83±0.30*
Total upper area	2.75±1.24*	7.63±1.24***	4.88±1.35***
Upper arm muscle area	1.44±1.09	5.07±1.10***	3.63±1.22**
Upper arm fat area	1.08±0.43*	2.41±0.49***	1.33±0.52*
Upper arm fat index	1.55±0.79	2.54±0.86**	0.99±0.91

* $P \leq 0.05$; ** $P \leq 0.005$; *** $P \leq 0.001$.

Note: Significant difference was determined as follows: Difference/S.E.(Chambers, 1958).

and log of skinfold thicknesses at triceps and biceps. With respect to ratios and indices, it is found that there are significant differences between the LIG and MIG with regard to weight/height, weight/height^2, surface area/weight ratio, body fat, upper arm area and upper arm fat area. On the other hand, the differences between the LIG and HIG are found to be highly significant in respect of many anthropometric variables, except in the case of height, sitting height, bi-iliac diameter and cormic index. As far as the comparison between the MIG and HIG is concerned, it is fouhd that the differences are not significant in respect of height, bi-iliac diameter, chest girth(inhale) and biceps skinfold thickness. With respect to ratios and indices, the differences between the MIG and HIG are not significant only in respect of ponderal index, chest girth(exhale)/height ratio, surface area/weight ratio and upper arm fat index.

Regarding the Lapalang males, Table 5.4.7 shows the means and standard deviations of anthropometric variables according to the three income groups. It is seen that the mean values of all anthropometric measurements, taken for the present study, are higher among the HIG than those among the LIG and HIG. The F-values also show that the differences among the three income groups with regard to body measurements are highly significant, except in the case of sitting height and bi-iliac diameter. A similar observation has been made in the case of anthropometric ratios and indices. With the exception of ponderal index and surface area, Table 5.4.7 shows that the mean values of all anthropometric ratios and indices are increasing with the increasing level of per capita monthly income. The analysis of variance also indicates that the income group differences in anthropometric ratios and indices are highly significant, except in the case of ponderal index, cormic index and ble 5.4.7. **Anthropometric variables for LA adult males by income groups**

nthropometric variables	LIG (N = 25)		MIG (N = 29)		HIG (N = 23)		F-value
	Mean age(years) = 37.42 ± 10.14		Mean age(years) = 38.02 ± 11.20		Mean age(years) = 37.79 ± 10.33		
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	
bsolute measurements:							
ight(kg)	48.60	5.37	51.90	4.03	53.48	4.42	6.80**
eight(cm)	156.90	5.33	159.85	4.44	159.12	4.04	2.76
tting height(cm)	82.10	2.99	83.04	2.26	83.06	3.17	1.40
acromial diameter(cm)	36.01	1.50	36.90	1.62	37.62	1.52	6.23**
-iliac diameter(cm)	27.02	0.83	27.41	1.20	27.63	1.22	1.88
d upper arm circum.(cm)	23.52	2.05	25.01	1.03	25.52	1.19	11.62**
nest girth(inhale) (cm)	83.56	3.36	84.62	2.27	86.22	3.39	4.55*
nest girth(exhale) (cm)	79.59	3.17	80.69	2.32	82.35	3.20	5.29**
og of skinfold thickness:							
iceps (left)	0.4944	0.1389	0.5614	0.0701	0.5745	0.1051	3.85*
riceps(left)	0.7758	0.0973	0.8233	0.0753	0.8641	0.0775	6.44**
ndices and Rarios:							
ight/height	0.3092	0.0276	0.3248	0.0248	0.3364	0.0244	6.43**
ight/height^2	1.97	0.15	2.04	0.17	2.11	0.15	4.68*
eight for height	82.79	6.50	85.39	7.52	89.11	6.33	4.92**
onderal index	43.06	1.06	42.91	1.57	42.28	1.06	2.41
ormic index	0.5235	0.0170	0.5204	0.0151	0.5220	0.0132	2.00
hest girth(exhale)/height	0.5085	0.0176	0.5062	0.0153	0.5177	0.0209	3.00*
urface area	1.52	0.10	1.58	0.07	1.60	0.08	6.41**
urface area/weight	3.14	0.15	3.09	0.18	3.00	0.14	4.29*
ody fat	5.38	1.15	5.88	0.87	6.43	1.11	6.28**
otal upper arm area(TUA)	44.34	7.84	49.86	4.09	51.91	4.88	10.81**
pper arm muscle area(UMA)	37.43	6.59	41.60	3.59	43.19	4.73	8.13**
pper arm fat area(UFA)	6.91	1.92	8.26	1.57	8.72	1.27	7.89**
pper arm fat index(AFA)	15.52	3.06	16.72	3.16	16.88	2.51	1.54

P<0.05; ** P<0.01.

Table 5.4.8. **Differences between two means (For LA adult males)**

Anthropometric variables	LIG vs MIG	LIG vs HIG	MIG vs HIG
	Difference ± S.E.	Difference ± S.E.	Difference ± S.E.
<u>Absolute measurements</u>:			
Weight	3.30±1.31*	4.88±1.41***	1.58±1.19
Height	2.95±1.35*	2.22±1.36	0.73±1.18
Sitting height	0.94±0.73	0.96±0.89	0.02±0.80
Biacromial diameter	0.89±0.42*	1.61±0.44***	0.72±0.44
Bi-iliac diameter	0.39±0.28	0.61±0.30*	0.22±0.34
Mid upper arm circum.	1.49±0.45**	2.00±0.48***	0.51±0.31
Chest girth(inhale)	1.06±0.79	2.66±0.97*	1.60±0.82
Chest girth(exhale)	1.10±0.77	2.76±0.92**	1.66±0.79*
<u>Log of skinfold thickness</u>:			
Biceps	0.0670±0.0307*	0.0801±0.0354*	0.0131±0.0255
Triceps	0.0475±0.0240	0.0883±0.0253***	0.0408±0.0214
<u>Indices and Ratios</u>:			
Weight/height	0.0156±0.0072*	0.0272±0.0075***	0.0116±0.0069
Weight/height^2	0.07±0.04	0.14±0.04***	0.07±0.04
Weight for height	2.60±1.91	6.32±1.85**	3.72±1.92
Ponderal index	0.15±0.56	0.78±0.31*	0.63±0.37
Cormic index	0.0031±0.0044	0.0015±0.0044	0.0016±0.0039
Chest girth(exh.)/height	0.0023±0.0045	0.0092±0.0056	0.0115±0.0052*
Surface area	0.06±0.02**	0.08±0.03*	0.02±0.02
Surface area/weight	0.05±0.04	-0.14±0.04***	0.09±0.04
Body fat	0.53±0.28	1.08±0.33**	0.55±0.28
Total upper arm area	5.52±1.74**	7.56±1.87***	2.05±1.27
Upper arm muscle area	4.17±1.48*	5.76±1.65***	1.59±1.19
Upper arm fat area	1.35±0.48*	1.81±0.47***	0.46±0.39
Upper arm fat index	1.20±0.85	1.36±0.80	0.16±0.80

* $P \leq 0.05$; ** $P \leq 0.005$; *** $P \leq 0.001$.

Note:-Significant difference was determined as follows: Difference/S.E.(Chambers, 1958).

upper arm fat index.

As far as the comparison between two groups is concerned, it is seen from Table 5.4.8 that the differences between the LIG and HIG are statistically significant in respect of many anthropometric traits, except in the case of height, sitting height, cormic index, chest(exhale)/height ratio and upper arm fat index. The differences between the LIG and MIG are not significant in respect of sitting height, bi-iliac diameter, chest girths(inhale and exhale) and log of skinfold thickness at triceps. With respect to ratios and indices, it is found that there are significant differences between the LIG and MIG with regard to weight/height, surface area, upper arm area, upper arm muscle area and upper arm fat area. Table 5.4.8 further shows that the differences between the MIG and HIG are not significant, except in the case of chest girth(exhale) and chest girth(exhale)/height ratio. So, it may be observed that among the LA adult males, there is hardly or very little difference in anthropometric traits between the MIG and HIG, but the differences are appreciable between the LIG and HIG as well as between the LIG and MIG.

In view of the above findings for both the two groups of villages in the present population, it may be inferred that the per capita income of house-households seems to have influenced, to a great extent, the variations in body dimensions of adult males.

Anthropometric Variables by Economic Condition (FEMALES)

Table 5.4.9 shows the means and standard deviations of the anthropometric variables by income groups for the adult females of three villages, i.e. MA, NA and WA. It is seen that the females belonging to the MIG are heavier ble 5.4.9. **Anthropometric variables for adult females by income groups(MA+NA+WA)**

thropometric variables	LIG (N = 47) Mean age(years) =34.26 ± 8.13		MIG (N = 48) Mean age(years) = 33. 54 ± 9.23		HIG (N = 33) Mean age(years) = 34.34 ± 8.25		F-value
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	
solute measurements:							
ight(kg)	42.74	3.65	47.27	4.17	46.10	3.72	16.79***
eight(cm)	146.83	2.60	147.52	5.69	146.90	3.35	1.21
tting height(cm)	76.27	1.68	77.15	3.04	77.65	2.48	3.12*
acromial diameter(cm)	32.73	1.30	32.60	1.22	32.71	1.30	0.13
-iliac diameter(cm)	26.26	0.70	26.31	0.73	26.32	0.54	0.09
d upper arm circum.(cm)	21.89	2.00	24.21	1.73	23.86	1.27	22.74***
nest girth(inhale) (cm)	78.00	2.37	78.92	2.45	78.88	3.36	1.27
nest girth(exhale) (cm)	74.32	3.29	75.29	2.39	75.53	3.41	1.87
og of skinfold thickness:							
iceps (left)	0.6105	0.1144	0.6749	0.0882	0.6669	0.0820	5.80**
riceps (left)	0.9050	0.1164	0.9945	0.0885	0.9612	0.1029	11.72***
ndices and Ratios:							
ight/height	0.2912	0.0248	0.3202	0.0207	0.3145	0.0774	18.17***
eight/height^2	1.98	0.18	2.17	0.14	2.13	0.21	15.33***
eight for height	88.11	7.69	96.36	6.00	94.67	8.78	15.42***
onderal index	42.14	1.37	40.83	1.09	41.30	1.78	10.33***
ormic index	0.5198	0.0120	0.5232	0.0171	0.5274	0.0177	3.00
hest girth(exhale)/height	0.5064	0.0256	0.5114	0.0296	0.5151	0.0236	1.00
urface area	1.44	0.06	1.51	0.09	1.49	0.05	11.92***
Surface area/weight	3.38	0.16	3.20	0.15	3.24	0.17	15.76***
Body fat	5.57	1.20	6.95	1.08	6.51	1.21	17.11***
otal upper arm area(TUA)	38.42	6.91	46.63	7.12	45.43	4.81	20.71***
pper arm muscle area(UMA)	29.79	5.17	35.70	7.07	34.91	3.96	14.11***
pper arm fat area(UFA)	8.63	2.66	10.69	2.87	10.52	2.49	7.95**
Upper arm fat index(AFA)	22.20	4.52	23.30	6.40	23.11	4.61	0.54

P< 0.05; ** P< 0.005; *** P< 0.001.

able 5.4.10. **Differences between two means (For adult females of MA, NA and WA)**

thropometric variables	LIG vs MIG	LIG vs HIG	MIG vs HIG
	Difference ± S.E.	Difference ± S.E.	Difference ± S.E.
solute measurements:			
ight	4.53±0.80***	3.36±0.84***	1.17±0.88
eight	0.70±0.90	0.07±0.70	0.62±1.01
tting height	0.88±0.50	1.38±0.50*	0.50±0.62
acromial diameter	0.13±0.26	0.02±0.30	0.11±0.29
-iliac diameter	0.05±0.15	0.06±0.14	0.01±0.14
d upper arm circum.	2.32±0.38***	1.97±0.37***	0.35±0.33
nest girth(inhale)	0.92±0.49	0.88±0.68	0.04±0.68
nest girth(exhale)	0.97±0.59	1.21±0.76	0.24±0.69
g of skinfold thickness:			
ceps	0.0644±0.0210**	0.0564±0.0220*	0.0080±0.0191
iceps	0.0895±0.0212***	0.0562±0.0247*	0.0333±0.0128*
ndices and Ratios:			
ight/height	0.0290±0.0047***	0.0233±0.0140	0.0057±0.0138
ight/height^2	0.19±0.03***	0.15±0.05**	0.04±0.04
ight for height	8.25±1.42***	6.56±1.90***	1.69±1.76
nderal index	1.31±0.25***	0.84±0.37*	0.47±0.35
ormic index	0.0034±0.0030	0.0076±0.0035*	0.0042±0.0039
nest girth(exh.)/height	0.0050±0.0057	0.0087±0.0375	0.0037±0.0059
urface area	0.07±0.02***	0.05±0.01***	0.02±0.02
urface area/weight	0.18±0.03***	0.14±0.04***	0.04±0.04
ody fat	1.38±0.23***	0.94±0.27***	0.44±0.26
otal upper arm area	8.21±1.44***	7.01±1.31***	1.20±1.33
pper arm muscle area	5.91±1.27***	5.12±1.02***	0.79±1.23
pper arm fat area	2.06±0.57***	1.89±0.58**	0.17±0.60
pper arm fat index	1.10±1.13	0.91±1.04	0.19±1.22

$P \leq 0.05$; ** $P \leq 0.005$; *** $P \leq 0.001$.

te:-Significant difference was determined as follows: Difference/S.E.(Chambers, 1958).

and taller than those in the LIG and HIG. Similarly, the mean values of mid upper arm circumference and skinfold thickness at triceps and biceps are higher in the MIG than those in the LIG and HIG. Nevertheless, it indicates that the female body dimensions are also associated with per capita income of households. However, the analysis of variance (Table 5.4.9) shows that the income group differences in anthropometric measurements are significant only in respect of weight, sitting height, mid upper arm circumference and log of skinfold thicknesses at biceps and triceps.

Table 5.4.9 further shows that the mean values of many ratios and indices in the MIG are higher than those in the LIG and HIG. With the exception of cormic index, the differences among the three income groups in respect of anthropometric ratios and indices are highly significant.

The differences between any two income groups in respect of anthropometric variables are shown in Table 5.4.10. It is found that the differences between the LIG and MIG are statistically significant in respect of weight, mid upper arm circumference and log of skinfold thickness at biceps and triceps. With respect to ratios and indices, the differences between the LIG and MIG are generally significant, except in the case of cormic index, chest girth(exhale)/height ratio and upper arm fat index.

As regards the comparison between the LIG and HIG, it is found that there are significant differences between them with regard to weight, sitting height, mid upper arm circumference and log of skinfold thickness at biceps and triceps. The differences between these two income groups are also significant in respect of many ratios and indices, except in the case of able 5.4.11. **Anthropometric variables for LA adult females by income groups**

	LIG (N = 25)		MIG (N = 25)		HIG (N = 15)		F-value
	Mean age(years) = 35.42 ± 7.96		Mean age(years) = 36.92 ± 8.35		Mean age(years) = 34.76 ± 9.30		
	X̄	SD	X̄	SD	X̄	SD	
bsolute measurements:							
ight(kg)	42.96	3.57	47.80	3.66	47.53	4.59	11.08***
eight(cm)	146.76	2.28	149.36	6.04	148.13	3.59	2.13
itting height(cm)	76.03	1.55	77.90	3.39	77.17	2.21	3.27*
iacromial diameter(cm)	32.83	1.05	33.40	1.41	33.04	1.13	2.56
i-iliac diameter(cm)	26.56	0.71	26.31	0.78	26.53	0.74	0.76
d upper arm circum.(cm)	21.70	1.77	23.34	1.69	24.01	1.55	9.86**
hest girth(inhale) (cm)	77.92	3.45	78.02	3.23	78.73	3.68	0.28
hest girth(exhale) (cm)	74.25	3.30	74.52	3.13	76.67	3.79	2.58
og of skinfold thickness:							
iceps (left)	0.5858	0.0974	0.6702	0.1146	0.6567	0.0714	4.74*
riceps (left)	0.8980	0.1263	0.9600	0.1228	0.9612	0.1034	1.99
ndices and Ratios:							
ight/height	0.2926	0.0229	0.3199	0.0187	0.3205	0.0323	9.67**
ight/height^2	1.99	0.15	2.14	0.14	2.17	0.25	5.59*
eight for height	88.53	6.84	95.72	5.86	96.69	10.80	7.27**
onderal index	41.92	1.11	41.18	1.28	41.00	1.73	2.79
ormic index	0.5181	0.0128	0.5217	0.0136	0.5210	0.0110	0.50
hest girth(exhale)/height	0.5062	0.0269	0.5001	0.0340	0.5071	0.0224	0.33
urface area	1.44	0.06	1.52	0.08	1.51	0.06	9.54**
urface area/weight	3.37	0.15	3.24	0.17	3.20	0.19	5.01*
ody fat	5.54	1.35	6.72	1.15	6.69	1.17	6.53**
otal upper arm area(TUA)	37.72	6.04	43.99	6.27	46.06	5.80	20.18***
pper arm muscle area(UMA)	29.24	4.45	33.64	5.89	35.52	5.48	7.42**
pper arm fat area(UFA)	8.48	2.81	10.45	2.51	10.54	2.35	4.40*
pper arm fat index (AFA)	22.19	5.26	23.97	5.43	23.10	5.40	0.66

$P < 0.05$; ** $P < 0.005$; *** $P < 0.001$.

able 5.4.12. **Differences between two means (For LA adult females)**

nthropometric variables	LIG vs MIG	LIG vs HIG	MIG vs HIG
	Difference ± S.E.	Difference ± S.E.	Difference ± S.E.
osolute measurements:			
ight	4.84±1.02***	4.57±1.38**	0.30±1.39
ight	2.60±1.29*	1.37±1.03	1.23±1.52
itting height	1.87±0.42***	1.14±0.65	0.73±0.87
acromial diameter	0.57±0.35	0.21±0.36	0.36±0.41
-iliac diameter	0.25±0.21	0.03±0.24	0.22±0.25
d upper arm circum.	1.64±0.49**	2.31±0.53*	0.67±0.52
hest girth(inhale)	0.10±0.95	0.81±1.17	0.71±1.15
hest girth(exhale)	0.27±0.91	2.42±1.18*	2.15±1.16
og of skinfold thickness:			
iceps	0.0844±0.0301*	0.0709±0.0268*	0.0135±0.0295
riceps	0.0620±0.0352	0.0632±0.0368	0.0012±0.0363
ndices and Ratios:			
ight/height	0.0273±0.0059***	0.0279±0.0046***	0.0006±0.0091
ight/height^2	0.05±0.04***	0.18±0.07*	0.03±0.07
ight for height	7.19±1.80***	8.16±3.11*	0.97±3.03
nderal index	0.74±0.34*	0.92±0.50	0.18±0.51
ormic index	0.0036±0.0037	0.0029±0.0038	0.0007±0.0039
hest girth(exh.)/height	0.0061±0.0087	0.0009±0.0079	0.0070±0.0089
urface area	0.08±0.02***	0.07±0.02**	0.01±0.02
urface area/weight	0.13±0.05*	0.17±0.06*	0.04±0.06
ody fat	1.18±0.35**	1.15±0.41*	0.03±0.38
otal upper arm area	6.27±1.74***	8.34±1.92***	2.07±1.95
pper arm muscle area	4.40±1.48**	6.28±1.67***	1.88±1.84
pper arm fat area	1.97±0.75*	2.06±0.83*	0.09±0.79
pper arm fat index	1.78±1.51	0.91±1.74	0.87±1.77

P≤0.05; ** P≤0.005; *** P≤0.001.

ote:-Significant difference was determined as follows: Difference/S.E.(Chambers, 1958).

weight/height, chest girth(exhale)/height and upper arm fat index. As far as the comparison between the MIG and HIG is concrned, it is found that there is not much significant difference, except in the case of triceps skinfold thickness, which is higher in the MIG.

With regard to Lapalang(LA) adult females, Table 5.4.11 shows the statistical constants of anthropometric variables according to income groups. It is found that the adult females in the MIG are heavier and taller than those in the LIG and HIG. The mean values of bi-iliac diameter, mid upper arm circumference, chest girths (inhale and exhale) and log of skinfold thickness at triceps are higher in the HIG than in the LIG and MIG. The F-values indicate that the differences among the three income groups with regard to body dimensions are significant in respect of sitting height, mid upper arm circumference and log of biceps skinfold thickness.

It is also seen from Table 5.4.11 that with the exception of Ponderal index and surface/weight ratio, the mean values of anthropometric ratios and indices are lower in the LIG than those in the MIG and HIG. The analysis of variance shows that the differences among the three income groups are not significant in respect of ponderal index, cormic index, chest girth(exhale)/height ratio and upper arm fat index.

Table 5.4.12 shows the differences between any two income groups with regard to anthropometric traits. It is found that the adult females in the MIG differ significantly from those in the LIG in the case of weight, height, sitting height, mid upper arm circumference and log of biceps skinfold thickness. With respect to ratios and indices, the differences between these two income groups are not statistically significant only in respect of cormic index, chest girth(exhale)/height ratio and upper arm fat index. Between the LIG and HIG, it is found that there are significant differences in respect of weight, mid upper arm circumference, chest girth(exhale) and log of biceps skinfold thickness. With respect to ratios and indices, the differences between the LIG and HIG are not statistically significant only in respect of ponderal index, cormic index, chest girth(exhale)/height ratio and upper arm fat index, whereas between the MIG and HIG, it is seen that there are no significant differences in respect of anthropometric variables (Table 5.4.12).

As far as the present findings are concerned, it is all through observed that the adult body dimensions are very much influenced by economic condition. It is also found that there are significant differences between villages with regard to some anthropometric traits. These variations in adult body dimensions will also be discussed in the next chapter.

5.5. PHYSICAL GROWTH

In this section, we shall deal with physical growth and development of the War Khasi children. Anthropometric data, collected from five villages are pooled together. No attempt is made to show the differences between villages and/or religious groups as the sample size for the present study is not adequate enough. However, an attempt will be made to present our findings according to sex, age and economic condition.

Anthropometric Measurements for Boys and Girls

Anthropometric data, collected from a cross-sectional sample of the War Khasi boys and girls, are shown in Tables 5.5.1 to 5.5.10 as well as in Figures 5.5.1 to 5.5.20.

Weight

The means and standard deviations of weight for boys and girls are shown in Table 5.5.1. The means are plotted against age in Figure 5.5.1. It is seen from the Figure that the boys are slightly heavier than the girls at all ages until about 10 years of age. The girls are heavier than the boys from 11 to 12 years of age, then they are surpassed by the boys from 13 to 15 years. So, it indicates that adolescent growth spurt occurs between 11 and 12 years in girls, and between 13 and 14 years in boys.

The velocity curve (Figure 5.5.2), which shows the absolute growth from one age group to another, indicates that the girls grow faster than the boys from 3 to 5 years of age. But boys grow faster than girls from 6 to 8 years of age, then they are surpassed by the girls from 9 to 12 years. The curve reaches its peak point at the age between 11 and 12 years among the girls

Table 5.5.1. Statistical constants for weight(kg) of boys and girls

Age in years (Mid-pt)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	12.91	1.64	-	20	12.21	1.79	-
4	22	13.86	2.10	0.95	20	13.25	2.07	1.04
5	23	15.89	2.21	2.03	19	15.42	2.02	2.17
6	20	17.83	2.48	1.94	22	17.00	3.13	1.58
7	20	19.69	3.18	1.86	23	18.82	3.18	1.82
8	22	21.25	5.25	1.56	20	20.27	3.29	1.45
9	20	23.48	4.15	2.23	22	22.65	4.28	2.38
10	21	25.40	4.16	1.92	20	24.74	5.15	2.09
11	23	27.71	3.78	2.31	24	27.98	5.35	3.24
12	18	30.36	5.33	2.65	16	31.58	4.25	3.60
13	15	33.67	5.54	3.31	15	33.54	5.20	1.96
14	16	37.26	6.48	4.00	14	35.38	4.33	1.84
15	19	40.49	6.73	3.23	15	37.22	5.62	1.84

and between 13 and 14 years among the boys, when weight increases by 4.00kg and 3.60 kg for the boys and girls, respectively. It is also observed that the velocity tends to decline after 12 years of age for girls, and 14 years of age for tboys.

Height

Table 5.5.2 shows the statistical constants for the height of boys and girls. It is found that there is a continuous increment in height from

FIG.5.5.1. GROWTH CURVE (WEIGHT)

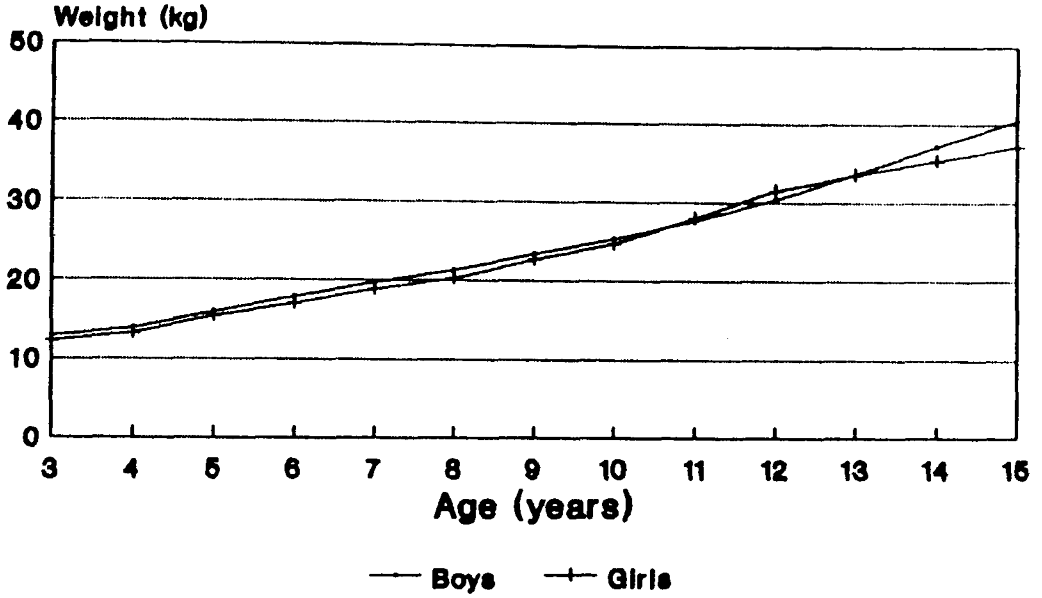
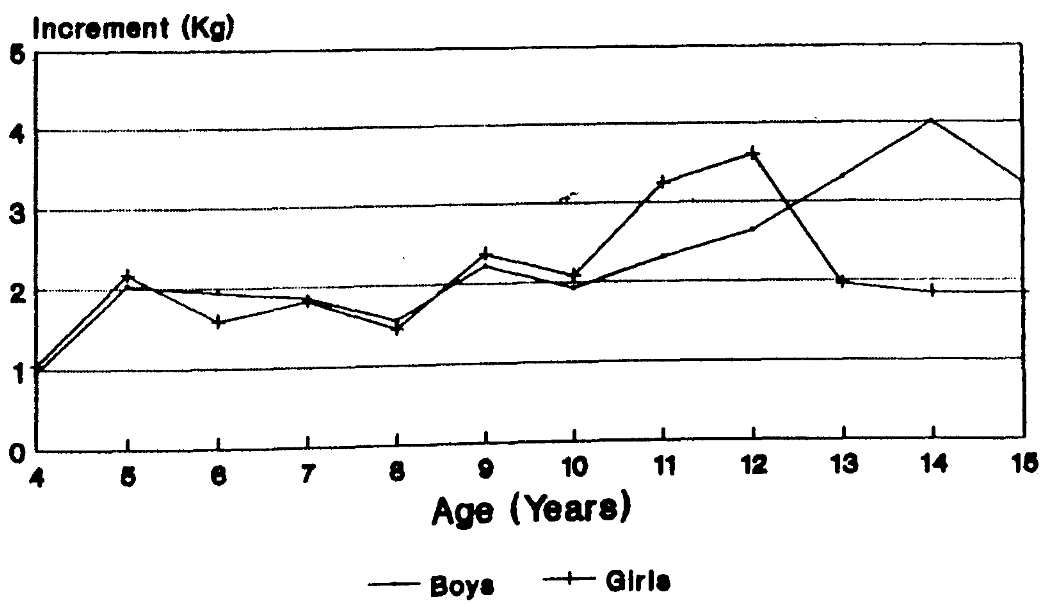


FIG.5.5.2. VELOCITY CURVE (WEIGHT)



3 to 15 years of age for both boys and girls. The mean values are also plotted against age in Figure 5.5.3. It is found that the boys are taller than the girls at all ages, except at 11 and 12 years of age, when the girls are taller than the boys.

Table 5.5.2. Statistical constants for height(cm) of boys and girls

Age in years	Boys				Girls			
(Mid-point)	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	90.68	4.80	-	20	90.20	4.38	-
4	22	96.72	5.69	6.04	20	96.19	4.61	5.99
5	23	102.78	5.75	6.06	19	102.12	5.33	5.93
6	20	107.98	6.63	5.20	22	107.24	5.53	5.12
7	20	113.86	6.58	5.88	23	111.23	6.08	3.99
8	22	118.96	5.84	5.10	20	116.02	6.40	4.79
9	20	124.20	6.28	5.24	22	121.27	6.44	5.25
10	21	127.52	6.37	3.32	20	127.15	5.80	5.88
11	23	132.44	6.63	4.92	24	133.17	5.20	6.02
12	18	137.75	7.12	5.31	16	139.80	6.39	6.63
13	15	142.85	7.24	5.10	15	142.36	7.39	2.56
14	16	149.87	6.28	7.02	14	143.42	5.36	1.06
15	19	153.11	6.40	3.24	15	144.38	5.42	0.96

The difference between mean values of the two succeeding age groups is plotted against age in Figure 5.5.4. The Figure shows that the boys grow faster than the girls from 3 to 8 years. It can also be noticed that the growth velocities are higher in girls than in boys from 9 to 12 years of age. The girls have gained the maximum growth spurt of 6.63 cm during their adolescent period, i.e. between 11 and 12 years, whereas the highest

FIG.5.5.3. GROWTH CURVE
(HEIGHT)

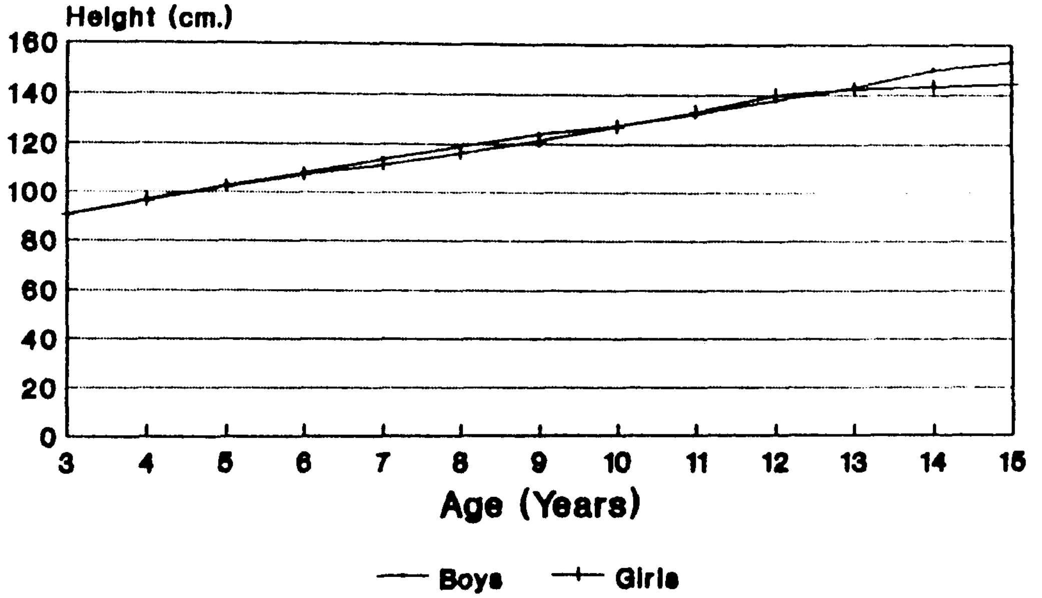
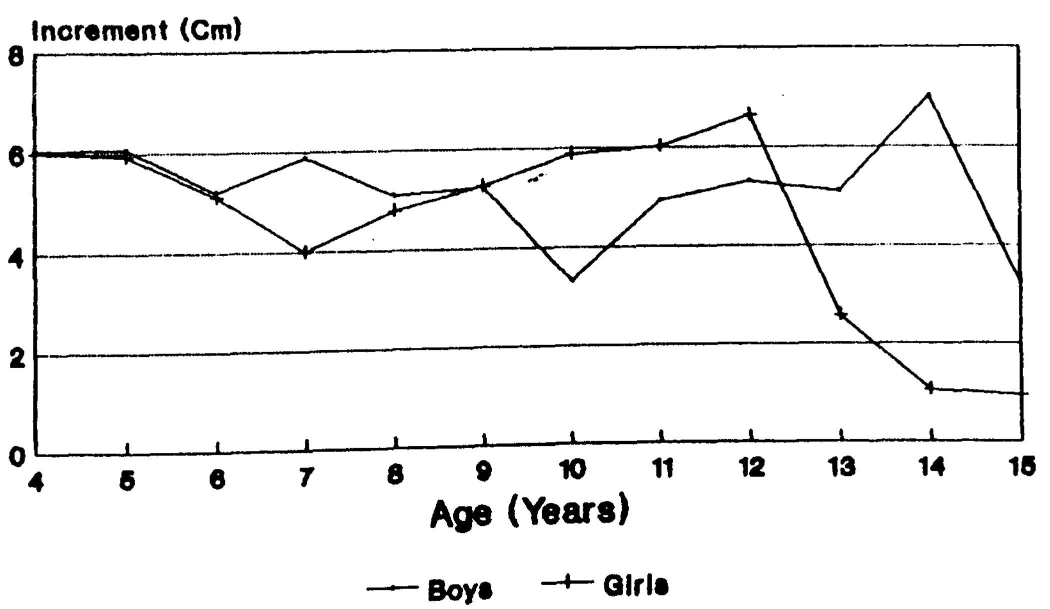


FIG.5.5.4. VELOCITY CURVE
(HEIGHT)



gain of 7.02 cm in boys takes place between 13 and 14 years of age.

Sitting height

The statistical constants for sitting height of boys and girls are shown in Table 5.5.3. The means are plotted against age in Figure 5.5.5. As in the case of stature and weight, the growth curve (Figure 5.5.5) shows that the boys have higher mean values of sitting height at all ages until adolescence, when the girls become taller than the boys.

Table 5.5.3. **Statistical constants for sitting height(cm) of boys and girls**

Age in years (Mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean +	SD	Absolute growth
3	25	52.94	2.40	-	20	51.92	2.47	-
4	22	54.96	2.89	2.02	20	54.28	2.86	2.36
5	23	56.96	2.15	2.00	19	56.24	3.25	1.96
6	20	58.75	2.92	1.79	22	57.78	3.48	1.90
7	20	60.60	3.42	1.85	23	59.36	4.02	1.58
8	22	63.08	3.46	2.48	20	61.60	2.48	2.24
9	20	65.09	3.44	2.01	22	63.47	3.14	1.87
10	21	66.60	4.16	1.51	20	65.88	3.63	2.41
11	23	68.28	4.18	1.68	24	68.84	4.03	2.96
12	18	70.62	4.28	2.34	16	72.09	4.26	3.25
13	15	73.55	3.95	2.93	15	73.24	3.13	1.15
14	16	77.26	4.12	3.71	14	74.27	3.83	1.03
15	19	78.96	4.10	1.70	15	74.98	4.24	0.70

Figure 5.5.6 shows the difference between mean values of the two succeeding age groups for boys and girls. It can be noticed that the

FIG.5.5.5. GROWTH CURVE
(SITTING HEIGHT)

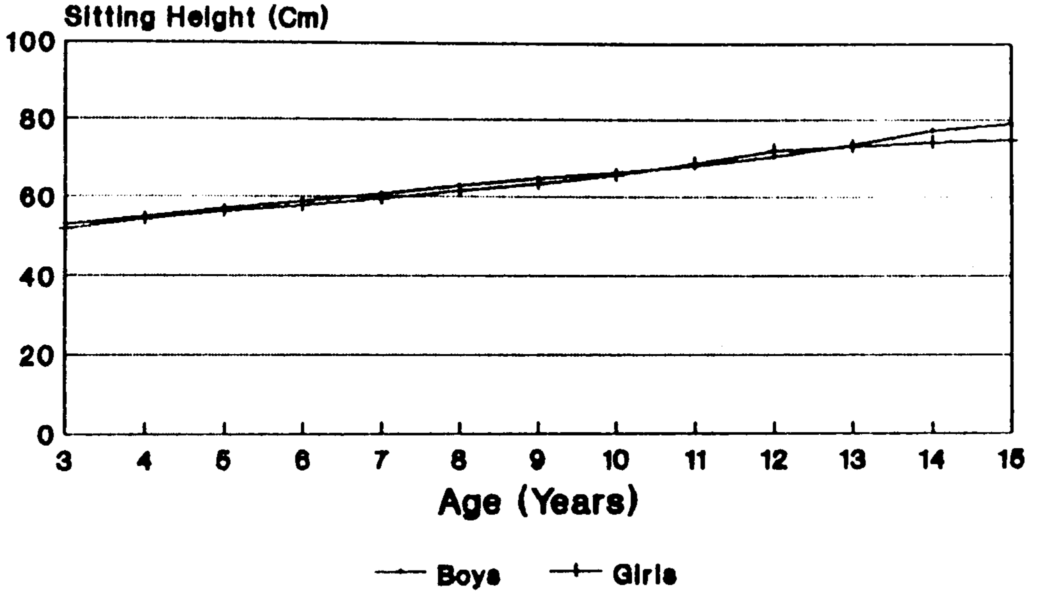
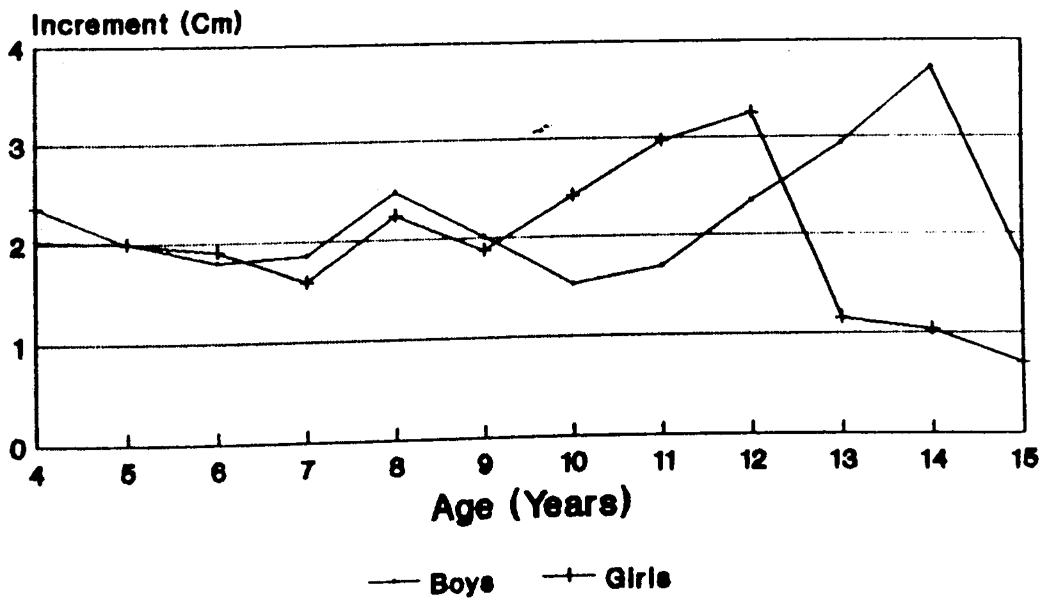


FIG.5.5.6. VELOCITY CURVE
(SITTING HEIGHT)



growth in sitting height is higher in girls than that in boys from 3 to 4 years as well as from 5 to 6 years of age. Thereafter, the growth velocities are higher in boys than in girls at all ages, except during adolescent period when the girls grow faster than the boys. The girls begin their adolescent growth spurt at the age of 10 and gain the maximum growth velocity of 3.25 cm at 12 years of age. Among the boys, the peak velocity of 3.17 cm is found to have occured at 14 years of age.

Table 5.5.4. Statistical constants for biacromial diameter(cm) of boys and girls

Age in years (Mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	20.44	0.87	-	20	20.02	0.65	-
4	22	21.74	0.92	1.30	20	21.34	0.87	1.32
5	23	22.72	1.03	1.02	19	22.10	1.06	0.76
6	20	23.83	1.24	1.11	22	23.06	1.27	0.96
7	20	24.69	1.23	0.86	23	23.98	1.43	0.92
8	22	25.27	1.28	0.58	20	24.82	1.44	0.84
9	20	25.92	1.30	0.65	22	25.57	1.53	0.75
10	21	26.44	1.25	0.52	20	26.59	1.74	1.02
11	23	27.48	1.38	1.04	24	27.72	1.62	1.13
12	18	29.10	1.40	1.62	16	29.34	1.68	1.62
13	15	30.25	1.47	1.15	15	30.34	1.50	1.00
14	16	32.80	1.33	2.55	14	31.47	1.23	1.13
15	19	33.96	1.54	1.13	15	32.35	1.44	0.88

FIG.5.5.7. GROWTH CURVE
(BIACROMIAL DIAMETER)

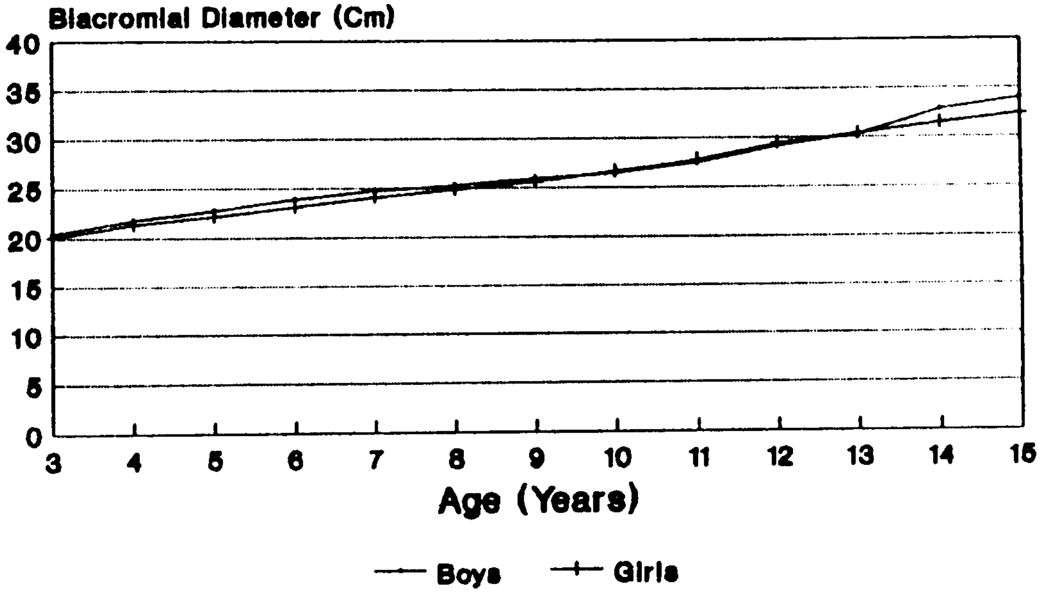
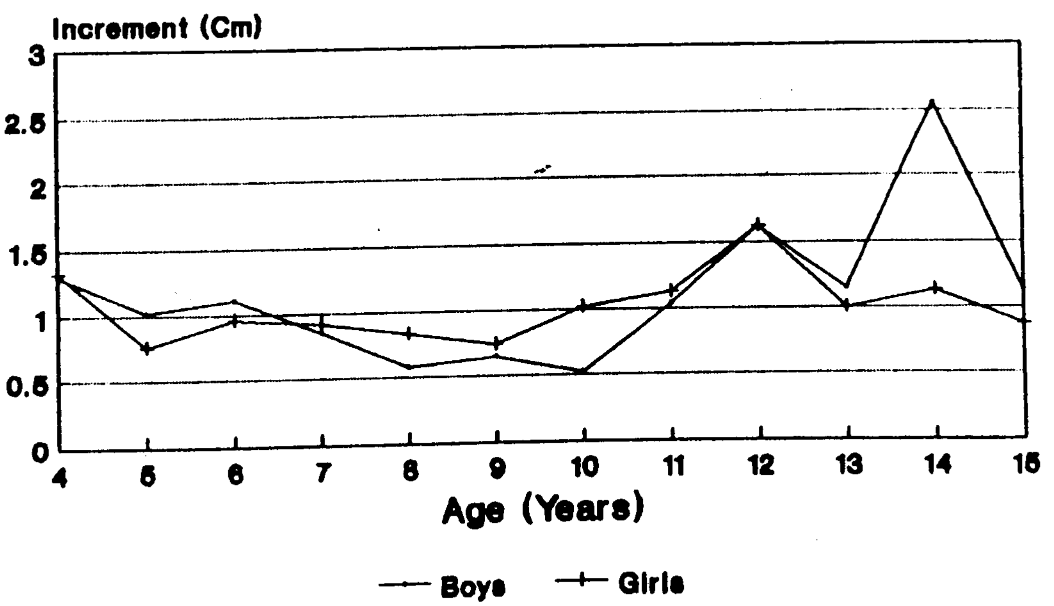


FIG.5.5.8. VELOCITY CURVE
(BIACROMIAL DIAMETER)



Biacromial diameter

Table 5.5.4 shows the statistical constants for biacromial diameter of boys and girls. Figure 5.5.7 shows the typical growth curves plotted according to mean values of biacromial diameter for both sexes. It is seen from the Figure that there is a gradual rise of the curves from 3 to 6 years for both boys and girls. Thereafter, it remains steady till the age of 9 years for girls, and 10 years for boys. Figure 5.5.7 further shows that the girls have higher mean values than the boys from 11 to 13 years, then they are surpassed again by the boys from 13 to 15 years of age.

The velocity curve for biacromial diameter (Figure 5.5.8) shows that the girls have gained their maximum growth spurt at the age of 12, whereas the peak velocity among the boys takes places between 13 and 14 years of age.

Bi-iliac diameter

The statistical constants for bi-iliac diameter of boys and girls are presented in Table 5.5.5. The mean values are plotted against age in Figure 5.5.9. It can be noticed from the Figure that the growth curve rises gradually from 3 to 15 years for both boys and girls. The boys have higher mean values than the girls from 3 to 10 years, whereas the higher mean values are found among the girls from the age of 11 to 13 years. Thereafter, the boys are more advanced till the terminal age of 15 years.

Among the girls, the maximum rate of increment in bi-iliac diameter occurs at 12 years of age as shown in Figure 5.5.10. Among the boys, the maximum growth spurt takes place at the age of 14 years. The velocity tends to slow down after 12 years for girls, and 14 years for boys.

ble 5.5.5. **Statistical constants for bi-iliac diameter(cm) of boys and girls.**

Age in years (mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	14.92	0.92	-	20	14.38	0.94	-
4	22	15.35	0.78	0.43	20	14.97	0.98	0.59
5	23	16.27	0.84	0.92	19	15.84	1.13	0.87
6	20	16.90	0.97	0.63	22	16.39	1.20	0.55
7	20	17.58	1.20	0.68	23	16.85	0.95	0.46
8	22	18.46	0.76	0.88	20	17.39	1.14	0.54
9	20	19.20	0.95	0.74	22	18.28	1.26	0.89
10	21	19.88	1.27	0.68	20	19.32	1.09	1.04
11	23	20.29	1.36	0.41	24	20.47	1.74	1.15
12	18	21.37	1.48	1.08	16	22.19	1.88	1.72
13	15	22.46	0.98	1.09	15	22.53	1.37	0.34
14	16	23.97	1.33	1.51	14	23.04	1.53	0.51
15	19	24.62	1.35	0.65	15	23.48	1.68	0.44

Head circumference

Table 5.5.6 shows the statistical constants for head circumference boys and girls. The means are plotted against age in Figure 5.5.11. It seen that the growth curve rises gradually and steadily with the advancing for both boys and girls. From 11 to 13 years of age, the girls have her mean values than the boys. Thereafter, they are surpassed by the s till the terminal age of 15 years.

The growth curve velocity for head circumference of boys and girls plotted in Figure 5.5.12. The maximum growth velocity in girls takes ace at 12 years of age, whereas in boys it occurs at the age of 14 years.

Table 5.5.6. **Statistical constants for head circumference(cm) of boys and girls**

Age in years (Mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	48.16	1.39	-	20	47.27	2.36	-
4	22	48.63	1.92	0.47	20	47.98	2.75	0.71
5	23	48.97	2.02	0.34	19	48.40	1.78	0.42
6	20	49.37	2.05	0.40	22	48.68	1.88	0.28
7	20	49.89	3.12	0.52	23	49.08	2.33	0.40
8	22	50.13	1.39	0.24	20	49.68	3.03	0.60
9	20	50.71	1.74	0.58	22	50.41	1.74	0.73
10	21	51.16	1.84	0.45	20	50.86	1.79	0.45
11	23	51.62	1.92	0.46	24	51.7	1.93	0.92
12	18	51.96	2.25	0.34	16	52.88	2.11	1.10
13	15	52.94	2.10	0.98	15	53.27	2.35	0.39
14	16	54.16	2.05	1.22	14	53.64	1.72	0.37
15	19	54.57	3.10	0.41	15	54.00	2.84	0.36

Table 5.5.7. **Statistical constants for mid upper arm circumference(cm) of boys and girls**

Age in years (Mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	14.54	1.35	-	20	13.80	0.76	-
4	22	15.20	1.48	0.66	20	14.75	0.98	0.95
5	23	15.84	1.75	0.64	19	15.28	1.36	0.53
6	20	16.10	2.03	0.26	22	15.63	1.45	0.35
7	20	16.44	2.11	0.34	23	16.50	1.66	0.87
8	22	16.86	1.63	0.42	20	16.97	1.93	0.47
9	20	17.38	1.74	0.52	22	17.83	2.48	0.86
10	21	17.97	1.80	0.59	20	18.23	2.20	0.40
11	23	18.67	2.15	0.70	24	19.05	1.64	0.82
12	18	19.28	2.24	0.61	16	20.25	1.78	1.20
13	15	20.29	2.11	1.01	15	20.89	2.42	0.64
14	16	21.52	2.28	1.23	14	21.16	2.33	0.27
15	19	22.14	2.62	0.62	19	21.69	2.48	0.53

FIG.5.5.9. GROWTH CURVE
(BI-ILIAC DIAMETER)

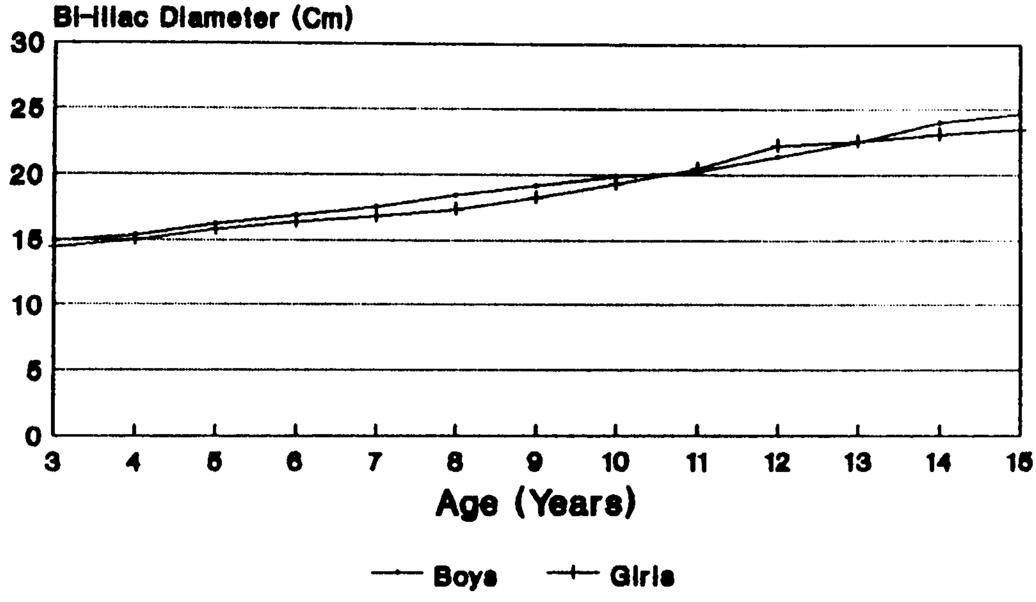


FIG.5.5.10. VELOCITY CURVE
(BI-ILIAC DIAMETER)

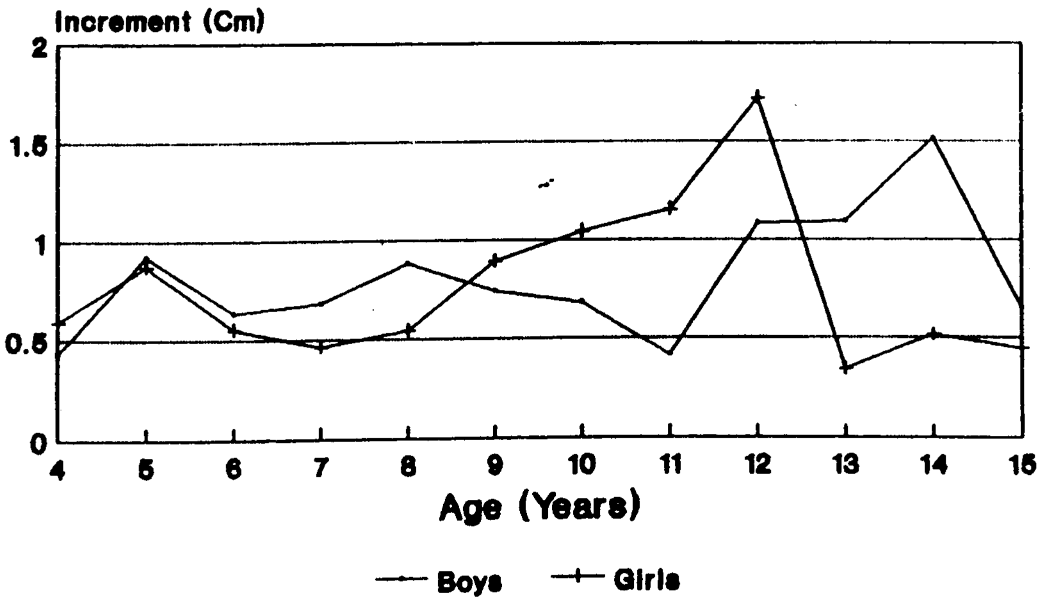


FIG.5.5.11. GROWTH CURVE (HEAD CIRCUMFERENCE)

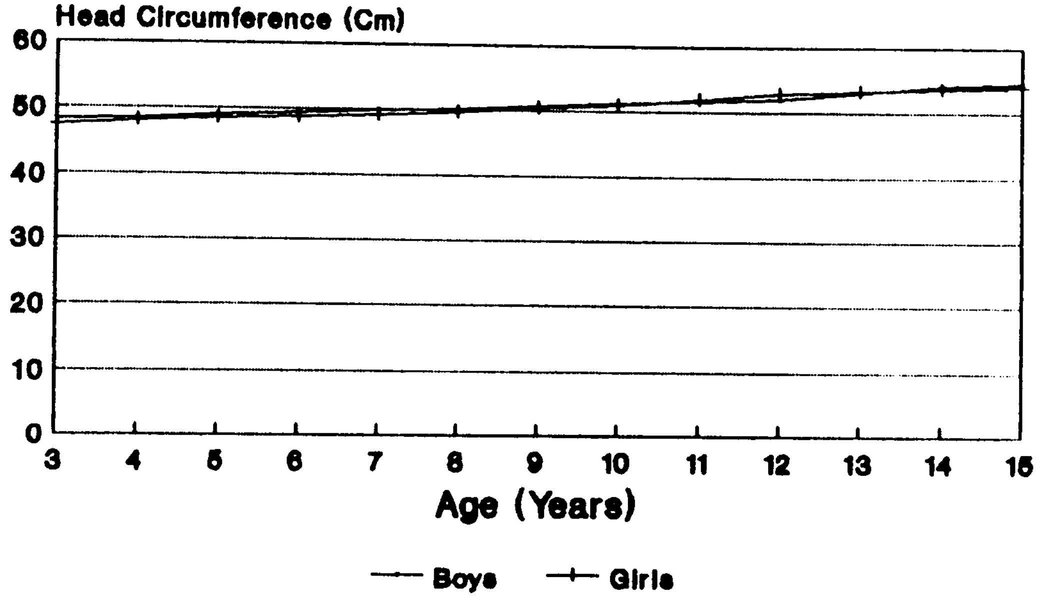


FIG.5.5.12. VELOCITY CURVE (HEAD CIRCUMFERENCE)

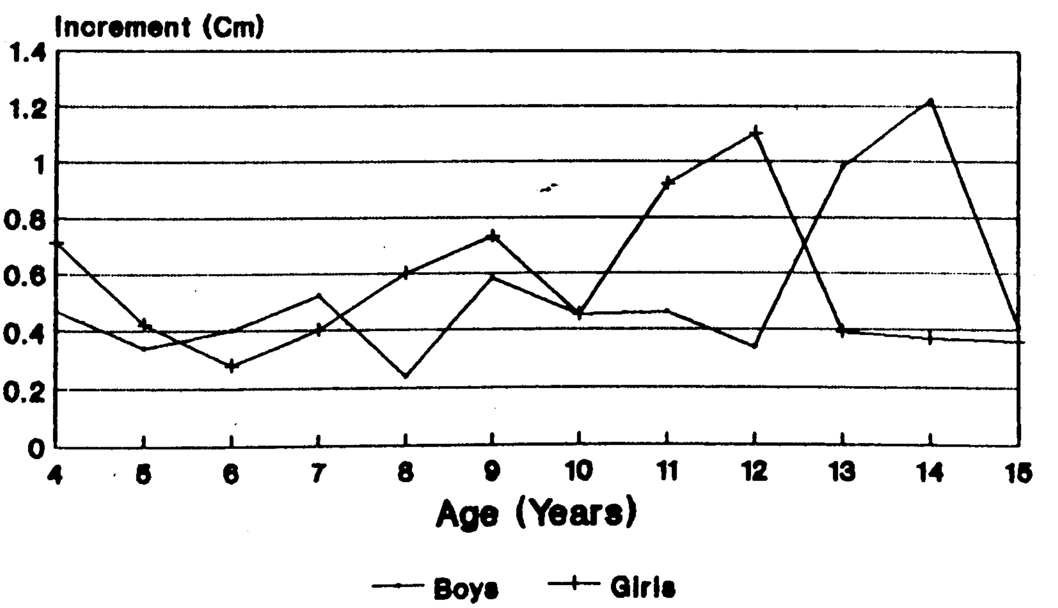


FIG.5.5.13. GROWTH CURVE
(MID UPPER ARM CIRCUMFERENCE)

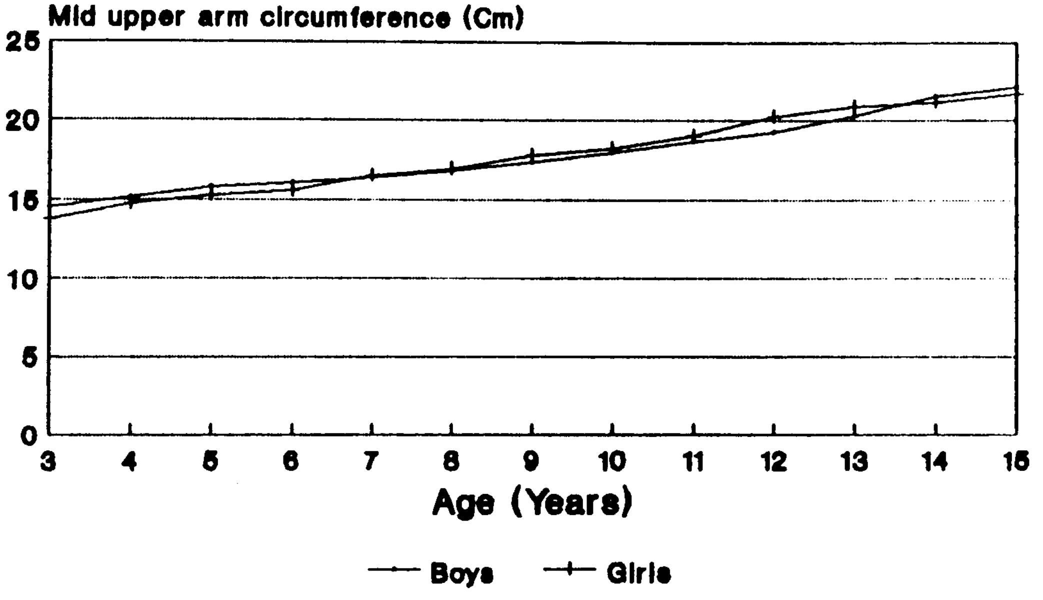
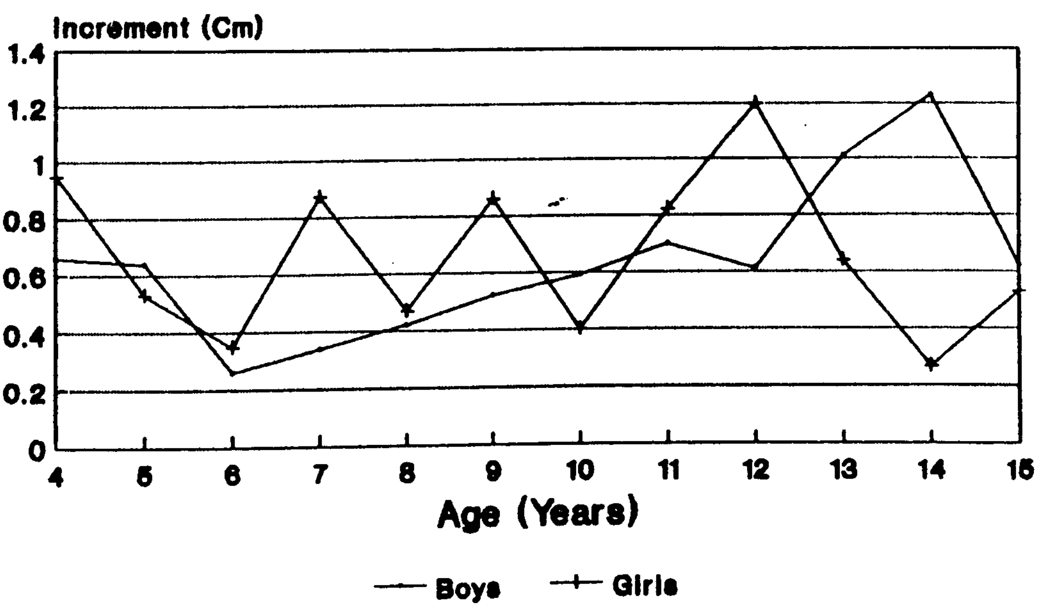


FIG.5.5.14. VELOCITY CURVE
(MID UPPER ARM CIRCUMFERENCE)



Mid upper arm circumference

The statistical constants for mid upper arm circumference of boys and girls are presented in Table 5.5.7, and the mean values are plotted against age in Figure 5.5.13. It is seen that the growth curve rises gradually and steadily from 3 to 15 years of age for both boys and girls. At 9 years, the growth curve is higher in girls than in boys and it continues to remain higher until 13 years of age. Thereafter, it is higher in boys till the terminal age group of 15 years.

The velocity curve (Figure 5.5.14) shows that the maximum gain in mid upper arm circumference occurs at the age of 12 in girls, and at the age of 14 in boys.

Chest girth

The statistical constants for chest girth are shown in Table 5.5.8 and the means are plotted against age in Figure 5.5.15 for both boys and girls. It is seen from the Figure that the growth curve rises gradually from 3 to 15 years of age for both sexes. From 11 to 12 years, the girls have higher mean values than the boys as their adolescent growth spurt begins two years earlier than the boys. However, the growth curve is higher in boys than in girls from 13 years onwards.

The differences between means of the two succeeding age groups are plotted against age in Figure 5.5.16. The maximum growth velocity of 2.85 cm in girls occurs at the age of 12 years and that (3,24 cm) in boys at 14 years of age.

Table 5.5.8. **Statistical constants for chest girth (cm) of boys and girls**

Age in years (Mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	49.30	3.08	-	20	48.29	2.91	-
4	22	50.46	3.28	1.16	20	49.66	3.23	1.37
5	23	52.70	4.37	2.24	19	50.79	4.27	1.13
6	20	54.80	3.48	2.10	22	53.34	5.87	2.55
7	20	56.58	5.36	1.78	23	54.99	5.11	1.65
8	22	58.94	4.28	2.36	20	57.87	3.17	2.88
9	20	60.36	4.39	1.42	22	59.75	4.14	1.88
10	21	61.75	5.12	1.39	20	60.83	3.36	1.08
11	23	63.08	5.29	1.33	24	63.26	4.45	2.43
12	18	65.44	5.32	2.36	16	66.11	4.84	2.85
13	15	68.32	4.22	2.88	15	68.25	4.36	2.14
14	16	71.56	4.94	3.24	14	70.14	5.20	1.89
15	19	73.98	5.25	2.42	15	71.37	5.26	1.23

Skinfold thickness at biceps(left)

Table 5.5.9 shows the statistical constants for the log of skinfold thickness(mm) at biceps. The means are plotted against age in Figure 5.5.17. The Figure shows that the boys lose a considerable amount of fat deposit at biceps from 4 to 5 years of age. From 6 to 11 years , they begin to putting on fat, but the loss of fat from 4 to 5 years could not be recouped even for the next four subsequent years. It is, however, seen that a large deposit of fat at biceps occurs at the age of 14 years.

FIG.5.5.15. GROWTH CURVE
(CHEST GIRTH)

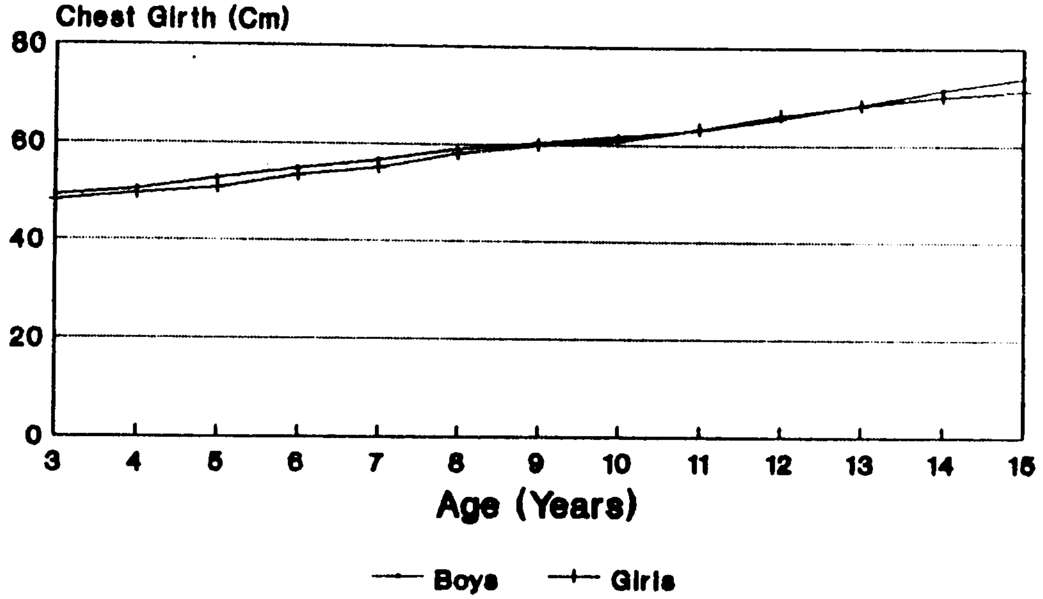
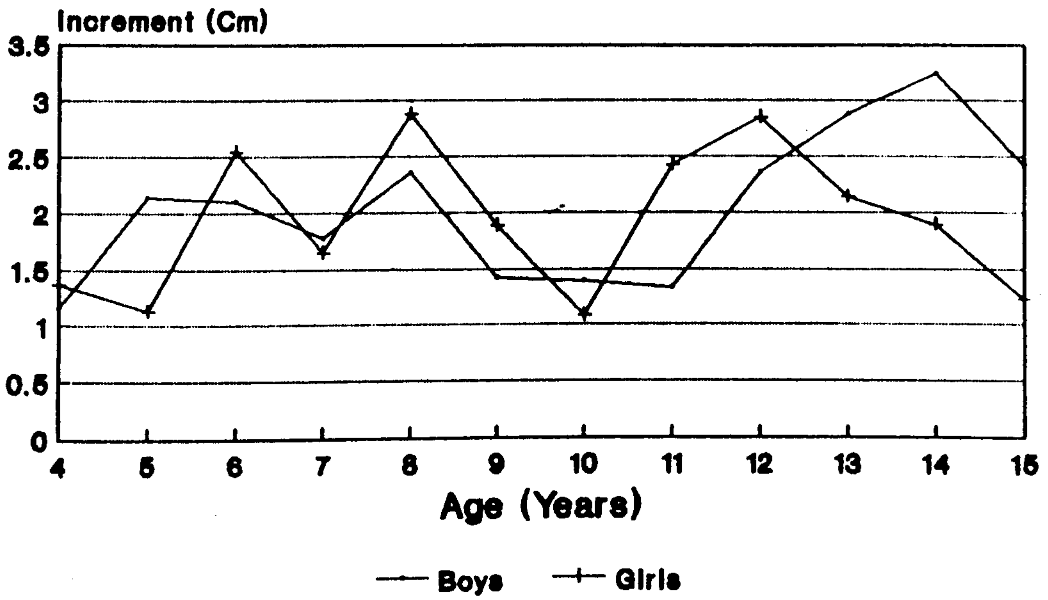


FIG.5.5.16. VELOCITY CURVE
(CHEST GIRTH)



Among the girls, Figure 5.5.17 shows that there is a loss of fat at 4 and 6 years of age. At 7 years of age, there is a gain in fat at biceps, but it is not equal to that amount lost at 4 and 6 years of age. A larger amount of fat accumulation is, however, gained from 8 to 9 years of age. At 10 years, there is a loss of fat, but it is compensated in the next subsequent year, and a large amount of fat deposit takes place at the age of 13 years.

Table 5.5.9. Statistical constants for log of biceps skinfold thickness(mm)

Age in years (Mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	0.7242	0.0899	-	20	0.7340	0.0645	-
4	22	0.6628	0.0934	- 0.0614	20	0.6721	0.0755	- 0.0619
5	23	0.6201	0.0719	- 0.0427	19	0.7076	0.0719	0.0355
6	20	0.6345	0.0969	0.0144	22	0.6776	0.0792	- 0.0300
7	20	0.6590	0.0682	0.0245	23	0.6955	0.0899	0.0179
8	22	0.6721	0.0864	0.0131	20	0.7243	0.0969	0.0288
9	20	0.7093	0.0934	0.0372	22	0.7582	0.0719	0.0339
10	21	0.7259	0.1106	0.0166	20	0.7482	0.0755	- 0.0100
11	23	0.7324	0.1106	0.0065	24	0.7731	0.0828	0.0249
12	18	0.6920	0.0934	- 0.0404	16	0.7760	0.0899	0.0029
13	15	0.7110	0.1004	0.0190	15	0.8122	0.1038	0.0362
14	16	0.7574	0.1139	0.0464	14	0.7903	0.1106	- 0.0219
15	19	0.7364	0.1038	- 0.0210	15	0.7980	0.0935	0.0077

The increment of fat per year is shown in Figure 5.5.18 for both boys and girls. Among the boys, there are two periods of fat accumulation

FIG.5.5.17. GROWTH CURVE
(LOG OF BICEPS SKINFOLD THICKNESS)

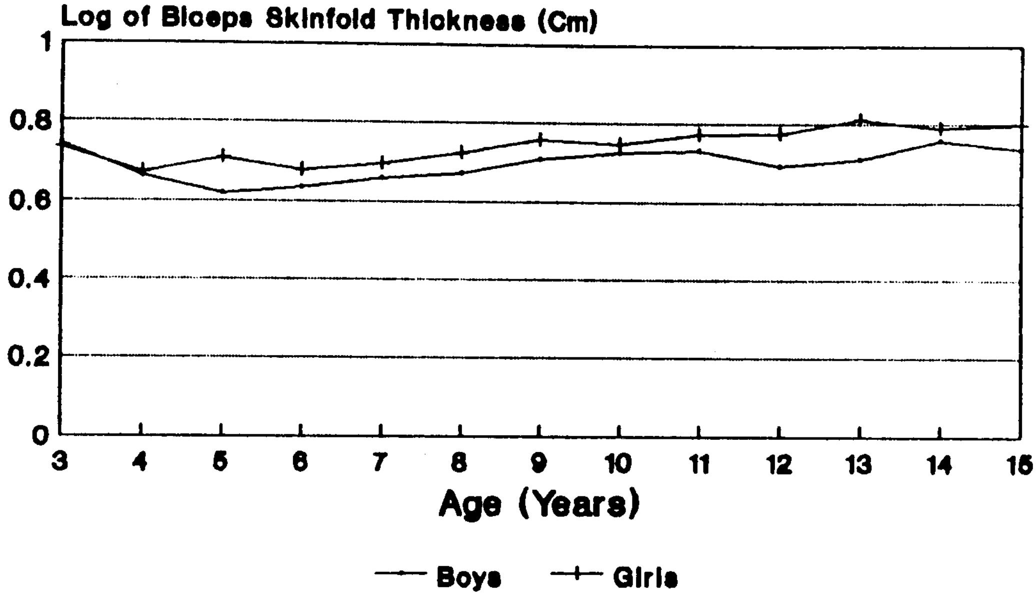
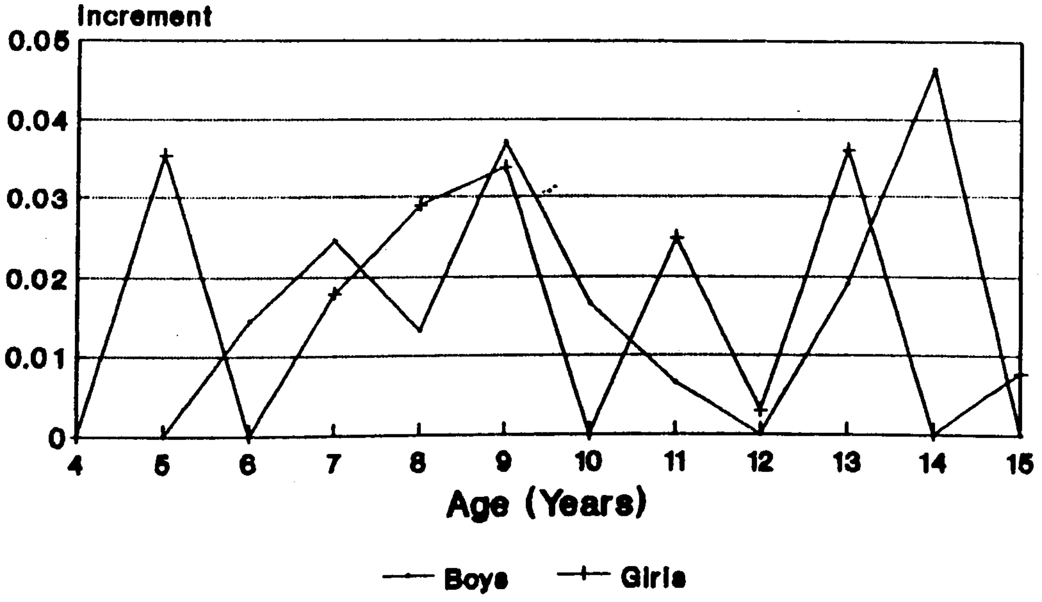


FIG.5.5.18. VELOCITY CURVE
(LOG OF BICEPS SKINFOLD THICKNESS)



at biceps, one at the age of 9 and the other at the age of 14 years. Similarly, there are two peak velocities of fat accumulation in girls, one at 9 years of age and the other at the age of 13 years.

Skinfold thickness at triceps(left)

Table 5.5.10 shows the statistical constants for the log of triceps skinfold thickness recorded in milimiters for both boys and girls. The mean values are plotted against age in Figure 5.5.19.

Table 5.5.10. **Statistical constants for log of triceps skinfold thickness(mm)**

Age in years (Mid-point)	Boys				Girls			
	N	Mean	SD	Absolute growth	N	Mean	SD	Absolute growth
3	25	0.8954	0.0719		20	0.9212	0.1139	
4	22	0.8727	0.0755	- 0.0227	20	0.8837	0.0607	- 0.0375
5	23	0.8351	0.0828	- 0.0376	19	0.9180	0.0720	0.0343
6	20	0.8573	0.0682	0.0222	22	0.8893	0.0792	- 0.0287
7	20	0.8669	0.0793	0.0096	23	0.8998	0.0899	0.0105
8	22	0.8820	0.0864	0.0151	20	0.9117	0.0934	0.0119
9	20	0.8976	0.0899	0.0156	22	0.9370	0.0645	0.0253
10	21	0.9175	0.1004	0.0199	20	0.9325	0.1003	- 0.0045
11	23	0.9238	0.0935	0.0063	24	0.9465	0.1072	0.0140
12	18	0.8887	0.0683	- 0.0357	16	0.9513	0.1038	0.0048
13	15	0.9074	0.0969	0.0187	15	0.9890	0.0969	0.0377
14	16	0.9410	0.1038	0.0336	14	0.9647	0.1106	- 0.0248
15	19	0.9269	0.1106	- 0.0141	15	0.9745	0.1173	0.0098

FIG.5.5.19. GROWTH CURVE
(LOG OF TRICEPS SKINFOLD THICKNESS

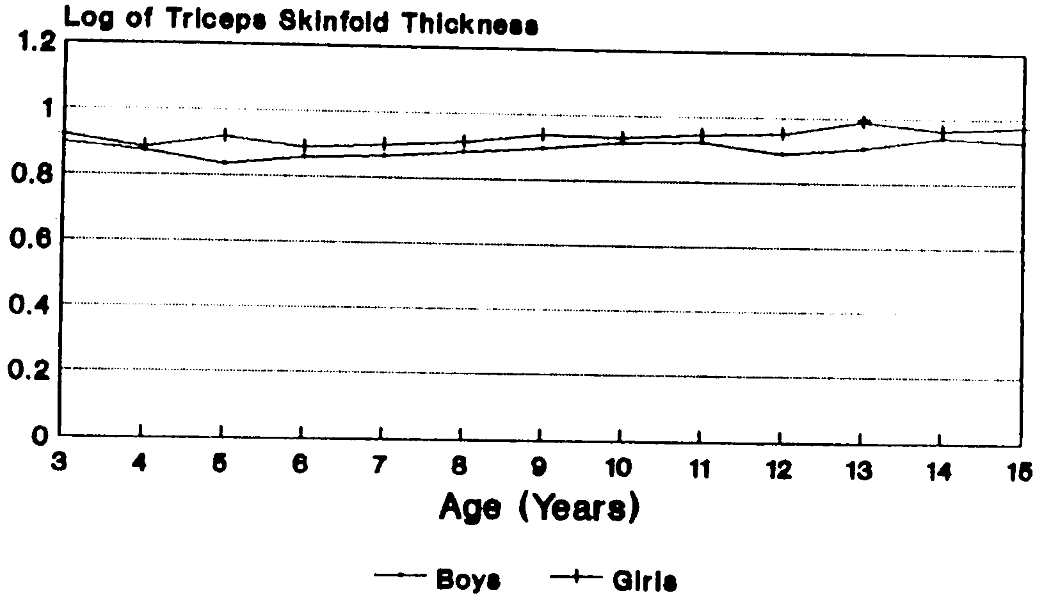
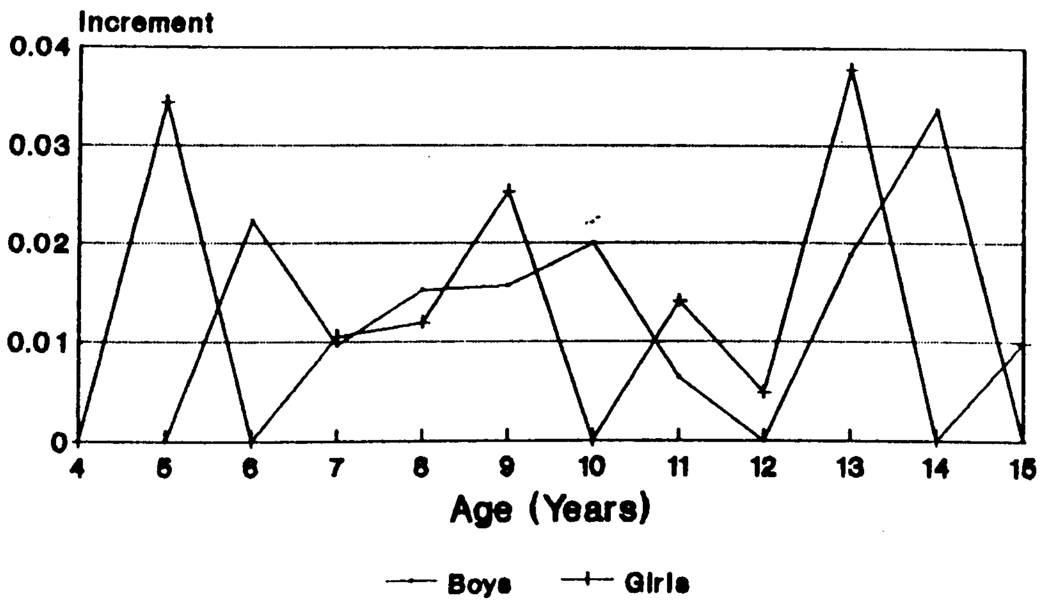


FIG.5.5.20. VELOCITY CURVE
(LOG OF TRICEPS SKINFOLD THICKNESS



It is seen from the Figure that the growth curve closely follows that of the biceps region for both sexes. Among the boys, a large deposit of fat at triceps is lost at 4 and 5 years. There is a rise in fat accumulation at the age of 6 years, and it continues to increase till the age of 11. It can also be seen from the Figure that the loss of fat at 4 and 5 years of age is recouped until about the age of 9 years. The loss in fat deposit is also found to occur at 12 years of age. Thereafter, it starts increasing and reaches its peak at the age of 14 years.

As far as the growth curve for the girls is concerned, it is seen from the Figure 5.5.19 that a considerable amount of fat is lost at the ages 4 and 6 years. In fact, the growth pattern of fat at triceps is also similar to that at biceps. The loss of fat at 4 and 6 years of age is not compensated till the age of 9 years. At 10 years of age, little amount of fat deposit is lost, and thereafter it starts increasing until about the age of 13 years, when a large quantity of fat deposit is seen at triceps region.

The pattern of increment in fat deposit is shown in Figure 5.5.20. It can be noticed that the maximum gain in fat among boys occurs at the age of 14 years, and in the case of girls at about 13 years of age.

Anthropometric Measurements by Economic Condition(BOYS)

The means and standard deviations of anthropometric measurements according to income groups, based on the per capita monthly income of the household, for the War Khasi boys are presented in Table 5.5.11 as well as in Figures

Table 5.5.11. Means and standard deviations of anthropometric measurements among the War Khasi boys by economic condition

Anthropometric traits		3 - 5 years			6 - 8 years			- 11 years		
		LIG(N=27)	MIG(N=23)	HIG(N=20)	LIG(N=2-)	MIG(N=22)	HIG(N=15)	LIG(N=22)	MIG(N=22)	HIG(N=20)
Absolute measurements:										
Weight (kg)	$\bar{X}$	13.29	14.45	15.30	18.96	19.40	20.56	24.85	25.67	26.52
	SD	2.32	2.34	2.49	3.03	3.12	4.96	3.16	4.03	4.58
Height (cm)	$\bar{X}$	94.57	96.20	97.41	111.94	112.90	115.96	127.84	128.75	129.22
	SD	5.12	6.34	7.02	5.48	5.72	6.64	5.48	5.16	6.37
Sitting height (cm)	$\bar{X}$	52.85	54.37	55.40	59.92	60.34	62.19	67.27	68.75	69.39
	SD	3.52	2.86	3.73	2.47	2.82	3.78	2.95	3.23	3.14
Biacromial diameter (cm)	$\bar{X}$	21.27	21.87	22.21	24.40	24.36	25.02	26.25	26.33	27.20
	SD	0.84	1.25	1.73	1.05	1.22	1.25	1.17	1.36	1.31
Bi-iliac diameter (cm)	$\bar{X}$	15.17	15.57	16.04	17.29	17.10	18.56	19.92	19.74	20.16
	SD	0.92	1.27	1.92	0.92	1.24	1.04	1.13	1.25	1.30
Mid Upper arm cir. (cm)(L)	$\bar{X}$	14.96	15.23	15.39	16.20	16.55	17.04	17.28	18.33	19.35
	SD	1.06	1.18	1.82	1.13	1.20	1.74	1.03	1.28	1.25
Head circumference (cm)	$\bar{X}$	48.47	48.86	49.23	49.92	50.56	50.80	51.03	51.50	52.07
	SD	2.72	2.88	2.46	1.75	2.13	2.37	1.57	2.45	2.31
Chest girth (cm)	$\bar{X}$	49.68	50.14	52.54	54.89	55.31	58.07	59.42	61.78	63.68
	SD	2.82	3.06	4.08	3.27	2.84	4.34	3.81	4.22	5.75
Log of skinfold thickness:										
Biceps (left)	$\bar{X}$	0.6425	0.6590	0.6972	0.6253	0.6580	0.6821	0.6964	0.7210	0.7490
	SD	0.0507	0.1004	0.1106	0.0509	0.0899	0.1139	0.1004	0.1072	0.1038
Triceps (left)	$\bar{X}$	0.8382	0.8675	0.8976	0.8549	0.8704	0.8814	0.8749	0.9106	0.9330
	SD	0.0755	0.0969	0.1104	0.1033	0.0934	0.1173	0.1072	0.1173	0.1072

5.5.21 to 5.5.42. It may be noted that in the present analysis, we have taken into consideration three income groups, i.e. 3 - 5 years, 6 - 8 years, and 9 - 11 years. Owing to paucity of data on other ages, i.e. 12 to 15 years, we have not been able to include them in the present analysis.

Weight

Figure 5.5.21 shows the bar diagram which indicates the differences in weight between income groups. It is seen that the boys belonging to the MIG and HIG are heavier than those belonging to the LIG. Similarly, the HIG boys are heavier than the MIG boys in all the age groups.

Height

The mean values of height according to income groups are shown in Figure 5.5.22. The Figure indicates that the boys in the LIG are shorter than those in the MIG and HIG. The differences between the MIG and HIG boys are also perceptible in all the age groups. In fact, the bar diagram shows that the MIG boys are in the middle of the LIG and HIG boys in all the age groups.

Sitting height

The differences between income groups in respect of sitting height are shown in Figure 5.5.23. As in the case of stature, the HIG boys have higher values of sitting height than the LIG and MIG boys in all the age groups. It is also true that sitting height of the MIG boys is consistently higher than that of the LIG, but lower than that of the HIG boys.

Biacromial diameter

Figure 5.5.24 shows the bar diagram which indicates the differences between income groups with regard to biacromial diameter. The Figure shows that there are differences between income groups and it is true in all the age groups. In the age group 6 - 8 years, the LIG boys have more or less similar values to those belonging to the MIG.

Bi-iliac diameter

Figure 5.5,25 shows that the LIG boys have broader hip than either the LIG or MIG boys in all the age groups. The differences between the LIG and MIG boys, in respect of bi-iliac diameter, are not clearly marked in the age groups 6 - 8 and 9 - 11 years. In these age groups, the LIG boys have slightly broader hip than those boys belonging to the MIG.

Mid upper arm circumference(left)

The mean values of mid upper circumference, according to income groups, are shown in Figure 5.5.26. The differences between income groups are perceptible in all the age groups, especially in the age group 9 - 11 years. In the age group 9 -11 years, the mean value of mid upper arm circumference tends to increase from the LIG to the HIG.

Head circumference

Figure 5.5.27 shows the mean values of head circumference by income groups. It is seen that the mean values are higher in the HIG boys than those in the MIG and LIG boys in all the age groups. In turn, the MIG boys have by and large greater head circumference than the LIG boys. The differences between the MIG and HIG are clearly noticeable in the age groups 3-5 and 9 - 11 years. In the age group 6 - 8 years, the difference between these two income groups is, however, negligible. Nevertheless, it indicates that the head circumference of boys in the present population is, to some extent, associated with the economic condition.

Chest girth

The mean values of chest girth by income groups of the households are shown in Figure 5.5.28. It is seen that the mean value rises rapidly with the increasing age group in all the three income groups. The difference between any two income groups is also very much perceptible in all the age groups. It is found that the boys in the MIG and HIG have higher values of chest girth than those in the LIG. This holds good for all the age groups.

Log of biceps skinfold thickness(left)

Figure 5.5.29 shows the mean values of the log of skinfold thickness at biceps according to income groups. The variations in biceps skinfold thickness are clearly noticeable in all the age groups. It is seen that the mean values of fat deposit are lower in the LIG than those in either the MIG or HIG. It is also observed that the boys belonging to the MIG have lower values than those belonging to the HIG.

Log of triceps skinfold thickness(left)

The mean values of the log of skinfold thickness at triceps, accor-

FIG.5.5.21. WEIGHT MEANS
(BOYS)

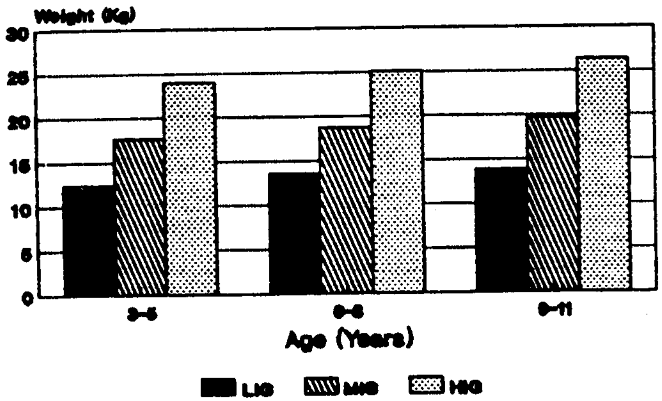


FIG.5.5.22. HEIGHT MEANS
(BOYS)

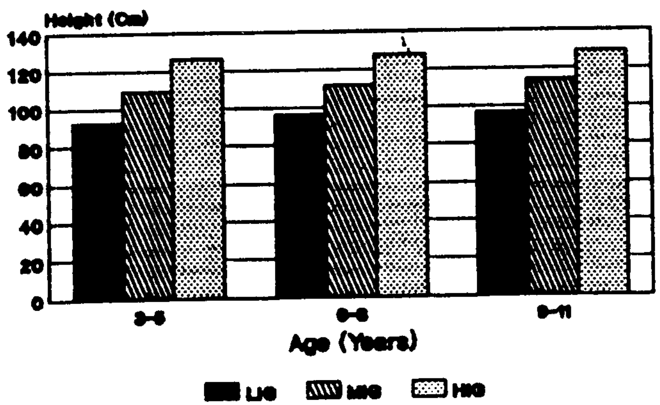


FIG.5.5.23. SITTING HEIGHT
(BOYS)

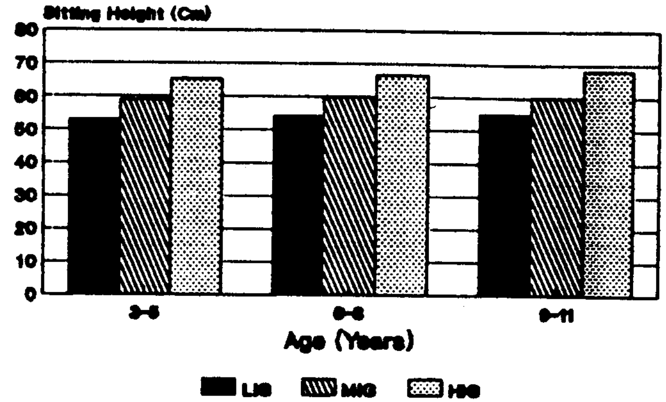


FIG.5.5.24.
BIACROMIAL DIAMETER FOR BOYS

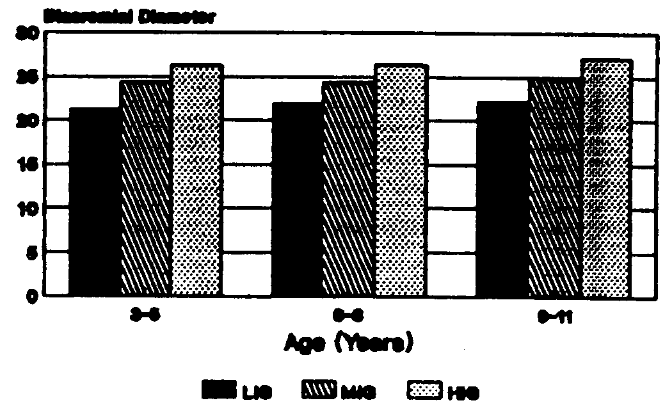


FIG.5.5.25. BI-ILIAC DIAMETER
(BOYS)

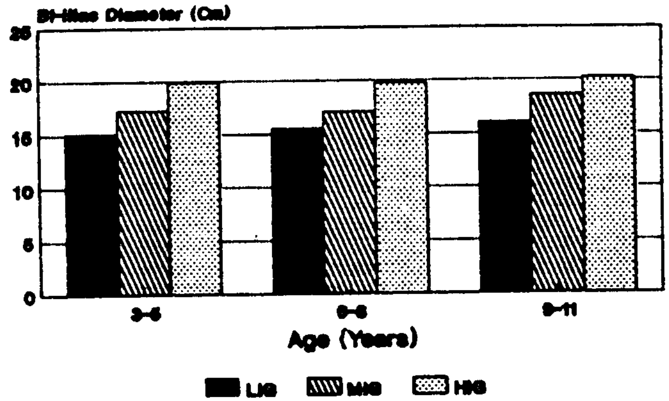


FIG.5.5.27.
HEAD CIRCUMFERENCE FOR BOYS

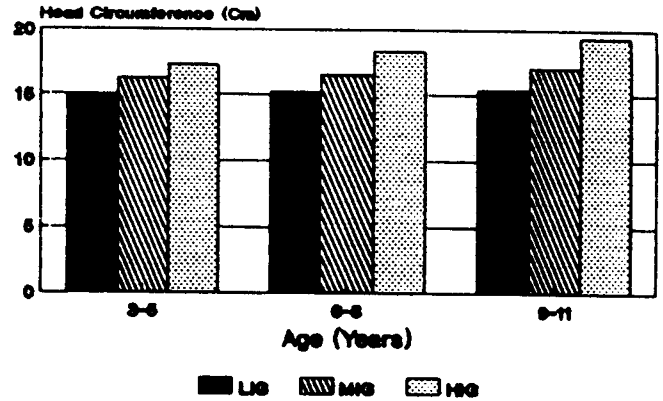


FIG.5.5.26. MID UPPER ARM CIRCUM
(BOYS)

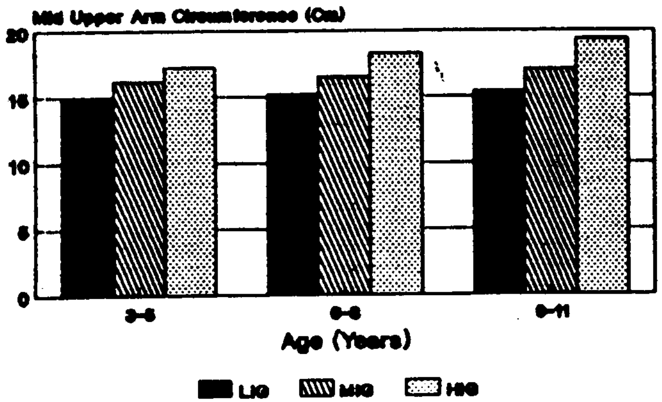


FIG.5.5.28. CHEST GIRTH
(BOYS)

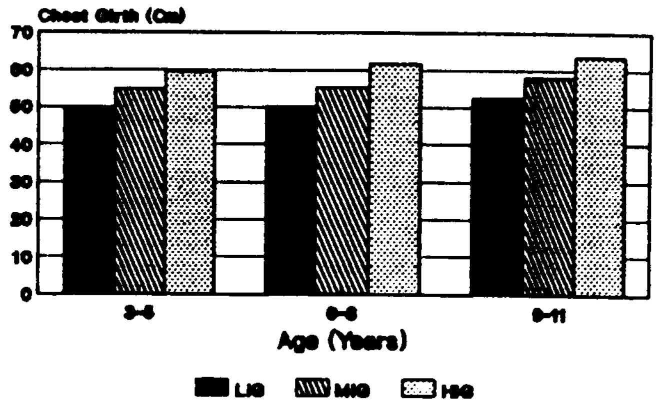


FIG.5.5.29. BICEPS
(BOYS)

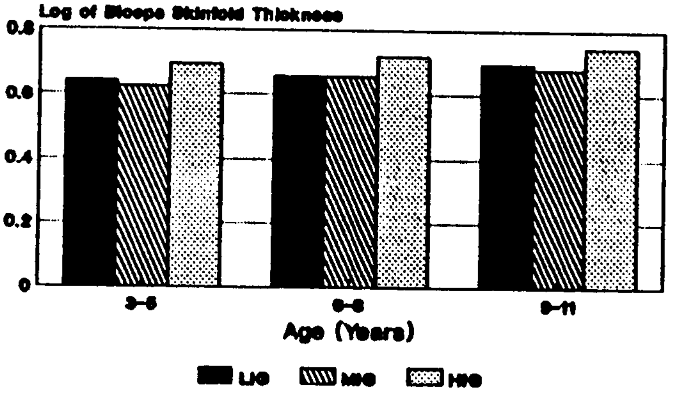
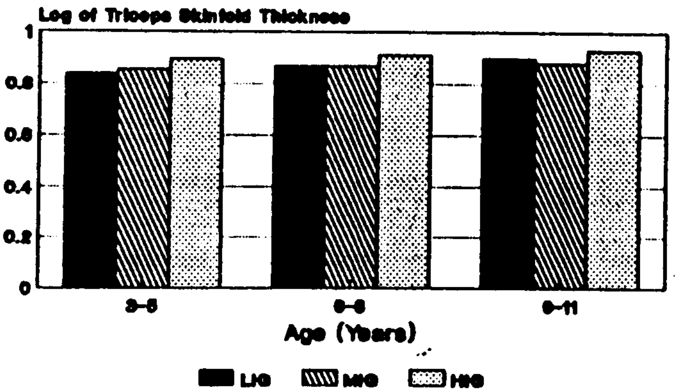


FIG.5.5.30. TRICEPS
(BOYS)



ding to income groups, are shown in Figure 5.5.30. As in the case of biceps, the values of skinfold thickness at triceps are higher in the HIG than in the MIG and LIG. It is further observed that the boys in the MIG have higher values than the boys in the LIG. It is also seen that the mean values increase as age advances. It is true for all the three income groups. So, it is understandable that the fat accumulation is, to a great extent, associated with the economic condition of the households.

Anthropometric Ratios and Indices by Economic Condition(BOYS)

The means and standard deviations of anthropometric ratios and indices for the War Khasi boys are shown, according to income groups, in Table 5.5.12 as well as in Figures 5.5.31 to 5.5.42.

Weight/height

The mean values of weight/height ratio, according to income groups, are shown in Figure 5.5.31. It is found that the mean value of this ratio is highest in the HIG followed by that in the MIG. Between the MIG and LIG, the former has got the higher value than the latter. In fact, the value of weight/height ratio tends to increase with the rise in income level for all the age groups.

Weight/height^2(Body mass) index

The differences between income groups in respect of body mass index are shown in Figure 5.5.32. It is seen that the differences between any two income groups are not very much perceptible in all the age groups, though

Table 5.5.12. Means and standard deviations of anthropometric ratios and indices among the War Khasi boys by economic condition

Ratios and indices		3 - 5 years			6 - 8 years			9 - 11 years		
		LIG (N=27)	MIG (N=23)	HIG (N=20)	LIG (N=24)	MIG (N=22)	HIG (N=16)	LIG (N=22)	MIG (N=22)	HIG (N=20)
Weight/height	$\bar{X}$	0.1407	0.1503	0.1571	0.1692	0.1718	0.1772	0.1944	0.1995	0.2052
	SD	0.0127	0.0134	0.0142	0.0128	0.0157	0.0201	0.0144	0.0176	0.0388
Weight/height^2	$\bar{X}$	1.50	1.56	1.61	1.51	1.52	1.53	1.52	1.55	1.57
	SD	0.06	0.08	0.10	0.07	0.11	0.12	0.09	0.12	0.16
Ponderal index	$\bar{X}$	39.92	39.47	39.20	41.98	42.04	42.34	43.82	43.62	43.33
	SD	1.24	1.28	1.47	1.27	1.42	1.82	1.36	1.48	1.50
Cormic index	$\bar{X}$	0.5590	0.5652	0.5687	0.5355	0.5345	0.5363	0.5261	0.5340	0.5370
	SD	0.0178	0.0152	0.0183	0.0182	0.0204	0.0194	0.0157	0.2062	0.0342
Chest/height	$\bar{X}$	0.5253	0.5214	0.5392	0.4904	0.4899	0.5009	0.4648	0.4798	0.4928
	SD	0.0169	0.0158	0.0179	0.0162	0.0192	0.0204	0.0212	0.0246	0.0357
Weight for height	$\bar{X}$	107.06	109.90	110.24	112.42	116.58	117.78	109.12	111.24	115.63
	SD	5.78	5.27	6.39	5.47	7.84	6.36	6.37	5.88	8.21
Weight for age	$\bar{X}$	112.42	116.58	117.73	108.68	108.94	111.39	106.25	108.33	110.03
	SD	6.15	6.92	7.44	6.32	7.28	9.56	6.48	5.59	8.37
Height for age	$\bar{X}$	99.20	100.64	101.56	98.97	99.65	100.79	99.22	101.05	100.14
	SD	3.48	4.14	4.96	3.44	4.21	5.36	3.27	4.20	5.72
Total upper arm area	$\bar{X}$	17.80	18.45	18.84	20.88	21.79	23.10	23.75	26.73	29.79
	SD	2.72	3.04	3.80	2.87	2.82	3.92	2.72	2.82	3.58
Upper arm muscle area	$\bar{X}$	13.02	13.27	13.26	15.48	16.08	17.07	17.45	19.79	22.07
	SD	2.72	3.12	3.57	2.96	2.78	3.42	3.33	3.36	4.12
Upper arm fat area	$\bar{X}$	4.78	5.18	5.58	5.40	5.71	6.03	6.29	6.94	7.72
	SD	2.74	3.02	2.78	2.19	2.12	3.59	2.52	3.22	4.02
Upper arm fat index	$\bar{X}$	26.85	28.08	29.62	25.86	26.20	26.10	26.48	25.96	25.91
	SD	6.93	5.79	6.95	3.89	5.40	6.57	4.13	5.20	5.33

the boys belonging to the LIG have somewhat lower values than those belonging to either the MIG or HIG, and in turn, the MIG boys have slightly lower values than the HIG in all the age groups.

Ponderal index

The mean values of ponderal index according to income groups are shown in Figure 5.5.33. So far as the ponderal index is concerned, the differences between income groups are not uniform. It is seen that in the age groups 3 - 5 and 9 - 11 years, the LIG boys have higher values than those belonging to the MIG and HIG. But it is not so in the age group 6 - 8 years, in which the LIG boys have lower value than those in the MIG and HIG. It is further observed that the MIG boys have somewhat higher values than the HIG boys in the age groups 3 - 5 and 9 - 11 years.

Cormic index

Figure 5.5.34 shows the variations in cormic index according to economic condition. It is found that the cormic index tends to rise with the rise in income level in all the age groups, except in the age group 6 - 8 years, in which the value among the LIG boys is slightly higher than that among the MIG boys. After all, the differences between income groups with regard to this index are perceptible in all the age groups.

Chest/height ratio

The mean values of chest/height ratio according to income groups are shown in Figure 5.5.35. In the age groups 3 - 5 and 6 - 8 years, the differences between the LIG and MIG boys in respect of chest/height ratio are not much perceptible, though the values are slightly higher in the LIG than in the MIG boys. It can, however, be observed that the boys in the HIG have higher values of chest/height ratio than those belonging to the lower income groups in all the age groups.

Weight for height

The differences between any two income groups with regard to weight for height (percentage of the ICMR standard) are shown in Figure 5.5.36. It shows that the boys belonging to the HIG have higher values of weight for height than those belonging to the MIG and LIG, and in turn, the MIG boys have higher values than the LIG boys. It holds true for all age groups. In short, it indicates that the weight for height is, to some extent, associated with the economic condition of the households.

Weight for age

The mean values of weight for age according to income groups are shown in Figure 5.5.37. As in the case of weight for height, the LIG boys have the lowest value of weight for age, when compared with the MIG and HIG. This is true in all the age groups.

Height for age

Figure 5.5.38 shows the differences between income groups with regard to height for age(percentage of the ICMR standard). As in the case of other indices, the mean value of height for age tends to increase with the increasing income level. The only exception is noticed with respect to the age group 9 - 11 years in which the MIG boys have got slightly higher mean value than the HIG boys. However, it also indicates that the height for age is associated with the economic condition

Total upper arm area

The mean values of the total upper arm area according to income groups are shown in Figure 5.5.39. The Figure shows that the total upper arm area in the LIG boys is lower than that in either the MIG or HIG. In other words, the mean value of the total upper arm area tends to increase with the increasing economic level.

Upper arm muscle area

Figure 5.5.40 shows the bar diagram which indicates the variations in upper arm muscle area according to economic condition. It shows that, as in the case of the total upper arm area, the differences between any two income groups in all the age groups are noticed, except in the age group 3 - 5 years in which the differences between income groups are not very much perceptible, and the MIG boys have got slightly higher value than the HIG boys.

Upper arm fat area

The differences between any two income groups with respect to the upper arm fat area are shown in Figure 5.5.41. As in the case of other indices, the differences between income groups are clearly noticeable in all the age groups. So, it indicates that the upper arm fat area is also associated with the per capita income of the households.

FIG.5.5.31. WEIGHT/HEIGHT (BOYS)

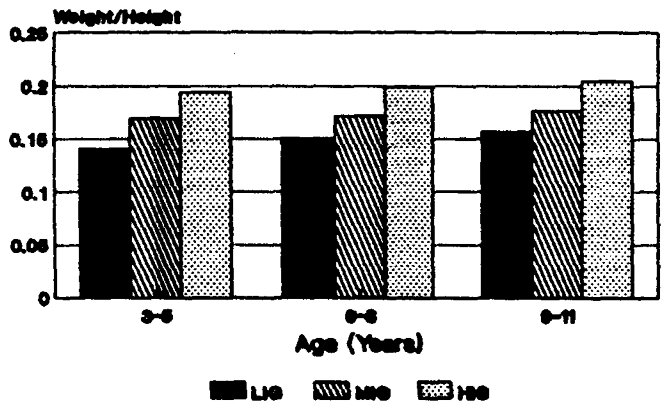


FIG.5.5.33. PONDERAL INDEX (BOYS)

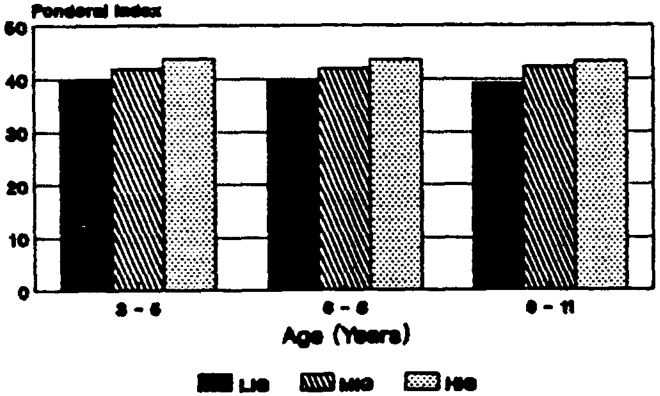


FIG.5.5.32. BODY MASS INDEX (BOYS)

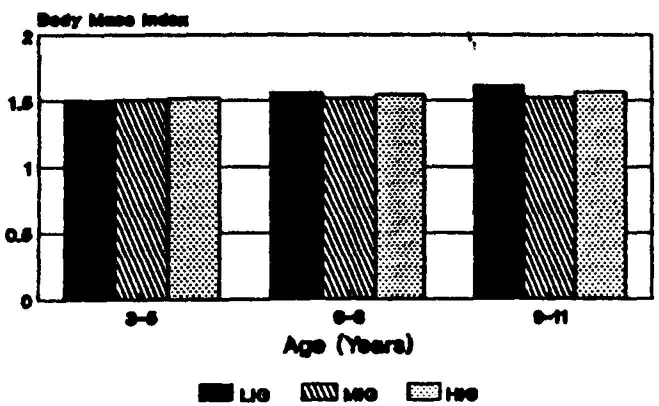


FIG.5.5.34. CORMIC INDEX (BOYS)

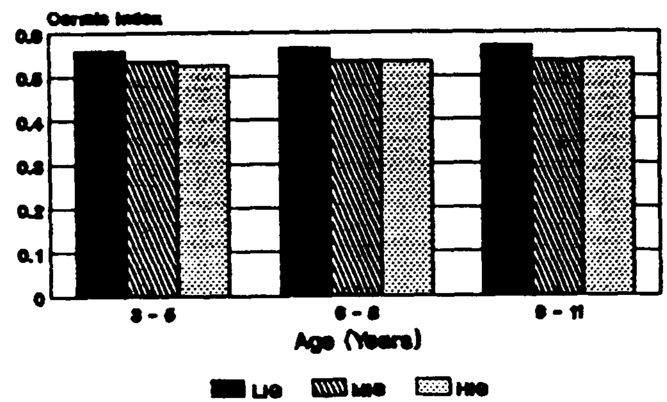


FIG.5.5.35. CHEST/HEIGHT (BOYS)

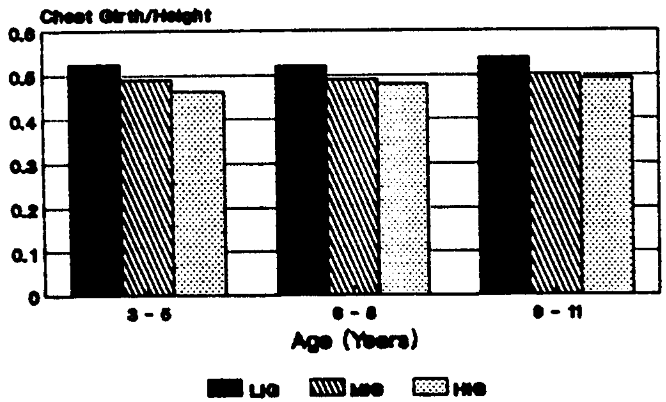


FIG.5.5.37. WEIGHT FOR AGE (BOYS)

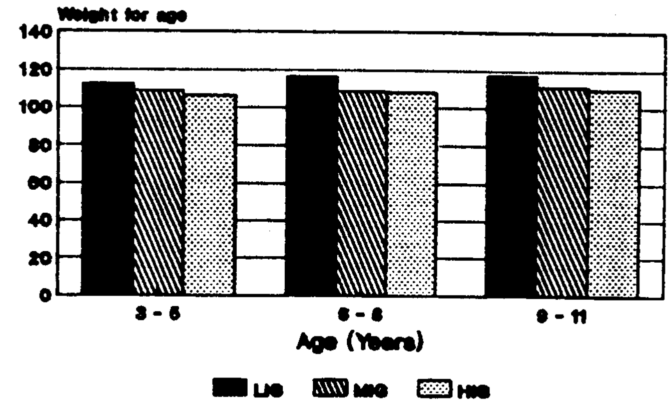


FIG.5.5.36. WEIGHT FOR HEIGHT (BOYS)

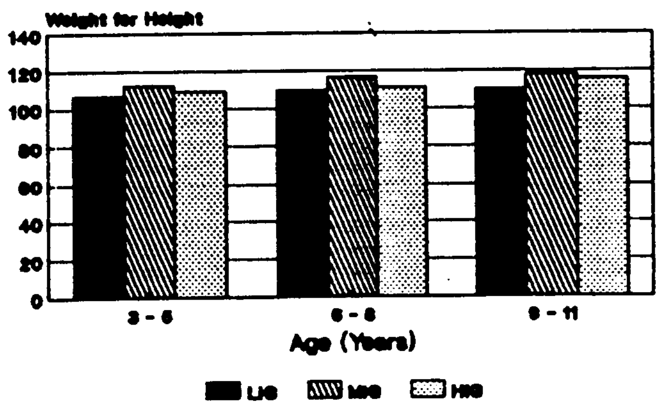


FIG.5.5.38.HEIGHT FOR AGE (BOYS)

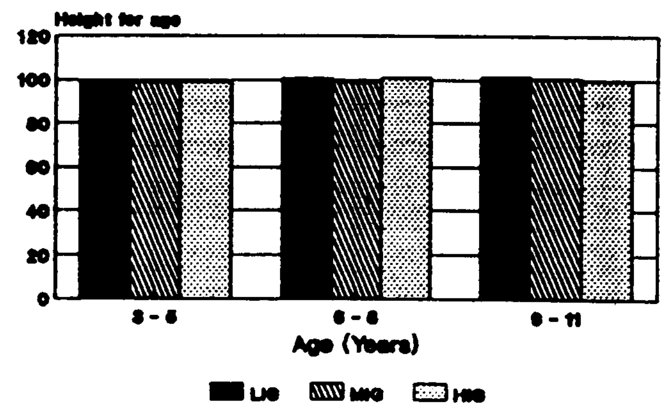


FIG.5.5.39.
TOTAL UPPER ARM AREA (BOYS)

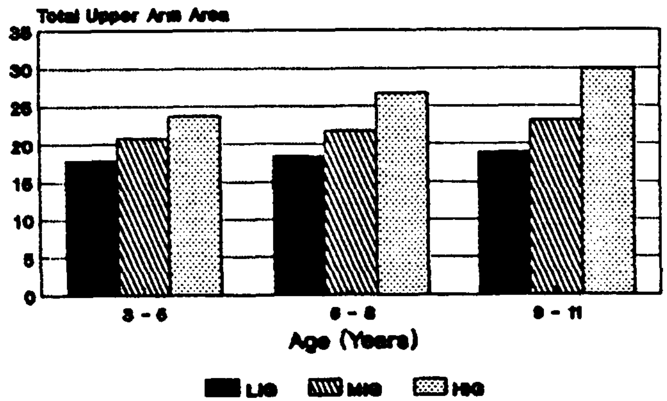


FIG.5.5.41.
UPPER ARM FAT AREA (BOYS)

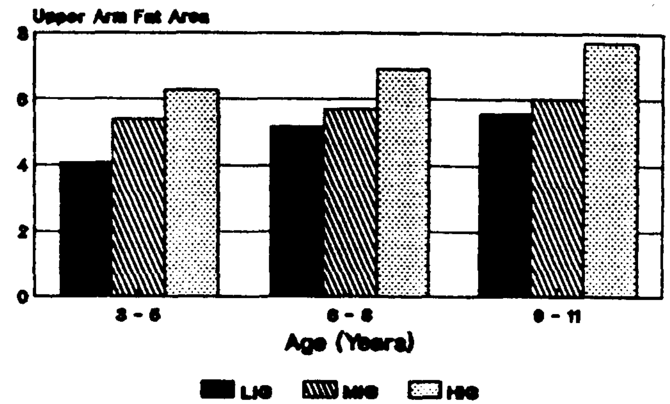


FIG.5.5.40.
UPPER ARM MUSCLE AREA (BOYS)

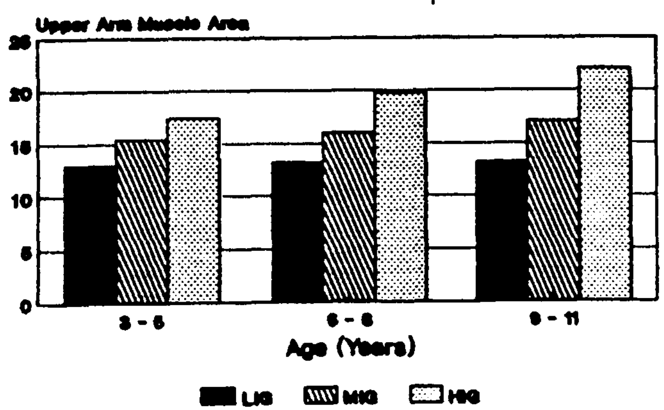
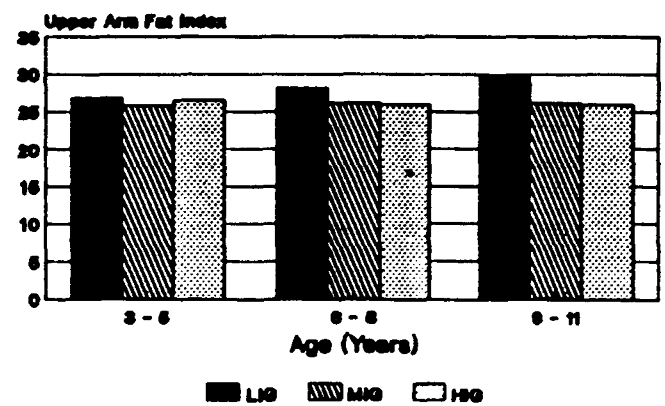


FIG.5.5.42.
UPPER ARM FAT INDEX (BOYS)



Upper arm fat index

Figure 5.5.42 shows the differences between income groups with regard to upper arm fat index. Unlike most of the other indices, it is noticed that the differences between income groups are not regular. In the first age group (i.e. 3 - 5 years), this index tends to increase with the increasing income level. But in the age group 6 - 8 years, the LIG boys have got lower value than the MIG and HIG boys, though the MIG boys have got slightly higher value than the HIG boys. In the last age group (i.e. 9 - 11 years), it is found that the mean value of the upper arm fat index tends to decrease with the increasing income level, So, it is quite opposite to that pattern found in the age group 3 - 5 years.

Anthropometric Measurements by Economic Condition (GIRLS)

The means and standard deviations of anthropometric measurements for girls are presented, according to economic condition, in Table 5.5.13 as well as in Figures 5.5.43 to 5.5.52.

Weight

Figure 5.5.43 shows that the girls belonging to the MIG and HIG are heavier than those belonging to the LIG and,in turn, the MIG girls have lower values than the HIG girls. This holds good for all the age groups. It also shows that the mean values of weight increases with the increasing age group in all the age groups.

Height

Figure 5.5.44 shows the variation in height according to income groups.

Table 5.5.13. Means and standard deviations of anthropometric measurements among the War hasi girls by economic condition

Anthropometric traits		3 - 5 years			6 - 8 years			9 - 11 years		
		LIG(N=22)	MIG(N=20)	HIG(N=19)	LIG(N=25)	MIG(N=20)	HIG(N=20)	LIG(N=20)	MIG(N=24)	HIG(N=15)
Absolute measurements:										
Weight(kg)	$\bar{X}$	12.46	13.59	13.97	17.66	18.74	19.70	23.97	25.10	26.40
	SD	1.65	2.12	2.70	2.06	2.27	4.12	3.28	3.92	4.20
Height(cm)	$\bar{X}$	92.48	96.29	96.71	109.23	111.56	113.68	126.47	127.81	129.12
	SD	4.22	4.78	4.95	3.66	4.22	5.46	4.15	5.62	6.11
Sitting height(cm)	$\bar{X}$	52.98	54.30	54.90	58.85	59.94	60.31	65.42	66.60	68.22
	SD	2.50	2.83	3.12	1.96	2.49	3.24	2.28	2.77	3.67
Biacromial diameter(cm)	$\bar{X}$	19.89	20.91	21.87	22.96	23.89	24.85	25.90	26.22	27.00
	SD	1.13	1.76	2.23	1.84	1.96	2.15	1.67	2.29	2.93
Bi-iliac diameter(cm)	$\bar{X}$	14.86	15.06	15.27	15.88	16.75	18.00	18.95	19.52	19.85
	SD	1.05	1.03	1.92	1.86	1.93	2.10	1.36	2.14	2.63
Mid upper arm cir.(cm)(L)	$\bar{X}$	13.85	14.77	15.21	15.69	16.14	16.55	16.76	17.89	18.87
	SD	0.96	1.23	1.76	1.13	1.62	2.16	1.25	2.47	3.94
Head circumference(cm)	$\bar{X}$	47.79	48.10	48.62	49.66	50.12	50.61	51.87	52.11	52.98
	SD	2.45	2.84	3.20	1.95	2.14	2.38	1.79	1.36	2.13
Chest girth(cm)	$\bar{X}$	48.77	49.73	50.20	52.65	54.74	57.82	59.73	60.67	62.91
	SD	2.62	1.89	2.10	2.16	2.87	3.17	2.12	3.24	4.29
Log of skinfold thickness:										
Biceps (left)	$\bar{X}$	0.6866	0.7059	0.7226	0.6628	0.7007	0.7324	0.7364	0.7679	0.7745
	SD	0.0719	0.0899	0.1004	0.0792	0.0934	0.1106	0.1038	0.1106	0.1072
Triceps(left)	$\bar{X}$	0.8965	0.9096	0.9206	0.8733	0.8987	0.9289	0.9154	0.9395	0.9609
	SD	0.0792	0.0828	0.1038	0.0899	0.0828	0.1139	0.1106	0.1139	0.1239

As in the case of boys, the girls in the LIG are shorter than those belonging to the MIG and HIG. The difference between the MIG and HIG girls is also noticeable in all the age groups. So, it indicates that height of girls associated with the economic condition.

Sitting height

The mean values of sitting height according to income groups are shown in Figure 5.5.45. The differences between income groups, in respect of sitting height, are also perceptible in all the age groups. It is found that the girls belonging to the HIG have higher values of sitting height than those belonging to the MIG and LIG. It is also noticed that the MIG girls have higher value of sitting height than the LIG girls.

Biacromial diameter

Figure 5.5.46 shows the bar diagram which indicates the variations in biacromial diameter according to income groups. It shows that the biacromial diameter tends to increase with the increasing economic level in all the age groups. It is found that the girls in the HIG have the broadest shoulders, in comparison with those in the MIG and LIG. In turn, the MIG girls have broader shoulder than the LIG girls.

Bi-iliac diameter

The mean values of bi-iliac diameter according to income group are shown in Figure 5.5.47. It shows that the girls in the LIG have narrower hip than those in the MIG and HIG. It is also seen that the HIG girls have broader hip than the MIG girls, though the difference between them with regard

FIG.5.5.43. WEIGHT MEANS
(GIRLS)

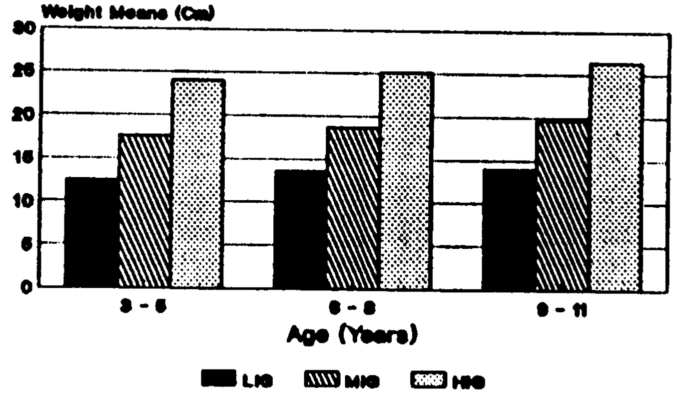


FIG. 5.5.44. HEIGHT MEANS
(GIRLS)

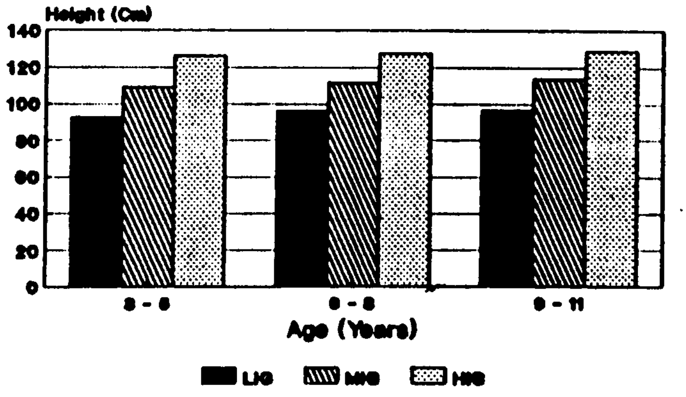


FIG.5.5.45. SITTING HEIGHT (GIRLS)

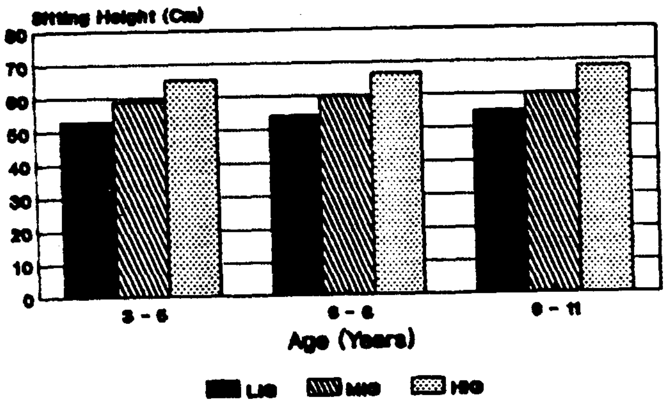


FIG.5.5.47. BI-ILIAC DIAMETER (GIRLS)

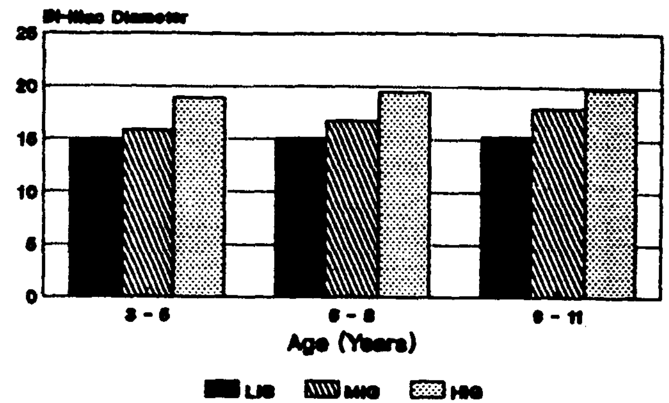


FIG.5.5.46. BIACROMIAL DIAMETER (GIRLS)

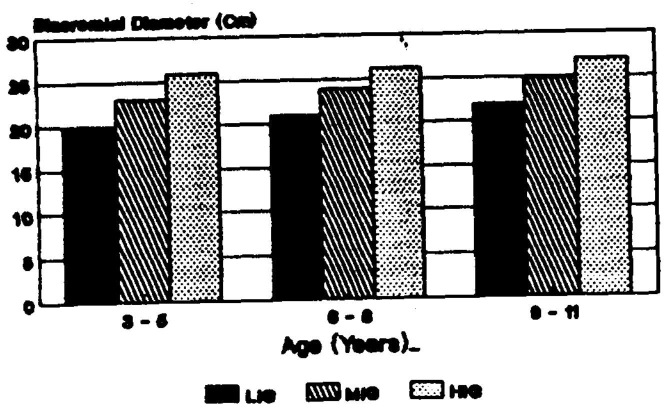


FIG.5.5.48. HEAD CIRCUMFERENCE (GIRLS)

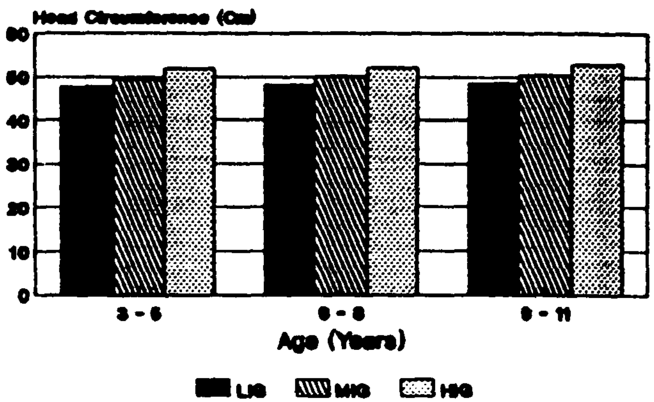


FIG. 5.5.49.
MID UPPER ARM CICUMFERENCE (GIRLS)

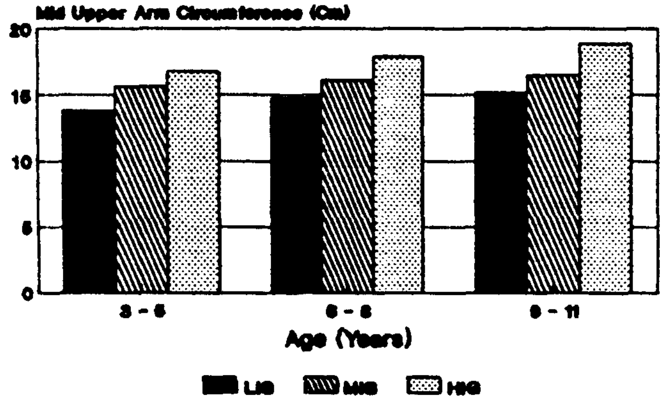


FIG. 5.5.51. BICEPS
(GIRLS)

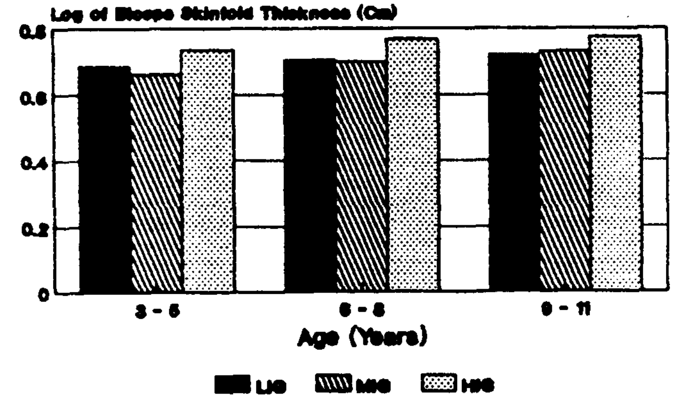


FIG.5.5.50. CHEST GIRTH
(GIRLS)

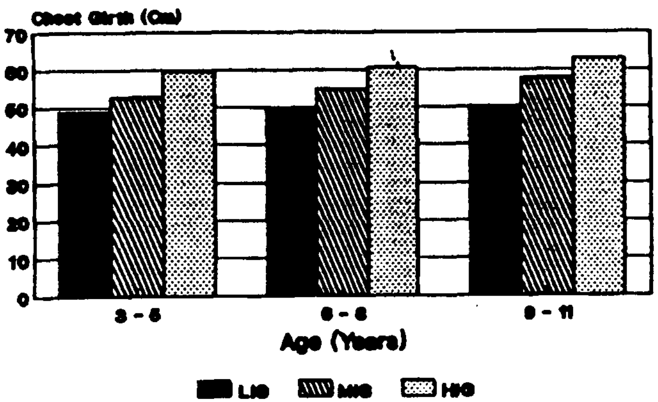
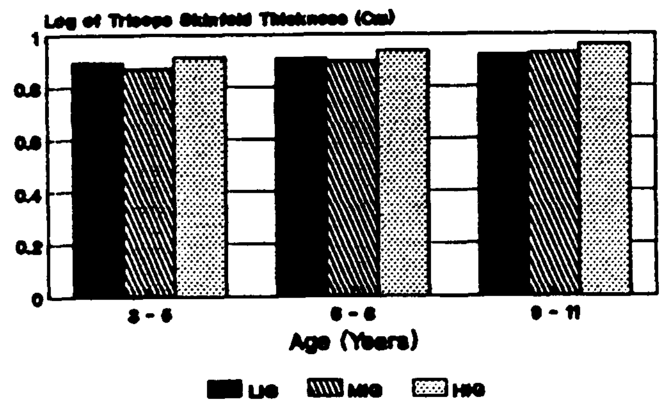


FIG.5.5.52. TRICEPS
(GIRLS)



to this anthropometric character is not very sharp.

Head circumference

Figure 5.5.48 shows the variations in head circumference according to income groups. The Figure shows that the girls belonging to the HIG have broader head than those belonging to the MIG and LIG. As regards the comparison between the LIG and MIG girls, it is seen that the former have broader head than the latter. In fact, the differences between income groups with regard to head circumference are clearly perceptible in all the age groups.

Mid upper arm circumference

The differences between income groups, with respect to mid upper arm circumference, are shown in Figure 5.5.49. It shows that there are marked differences between income groups in all the age groups. It is seen that the mid upper arm circumference of the girls tends to increase with the rise in age as well as in economic level. So, it indicates that the mid upper arm circumference is associated with the economic condition of the households.

Chest girth

Figure 5.5.50 indicates the variations in chest girth according to income groups. It is seen that the mean value of chest girth rises rapidly and steadily with the increasing age group for all the three income groups. It is found that the girls belonging to the LIG have lower mean value than those belonging to the MIG and HIG and, in turn, the MIG girls have lower value than the HIG girls. This is true in all the age groups. So, it indicates that the head circumference is also associated with the economic condition.

Log of biceps skinfold thickness(left)

The mean values of the log of skinfold thickness at biceps for the girls are shown in Figure 5.5.51 according to income groups. The variations in skinfold thickness at biceps are clearly noticeable in all the age groups. It is observed that skinfold thickness at biceps tends to increase with the rise in income level. However, the girls belonging to the HIG, show the highest mean value in all the three age groups, followed by the girls belonging to the MIG. The girls in the LIG have the lowest value, and it is true in all the age groups. So, it indicates that the fat accumulation is also associated with the economic condition.

Log of triceps skinfold thickness(left)

The mean values of the log of skinfold thickness at triceps according to income groups are shown in Figure 5.5.52. As in the case of biceps, the fat accumulation at triceps tends to increase with the increasing economic level. It is seen that the girls belonging to the HIG have higher mean value than those belonging to the MIG and LIG and it is true in all the age groups.

Anthropometric Ratios and Indices by Economic Condition(GIRLS)

The means and standard deviations of anthropometric ratios and indices by economic condition among the War Khasi girls are shown in Table 5.5.14 as well as in Figures 5.5.53 to 5.5.64.

Table ... Means and standard deviations of anthropometric ratios and indices among the War Khasi girls by economic condition

Ratios and indices		3 - 5 years			6 - 8 years			9 - 11 years		
		LIG(N=22)	MIG(N=20)	HIG(N=19)	LIG(N=25)	MIG(N=20)	HIG(N=20)	LIG(N=20)	MIG(N=24)	HIG(N=15)
Weight/height	$\bar{X}$	0.1350	0.1411	0.1447	0.1619	0.1680	0.1733	0.1896	0.1964	0.2047
	SD	0.0367	0.0246	0.0535	0.0195	0.0212	0.0236	0.0189	0.0305	0.0414
Weight/height^2	$\bar{X}$	1.46	1.47	1.50	1.48	1.51	1.53	1.50	1.54	1.58
	SD	0.05	0.09	0.11	0.07	0.09	0.12	0.06	0.10	0.07
Ponderal index	$\bar{X}$	39.88	40.37	40.16	41.96	42.00	42.13	43.88	43.69	43.34
	SD	1.23	1.36	1.58	1.39	1.50	1.74	1.55	1.72	1.89
Cormic index	$\bar{X}$	0.5726	0.5639	0.5676	0.5388	0.5370	0.5305	0.5173	0.5211	0.5285
	SD	0.0176	0.0145	0.0178	0.0149	0.0179	0.0197	0.0154	0.0188	0.0203
Chest/height	$\bar{X}$	0.5274	0.5167	0.5193	0.4822	0.4907	0.5086	0.4725	0.4747	0.4874
	SD	0.0189	0.0189	0.0199	0.0164	0.0183	0.1024	0.0178	0.0166	0.0196
Weight for height	$\bar{X}$	102.55	103.87	105.35	108.37	110.49	112.59	107.45	111.32	115.46
	SD	6.27	7.13	7.49	5.36	6.17	8.28	7.16	7.37	8.15
Weight for age	$\bar{X}$	102.72	104.78	106.48	100.99	105.33	110.29	104.52	107.39	107.52
	SD	7.84	6.96	8.35	8.89	9.75	10.12	6.97	7.85	9.47
Height for age	$\bar{X}$	100.06	100.65	101.62	98.45	98.92	99.34	98.87	99.74	100.69
	SD	5.89	6.54	7.38	4.76	6.39	7.25	5.37	6.48	7.59
Total upper arm area	$\bar{X}$	15.26	17.36	18.40	19.59	20.73	21.79	22.35	25.46	28.33
	SD	2.44	2.72	3.21	2.81	3.03	3.46	2.57	2.78	3.40
Upper arm muscle area	$\bar{X}$	10.29	11.88	12.62	14.16	14.83	15.33	15.98	18.28	20.36
	SD	2,79	2.66	2.74	2.88	2.90	3.15	2.53	2.96	4.21
Upper arm fat area	$\bar{X}$	4.97	5.48	5.78	5.43	5.90	6.46	5.37	7.18	7.97
	SD	2.36	2.95	3.06	2.17	3.46	4.50	2.87	4.15	4.92
Upper arm fat index	$\bar{X}$	32.57	31.57	31.41	27.72	28.46	29.65	28.50	28.20	28.13
	SD	5.37	4.77	5.85	5.02	6.33	6.75	3.76	4.12	4.46

Weight/height

Figure 5.5.53 shows the variations in weight/height ratio according to income groups. It is seen that the differences between income groups are perceptible in all the age groups. In other words, the mean value of weight/-height ratio tends to increase with the rise in economic level.

Weight/height^2(Body mass) index

The variations in body mass index according to income groups are shown in Figure 5.5.54. It shows that the differences between income groups with regard to body mass index are small, and it is true in all the age groups. Nevertheless, it is seen that the girls belonging to the HIG have higher mean values of body mass index than those belonging to the MIG or LIG. Again, the MIG girls have slightly higher values than the LIG girls.

Ponderal index

Figure 5.5.55 shows the mean values of ponderal index according to economic condition. It is seen that in the age group 3 - 5 years, the girls in the LIG have the lowest value when compared with the MIG and HIG. The same is true for the middle age group, i.e. 6 - 8 years. But in the age group 9 - 11 years, the ponderal index tends to decrease with the rise in income level. So, no consistent relationship between economic condition and ponderal index is noticed.

Cormic index

The variations in cormic index according to income groups are shown in Figure 5.5.56. The mean value of cormic index is found to be highest in the LIG in both 3 - 5 and 6 - 8 year age groups. In the age group 3 - 5 years, the HIG girls have the second highest value for this index, though they have got the lowest value in the age group 6 - 8 years. As far as the MIG girls are concerned, they have got the lowest value in the age group 3 - 5 years, and the second highest value in the age group 6 - 8 years. In the age group 9 - 11 years, the situation is just different, i.e. the HIG girls have got the highest value followed by the MIG and LIG. So, no constant pattern of relationship between cormic index and economic condition is observed.

Chest/height ratio

The differences between income groups with regard to chest/height ratio are shown in Figure 5.5.57. In the age group 3 - 5 years, the LIG girls have higher value than the MIG and HIG girls, and the MIG girls have the lowest value. On the contrary, it is seen that in the age group 6 - 8 and 9 - 11 years, the chest/height ratio of the girls increases with the rise in economic level.

Weight for height

The mean value of weight for height (percentage of the ICMR standard) according to economic condition are shown in Figure 5.5.58. It shows that the value of weight for height are higher in the MIG and HIG girls than those in the LIG girls. In fact, it is highest in the HIG, and it is true in all the age groups. So, it indicates that the weight for height is associated with the economic condition.

Weight for age

The differences between any two income groups with regard to weight for age(percentage of the ICMR standard) are shown in Figure 5.5.59. As in the case of weight for height, the differences between income groups are perceptible in all the age groups. It is seen from the Figure that the value of weight for height increases with the increasing income level. In other words, the girls belonging to the HIG have always higher value of weight for age, when compared with those in the MIG and LIG. It is true in all the age groups.

Height for age

Figure 5.5.60 shows the mean values of height for age (percentage of the ICMR standard) according to economic condition. As in the case of most of the indices, tne mean value of height for age is highest in the HIG girls, which is followed by the MIG and then by the LIG girls. This trend is true in all the age groups. So, it shows that the value of height for age tends to increase with the rise in income level.

Total upper arm area

Figure 5.5.61 shows the variations in the total upper arm area according to income groups. It is seen that the mean value of the total upper arm area tends to increase with the increasing income level in all the age groups. So, it shows that this index is also associated with the economic condition.

Upper arm muscle area

The differences between income groups, with respect to upper arm muscle area, are shown in Figure 5.5.62. It shows that the girls belonging to the HIG have the highest mean value, which is folowed by those belonging to the MIG and LIG. This is true in all the age groups. So, like most of the indices, the upper arm muscle area is also associated with the economic condition.

Upper arm fat area

Figure 5.5.63 shows the mean values of the upper arm fat index according to economic condition. It shows that there are marked differences between income groups in all the age groups. It is found that the girls in the HIG have the highest value, when compared with those in the MIG and LIG. Similarly, the girls in the MIG have higher value than those in the LIG. This trend is true in all the age groups. So, it indicates that the upper arm fat area is also associated with the economic condition.

Upper arm fat index

Figure 5.5.64 shows the variations in upper arm fat index according to income groups. It is seen that the differences between income groups vary with the varying age groups. In the age group 3 - 5 and 9 - 11 years, the upper arm fat index tends to decrease with the increasing income level. But this trend is not observed in the age group 6 - 8 years. In this age group, the value of upper arm fat index increases with the rise in income level. Thus, with respect to this index, no consistent pattern of relationship is observed in the girls of the present study.

FIG.5.5.53. WEIGHT/HEIGHT
(GIRLS)

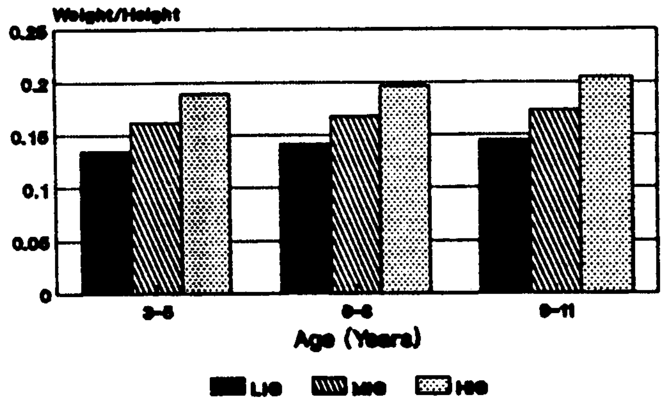


FIG.5.5.55. PONDERAL INDEX
(GIRLS)

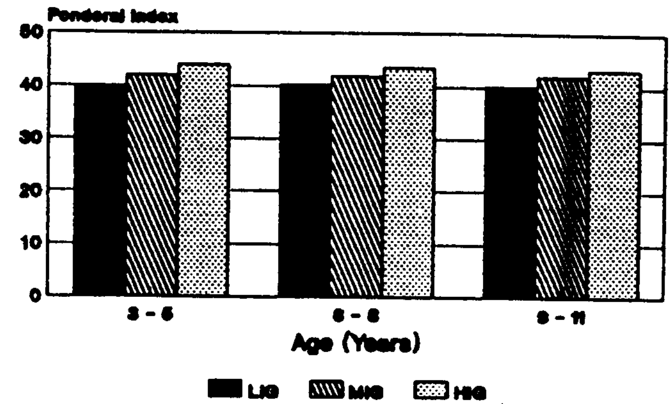


FIG.5.5.54. BODY MASS INDEX
(GIRLS)

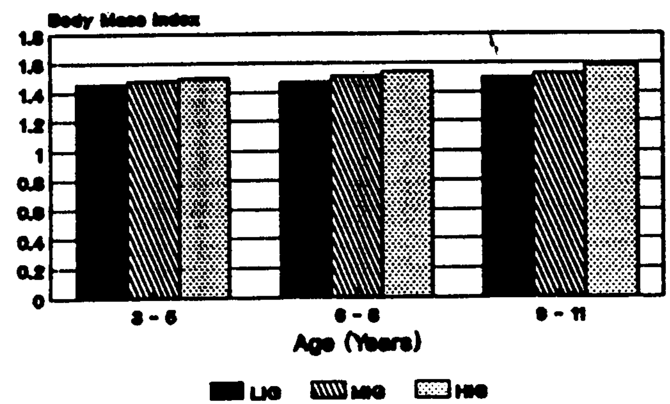


FIG.5.5.56. CORMIC INDEX
(GIRLS)

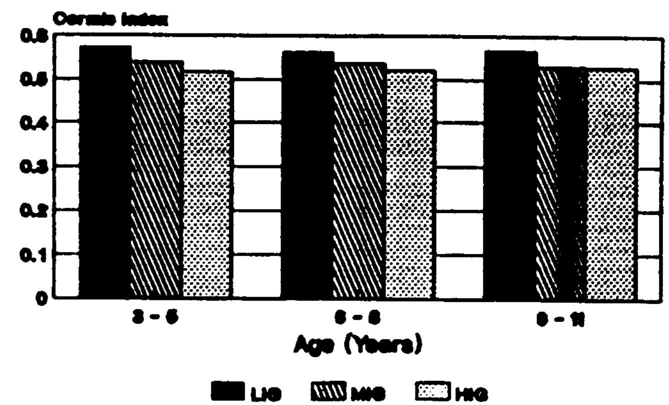


FIG.5.5.57. CHEST/HEIGHT (GIRLS)

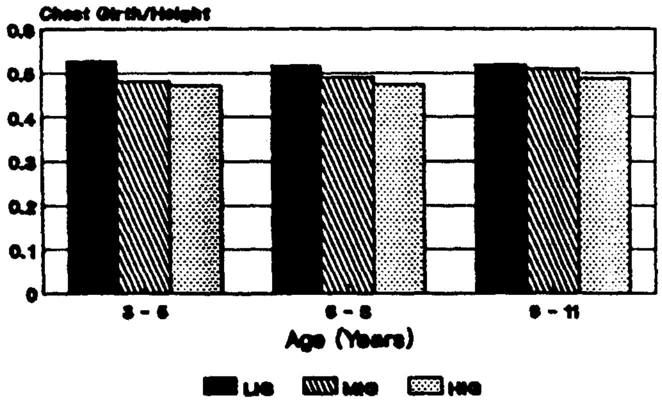


FIG.5.5.59. WEIGHT FOR AGE (GIRLS)

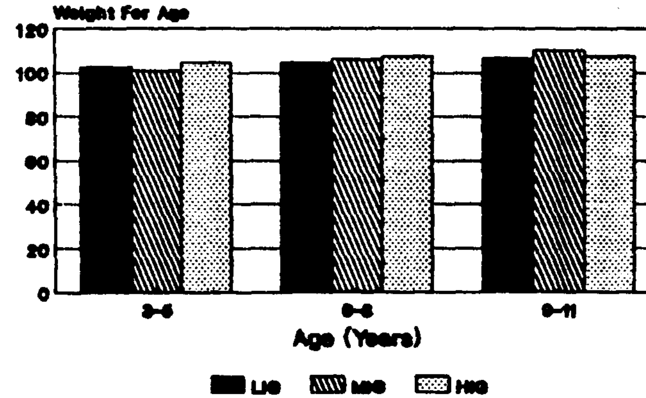


FIG.5.5.58. WEIGHT FOR HEIGHT (GIRLS)

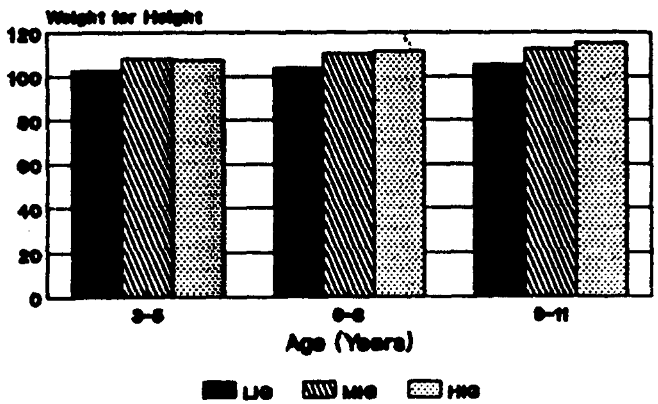


FIG.5.5.60. HEIGHT FOR AGE (GIRLS)

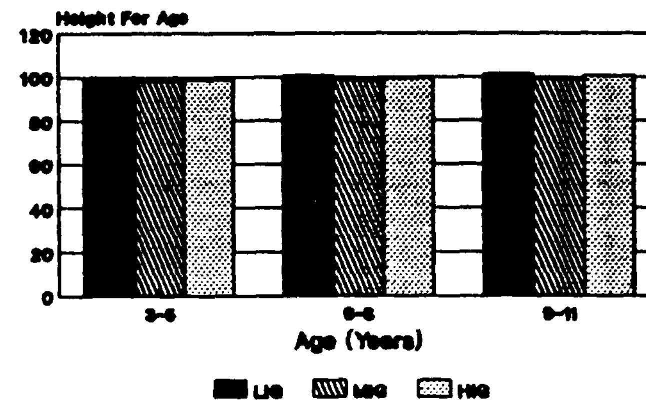


FIG.5.5.61.
TOTAL UPPER ARM AREA (GIRLS)

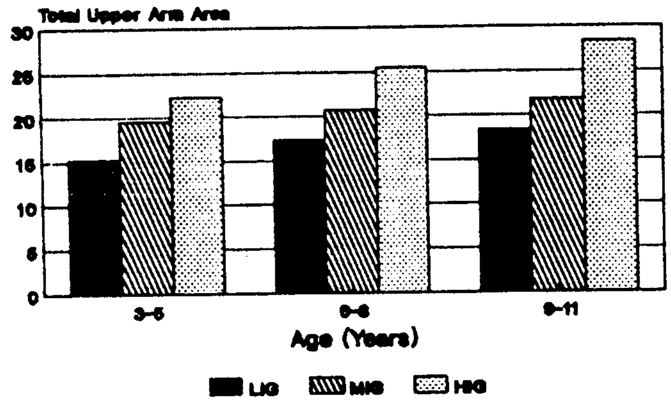


FIG.5.5.62.
UPPER ARM MUSCLE AREA (GIRLS)

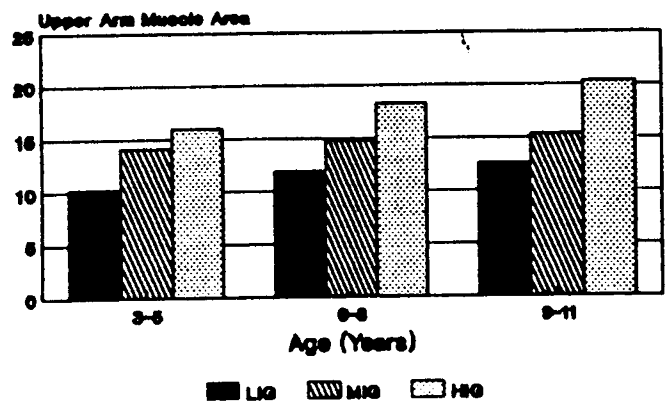


FIG.5.5.63.
UPPER ARM FAT AREA (GIRLS)

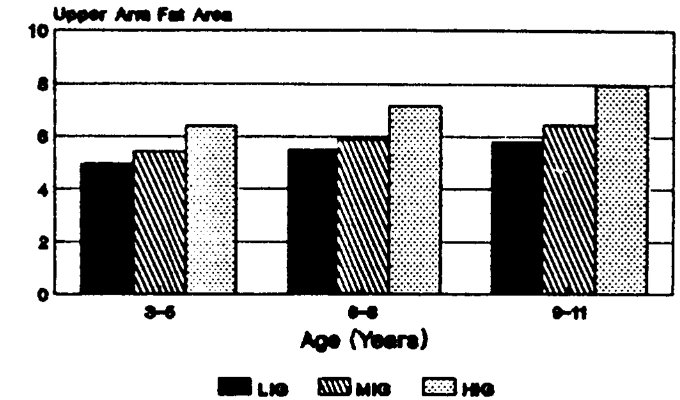
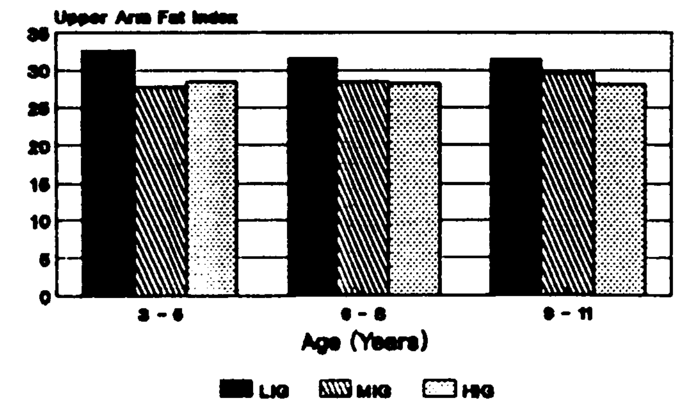


FIG.5.5.64.
UPPER ARM FAT INDEX (GIRLS)



5.6. HAEMOGLOBIN ESTIMATION

In this section, we shall deal with haemoglobin estimation in the present population. Data are presented in terms of sex, religion and economic condition.

Table 5.6.1 shows the haemoglobin content among the War Khasi by sex and religious groups. It is found that the mean values of haemoglobin level among the CH males and females are 13.99 ± 2.25 g/dl and 13.65 ± 2.56 g/dl, respectively. Among the NCH, these values are found to be 13.77 ± 2.39 g/dl and 13.00 ± 2.23 g/dl, respectively. The WHO Scientific Group (1968) has recommended the haemoglobin level of 13.00 g/dl for adult males and 12.00 g/dl for the non-pregnant adult females. So, it indicates that the haemoglobin content among the War Khasi is above the recommended levels in both the religious groups, i.e. the CH and NCH. Table 5.6.1 further shows that the CH males and females have higher mean values of haemoglobin level than their NCH counterparts. The difference between the two religious groups, with respect to haemoglobin content is found to be statistically significant for the females ($z = 2.10$, $P < 0.05$), though it is not significant for the males ($z = 0.71$, $P > 0.05$).

The number of persons with different levels of haemoglobin content is shown in Table 5.6.2. Among the CH, about 84.76 % of males and 78.79 % of females have haemoglobin level of 12.00 g/dl and above, whereas among the NCH, these frequencies are found to be 82.05 % and 69.03 % for males and females, respectively. It is also found that the frequencies of aneamia (<13.00 g/dl for males and < 12.00 g/dl for females) among the the CH are

26.67 % and 21.21 % in males and females, respectively. Among the NCH, these frequencies are found to be 30.77 % and 30.97 % in males and females, respectively. So, it shows that among the CH the frequency of aneamia is hiher in males than in females, though the difference between sexes is not statistically significant (d = 0.91, P > 0.05). On the other hand, the frequency of aneamia is slightly higher in females than in males among the NCH (d = 0.03, P > 0.05).

Table 5.6.1. **Haemoglobin content among the War Khasi**

Sex	Christians			Non-christians			Difference ± S.E.
	N	Mean	SD	N	Mean	SD	
Male	105	13.99	2.25	117	13.77	2.39	0.22 ± 0.31
Female	99	13.65	2.56	113	13.00	2.23	0.65 ± 0.31*

* $P < 0.05$.

Table 5.6.2. **Distribution of haemoglobin content among the War Khasi**

Haemoglobin content (g/dl)	Christians		Non-christians	
	Male(N = 105)	Female(N = 99)	Male(N = 117)	Female(N = 113)
8 - 9	4 (3.81)	7 (7.08)	7 (5.98)	5 (4.42)
10 - 11	12 (11.43)	14 (14.14)	14 (11.97)	30 (26.55)
12 - 13	30 (28.57)	28 (28.28)	37 (31.62)	37 (32.74)
14 - 15	29 (27.62)	25 (25.25)	33 (28.21)	22 (19.47)
16 -17	19 (18.10)	16 (16.16)	17 (14.53)	14 (12.39)
≥ 18	11 (10.48)	9 (9.09)	9 (7.69)	5 (4.42)

Figures within parentheses indicate percentage.

Table 5.6.3. Haemoglobin content(g/dl) by income groups among adult males

Income groups	Christians			Non-christians		
	N	Mean	SD	N	Mean	SD
LIG	33	13.47	2.44	45	13.27	2.20
MIG	46	13.92	2.11	42	13.93	2.55
HIG	26	14.78	2.01	30	14.30	2.28
F-statistics	5.01, $P < 0.01$			1.83, $P > 0.05$		

Table 5.6.4. Haemoglobin content(g/dl) by income groups among adult females

Income groups	Christians			Non-christians		
	N	Mean	SD	N	Mean	SD
LIG	31	13.26	2.71	40	12.27	1.82
MIG	40	13.33	2.49	43	13.13	2.22
HIG	28	14.54	2.25	30	13.78	2.44
F-statistics	2.40, $P > 0.05$			3.89, $P < 0.05$		

Table 5.6.5. **Difference in means of haemoglobin content(g/dl) between income groups**

Income groups compared	Males		Females	
	Difference ± S.E.	z-value[a]	Difference ± S.E.	z-value[a]
<u>Christians</u>:				
LIG vs MIG	0.45 ± 0.53	0.85	0.07 ± 0.63	0.11
LIG vs HIG	1.31 ± 0.58	2.26*	1.28 ± 0.65	1.97
MIG vs HIG	0.86 ± 0.50	1.72	1.21 ± 0.58	2.09*
<u>Non-christians</u>:				
LIG vs MIG	0.66 ± 0.51	1.29	0.86 ± 0.44	1.95
LIG vs HIG	1.03 ± 0.53	1.94	1.51 ± 0.53	2.85**
MIG vs HIG	0.37 ± 0.57	0.65	0.65 ± 0.56	1.16

a. z = Difference/S.E.; * $P < 0.05$; ** $P < 0.01$.

Table 5.6.3. shows the haemoglobin content in males according to income groups. It is seen that the haemoglobin content tends to increase with the increasing economic level for both the religious groups, though the differences among the three income groups are significant only among the CH ($F = 5.01$, D.F. = 2, 102; $P < 0.01$).

The haemoglobin content by income levels for the adult females is presented in Table 5.6.4. It is seen that the mean value of haemoglobin content is highest in the LIG, which is followed by the MIG, and then by the

LIG. However, the analysis of variance shows that the difference among the three income groups are significant only among the NCH ($F = 3.89$, D.F. = 2, 110; $P < 0.05$).

The differences between income groups, with respect to haemoglobin content for both the religious groups, are shown in Table 5.6.5. Among the CH, the difference in mean value of haemoglobin level is found to be significant in the case of the comparison between the LIG and HIG for males, and between the MIG and HIG for females. Among the NCH, on the other hand, there is no significant difference between income groups, except the difference between the LIG and HIG for females (Table 5.6.5).

In the foregoing chapters (i.e. chapter IV and chapter V), we have presented our findings on the War Khasi. In the subsequent chapter, we shall discuss the present findings in the light of data available on other populations with a view to making the implication of the findings.

CHAPTER VI

DISCUSSION

In the present study, we have dealt with the War Khasi in relation to nutrition and health traits with limited parameters. Accordingly, we have presented our findings in chapters IV and V. In this chapter, we shall discuss our findings in the light of data available on other populations. We shall also point out the implication of the present findings.

Christianity

For the purpose of the present study, we have grouped the War Khasi into two broad religious groups, i.e. the Christians(CH) and the Non-christians (NCH). It may be mentioned that the arrival of Christianity in this hilly region of the country has brought about a tremendous change in the life style and condition of the people, especially in the domain of religious beliefs and practices.(Das Gupta, 1984). Hinduism has also started spreading among the War Khasi, especially in Shella and Cherrapunji areas. However, the spread of Christianity is no doubt faster than that of Hinduism. Das Gupta (1984) has also observed that the Christian War Khasi are more advanced and educated than the Non-christian War Khasi (i.e.followers of **Niam Khasi** and other religions). It may be noted that in all the five villages, covered under the present study, there are only the Christians and the followers of **Ka Niam Khasi** or Khasi religion. As far as the present study is concerned, it may be observed that the Christians are more educated, having better dietary intakes, better economic condition, lower fertility and mortality, etc. than the Non-christians.

Average Family Size

The average family size in both the CH (6.97 ±2.77) and NCH (6.45 ± 2.95) is large in comparison with that of the national average (5.0) and other tribal populations (Rajyalakshmi, 1991). It is found that about 63.82 % and 52.34 % of the CH and NCH families, respectively, have a family size of more than 7. However, the average family size in both the CH and NCH is similar to that among the Muklom (6.67) of Arunachal Pradesh (Sarkar, 1995). Rajyalakshmi(1991) has suggested that the family size is associated with many socio-cultural factors like pre-marital relations, equal liberty for both sexes to divorce and re-marriage, high frequency of the cases of widowed, separated and divorce, high fertility rate, etc. In the present study, it has been observed that the fertility rate is high in both the religious groups. It is reported that the Family Planning Programmes, launched by the Government, have not yet reached their momentum in this tribal population (Khongsdier, 1991). However, it is true that many tribals in India have used medicinal herbs for controlling fertility rate(Gore et al.,1977;Rajyalakshmi,1991). As far as the present population is concerned, no information could be obtained, or has been reported regarding the use of medicinal herbs for controlling fertility rate. So, it seems that this population lives in natural condition. Nevertheless, a large number of factors might have attributed to the large family size.

Economic Condition

Among the War Khasi, agriculture and/or horticulture is/are the primary occupation of the people. The important agricultural produce include paddy, arecanut, bay leaf, betel leaf, lemon, orange, broom stick (thysamolanena), banana, pine apple, guava, pepper, ginger, tumeric, etc. The people, who practise the rice cultivation, are mostly those inhabiting in the plain areas, which are on the border of Bangladesh. As far as the present study is concerned, none of the households has reported to have cultivated paddy.

Besides agriculture, agricultural labour is the secondary occupation of the War Khasi. In the present study, it has been found that about 28.95% and 33.64 % of the families in the CH and NCH, respectively, do not possess any land property. So, these families depend largely on agricultural labour, though some of them are also engaged in business and services. Some others have trade and commerce relation with the Bangladeshis, Khynriam, and others at different marketing centres of the area.

On the basis of per capita monthly income, the War Khasi of the present study are broadly categorised into three economic groups (Chapter III). It is found that the frequency of households with low per capita income is higher among the NCH (42.06 %) than that among the CH (34.21 %), though the difference between them is not statistically significant.

Literacy

Education is believed to be one of the important social factors, which plays a key role to the development of human life. In their observation on the importance of education, Edmundson et al. (1992) point out, "Economic development begins with the change from traditional to innovative ways of thinking. Social development begins with the change from elitist to communal thought patterns. Biologic developemnt begins with awareness of the communal importance of public health as a key to private health". Therefore, education is undoubtedly associated with many bio-social development of an individual, or a population.

According to 1991 Census, the total literacy rate for the states of Mizoram, Nagaland, Manipur, Tripura, Assam, Meghalaya and Arunachal Pradesh are 81.23 %, 61.20 %, 60.96 %, 60.39 % 53.42 %, 48.26 % and 41.22 %, respectively. So, it shows that Meghalaya has the second lowest literacy rate among all the seven north-eastern states. It is really surprising, if we take into consideration the time since the arrival of modern education in this state, i.e. since 1841, or more than 150 years ago. So, though Christianity had arrived in Meghalaya much earlier than in other tribal states (Burman, 1988), its impact on literacy rate is not much perceptible. It may also be noted here that the State Government has implemented the Adult Education Programme for more than a decade now (Directorate of Information and Public Relation, 1992). However, considering the present literacy rate in the state, it shows that the implementation of this Programme has not produced much fruitful result. According to 1981 Census, the total literacy rate in the state was 42.02 %. It shows that the decadal growth rate in literacy is only 6.04 %. As far as the present study is concerned, the total literacy rate among the War Khasi is 53.26 % (i.e. 54.17 % among the CH and 52.60 % among the NCH). So, it is clearly evident that the literacy rate in this population is also low, when compared with those reported for the other states of North-Eastern region (except Arunachal Pradesh), though these figures among the War Khasi are higher than that reported for the state as a whole.

Nutrient Intakes

Calories and Protien: The calorie intakes among the CH(3008.69kcal) and NCH (3050.66) of the War Khasi are above the recommended allowance (2875 kcal) for an Indian adult man doing 'moderate work'(ICMR, 1989). In the north-eastern region, Roy and Rao (1962) have reported the calorie intakes of 2600 kcal, 3150 kcal, 2960 kcal, 2650 kcal and 2650 kcal among the Tripuri, Riang, Padam Abor, Minyong Abor and Gallong Abor, respectively. So, it shows that the calorie intakes in both the religious groups of the War Khasi are higher than those among the Tripuri, Padam Abor, Minyong Abor and Gallong Abor, but marginally lower than that among the Riang of Tripura.

In comparison with other Indian populations, the consumption of calories among the CH and NCH is higher than that among the Baiga(2600 kcal), Muria (2760 kcal), Urali (2410 kcal), Kanikkar (2200 kcal), Muthuvan

(2640 kcal), Malapantharam (1850 kcal), Ullatan (2450 kcal), Paniya (1975 kcal), Mulla Kurumba (2730 kcal) and other tribal populations (Roy and Rao, 1962). It is also higher than that reported for the Kharwar (2565 kcal) of Bihar (Bhattacharya et al., 1972), Koya (2380 kcal) of Orissa (Roy and Roy, 1971), Mirpur population (2106 kcal) of West Bengal (Bhattacharya et al., 1981), Maria Gond (2630 kcal) of Maharashtra (Rao and Rao, 1994), Maria Gond (2038 kcal) of Madhya Pradesh (Rao et al., 1986), Pasi (2403 kcal) and Bramhakalpit Brahman (2439 kcal) of Gaya town (Chowdhury and Haque,1993). But it is not as high as that among the Toda(3100 kcal) of Nigiri hills (Roy and Rao, 1962) and Lepcha (3571.86 kcal) of Kalimpong (Basu et al. , 1987). It is, however, similar to that reported for the Kota (3060 kcal) of Nilgiri hills (Roy and Rao, 1962) and Sherpa (3017.12 kcal) of Khumbu (Basu et al., 1987).

With regard to protien intake, it is found that both the CH(96.88 g) and NCH (86.88 g) have consumed much more than the recommended allowance (60 g). The consumption of protien in both the religious groups of the present population is higher than that reported for the Tripuri (63 g) and Riang (76 g) of Tripura, and the Minyong Abor (68 g), Gallong Abor (70 g) of Arunachal Pradesh (Roy and Rao, 1962).

Turning to other Indian tribal populations, several studies (Roy and Rao, 1962; Roy and Roy, 1971; Bhattacharya et al., 1972; Pingale,1973; Pratap, 1973; Sherma et al., 1977; Gore et al., 1977; Sen Gupta, 1980; Roy and Chaudhuri, 1983; Rao et al., 1986; Rajyalakshmi, 1991 and Rao and Rao, 1994) show that the protien intake among the Indian tribes varies from

13.0 g among the Kanikkar and and Malapantharam (Roy and Rao, 1962) to 130.0 g among the Great Nicobarese (Roy and Chaudhury, 1983). In comparison with the findings of the above mentioned studies, it is found that the protien intake among the CH is higher than that among many tribal population, except among the Great Nicobarese (130.0 g) and Onge (117.6 g) of Little Andaman (Roy and Chaudhury, 1983). On the other hand, the consumption of protien among the NCH is similar to that among the Kharowar (88.3 g) and Kota (89.9 g) as reported by Roy and Chaudhury, 1983). In brief, it shows that the consumption of protien among the CH and NCH is high in comparison with other Indian tribal populations.

Fat: A very few studies have shown the quantitative aspects of fat on the diets of different Indian populations. In the present population, it is found that the consumption of fat in both the CH (38.17 g) and NCH (35.13 g) is much more than the recommended allowance (20.0 g) given by the Indian Council of Medical Research (ICMR, 1989). It is also higher than that reported for the Koya (9.10 g) of Orissa (Roy and Roy, 1971), Kharwar (21.20 g) of Bihar (Bhattacharya et al., 1972), Mirpur population(15.60g) of West Bengal (Bhattacharya et al., 1981) and Pasi (26.0 g) of Bihar(Chowdhury and Haque, 1993), but similar to that among the Bramhakalpit Brahman (38.0 g) of Bihar (Chowdhury and Haque, 1993).

Calcium and Iron: Among the War Khasi, the consumption of calcium is above the recommended allowance(400.0 mg) in both the CH(538.32 mg) and NCH (617.77mg). In the north eastern region, Roy and Rao (1962) have reported that the calcium intakes among the Riang, Tripuri, Padam Abor, Min-

Abor and Gallong Abor are 400.0 mg, 200.0 mg, 1000.0 mg, 600.0 mg and mg, respectively. So, it indicates that the consumption of calcium g the CH and NCH is higher than that among the Riang and Tripuri, but than that found among the Padam Abor and Gallong Abor. However, it re or less similar to that among the Minyong Abor of Arunachal Pradesh.

In comparison with other Indian populations, the calcium intake th the religious groups of the War Khasi is higher than that among the (400.0 mg), Urali (300.0 mg), Kanikkar (400.0 mg), Ullatan (400.0 mg), a (280.0 mg) and other tribal populations, as reported by Roy Roy and 1962). It is also higher than that reported for the Pasi (242.0 mg) har (Chowdhury and Haque, 1993), Gadara (56.0 mg) and Kondadora (66.0 f Viziayanagaram (Rajyalakshmi, 1991), Maria Gond (235.0 mg) of Maha- ra (Rao and Rao, 1994), Maria Gond (242.0 mg) of Madhya Pradesh (Rao ., 1986);Kharwar (462.0 mg) of Bihar (Bhattacharya et al., 1972), Koya mg) of Orissa (Roy and Roy, 1971) and Mirpur population (336.0 mg) st Bengal (Bhattacharya et al., 1981). But it is not as high as ported for the Muthuvan (1200.0 mg), Toda (1600.0 mg), Irula(1600.0 Nilgiri hills (Roy and Rao, 1962), Jatapu (1159.0 mg) and Savara .0 mg) of Viziayanagaram (Rajyalakshmi, 1991), Bramhakalpit Brahman mg) of Bihar (Chowdhury and Haque, 1993). It is, however, simi- that found among the Baiga (600.0 mg) of Madhya Pradesh and Kota mg) of Nilgiri hills (Roy and Rao, 1962).

The consumption of iron among the CH (32.44 mg) and NCH (29.11 mg) ut 115.86 % and 103.96 % of the recommended allowance (28.0 mg), respectively. This iron intake in both the religious groups is higher than that reported for some tribal populations in the north-eastern region (Roy and Rao, 1962), though the consumption of iron among the Padam Abor (31. 0 mg) of Arunachal Pradesh is higher than that among the CH of the present population.

In comparison with other tribal and non-tribal populations, it is found that the iron intake in the CH and NCH is higher than that reported for the Urali (12.0 mg), Kanikkar (8.0 mg), Malapantharam (8.0 mg), Muthuvan (22.0 mg), Ullatan (11.0 mg) of Kerala, Paniya (21.0 mg), Mulla Kurumba (24.0 mg), Urali Kurumba (24.0 mg) and Toda (17.0 mg) of Nigiri hills (Roy and Rao, 1962), Mirpur population (34.6 mg) of West Bengal (Bhattacharya et al., 1981), Kharwar (46.4 mg) of Bihar (Bhattacharya et al., 1972), Bramhakalpit Brahman (44.0 mg) of Bihar (Chowdhury and Haque, 1993), and the other tribal populations as reported by Rajyalakshmi (1991). But it is similar to that among the Irula (31.0 mg) of Madras (Roy and Rao, 1962) and Pasi (33.0 mg) of Bihar (Chowdhury and Haque, 1993).

Vitamin A (β Carotene): The consumption of vitamin A in both the CH (1701.07 µg) and NCH (1665.37 µg) is much lower than the recommended allowance (2400.0 µg). In comparison with the tribal populations in the north-eastern region (Roy and Rao, 1962), it is found that the consumption of vitamin A in both the religious groups is higher than that among the Tripuri, Riang, and Minyong Abor, but lower than that among the Padam Abor. It is, however, similar to that among the Gallong Abor of Arunachal Pradesh.

In comparison with other tribal and non-tribal populations, the consumption of vitamin A in both the CH and NCH is higher than that among the Muria of Madhya Pradesh; Urali, Kanikkar, Malapantharam, Muthuvan and Ullatan of Kerala; Urali Kurumba, Toda and Kota of Nilgiri hills (Roy and Rao, 1962). It is also higher than that among the Koya of Orissa (Roy and Roy, 1971), Kharwar of Bihar (Bhattacharya et al., 1972), Maria Gond of Maharashtra (Rao and Rao, 1994), Maria Gond of Madhya Pradesh (Rao et al., 1986), Pasi and and Bramhakalpit Brahman of Bihar (Chowdhury and Haque, 1993) and other tribal populations (Rajyalakshmi, 1991). It is, however, lower to that among the Baiga of Madhya Pradesh, Paniya of Nilgiri hills (Roy and Rao, 1962) and Mirpur population of West Bengal (Bhattacharya et al., 1981). But it is similar to that among the Urali Kurumba and Irula of Nilgiri hills (Roy and Rao, 1962).

Vitamin B_1 (Thiamine) and Vitamin B_2 (Riboflavin): The consumption of vitamin B_1 is always high in many tribal populations (Roy and Rao, 1962); Roy and Roy, 1971; Bhattacharya et al., 1972; Rajyalakshmi, 1991; Rajyalakshmi, 1991; Rao and Rao, 1994). Among the War Khasi, it is found that the consumption of vitamin B_1 in both the CH (1.65 mg) and NCH (1.53 mg) is above the recommended allowance (1.4o mg). With respect to the consumption of vitamin B_2 , it is found to be much lower than the recommended allowance (1.60 mg) in both the CH (0.93 mg) and NCH (0.79 mg). This low consumption of vitamin B_2 can be observed in many tribal populations (Roy and Rao, 1962; Roy and Roy, 1971; Bhattacharya et al., 1972; Rajyalakshmi, 1991; Rao and Rao, 1994).

Vitamin C (Ascorbic Acid): The consumption of vitamin C among the CH (42.76 mg) and NCH (39.75 mg) is by and large according to the recommended allowance (40.0 mg). It is found that this intake of vitamin C in both the religious groups of the War Khasi is higher than that among the Tripuri (12.0 mg), Riang (27.0 mg), Minyong Abor (16.0 mg) and Gallong Abor (17.0 mg), but much lower than that reported for the Padam Abor(65. 0 mg) of Arunachal Pradesh (Roy and Rao, 1962).

The consumption of vitamin C in both the religious groups of this population is also higher than that reported for many tribal populations (Roy and Rao, 1962; Bhattacharya et al., 1972; Rajyalakshmi,1991) ,though it is lower than that among the Baiga (59.0 mg) of Madhya Pradesh, Urali (46.0 mg) of Kerala, Mulla Kurumba (49.0 mg) and Irula (52.0 mg) of Madras (Roy and Rao, 1962) and Koya (56.0 mg) of Orissa (Roy and Roy,1971).

Niacin (Nicotinic Acid) and other Vitamins: The consumption of niacin and other vitamins like vitamin B_{12} , and follic acids among the CH is found to be above the recommended allowances(Table 4.2.2B). However, the consumption of niacin is found to be much lower than those found among the tribal populations in the north-eastern region (Roy and Rao, 1962). It is, however, similar to that reported for the Urali Kurumba (24.0 mg),Toda (24.0 mg) and Kota (25.0 mg) of Nilgiri hills (Roy and Rao, 1962),Koya(25.9 mg) of Orissa (Roy and Roy, 1971) and Pasi (23.0 mg) of Bihar (Chowdhury and Haque, 1993).

From the above discussion, it is understandable that the overall nutrient intakes among the War Khasi (both CH and NCH) is by and large as per recommended allowances. It is also seen that the overall nutrient intake in this population is above and/or very similar to those found in other tribal and non-tribal populations of this country.

Nutritional Anthropometry

It is seen from our analyses of data in chapter IV that the use of international, or national population reference as a standard or target of growth performance of children may be essential for comparative purposes of growth studies, but not for the assessment of growth and nutritional status of children,i.e. by assuming the international or natioanl standard as a measure of the magnitude of malnutrition. We have already shown that an assessment of growth and nutritional status of children depends upon a uniform and systematic method of determining the cut-off points and trigger levels applicable to any population, irrespective of different standards.

Recently, Osmani (1992) has made a review of literature regarding controversy over the measurement of undernutrition among children by the anthropometric method. He has summarised that one of the two groups is influenced by the theory of "Genetic Potential" and the other by the"Heretic View". According to the Genetic Potential Theory, "...thre is no difference in the genetic potential of different races of the world". The failure to achieve the maximal genetic potential is believed to be due to environmental factors like nutrition, etc., thereby resulting in growth retardation. The exponents of the Genetic Potential Theory have substantiated their arguments by showing the emperical evidence that the children, belonging to the high socio-economic strata in many developing countries, have shown their growth pattern similar to that of their coevals in developed countries. The Heretic View, on the other hand, maintains that the "... deviations from genetic potential does not entail any functional impairment", i.e. children or adults can be"small but healthy". Accordingly, Seckler (1982) has advised the Indian nutrition scientists that the use of international standard, or the national standard which is derived from the Indians, belonging to the high socio-economic groups, may be likely to overestimate undernutrition.

Thogh the WHO Working Group (1986) does not consider this point of view as very important, the above phrase, "Small but Healthy" coined by Seckler seems to have some implications in the present study, if we take into consideration the complex interaction between genetical and environmental factors on growth pattern of children as well as on variations in adult body dimensions. In this connection, one may recall what Tanner (1978) says, "Though rate of growth remains one of the main useful of all indices of public health and economic well-being in developing and heterogenously developed countries, it must not be thought that bigger, or faster is necessarily better. From an ecological point of view, smallness has advantages. ...." Recently, he (Tanner, 1992) has further observed, "It does look, as though height indeed can be a proxy for health and for the attainment of biological potential. This is true, of course, only when comparing groups , not in comparing individuals, the variation between whom is overhelming due to genetical causes except in the direct circumstances. But between social classes, urban and rural dwellers, educated and uneducated, the height is a useful proxy for <u>aisance de vie</u>".

If genes and environment are responsible for human variation, with respect to growth or adult physique, their effective role in growth and metabolic processes cannot be ignored (Payne, 1992). In fact, physical growth and development of children is influenced by a large number of biological and environmental factors (Eveleth and Tanner, 1990). Therefore, growth retardation in a population is not only the manifestation of undernutrition and infection, but also that of genetical and environmental interaction. The way in which a population has reacted and is reacting to environmental conditions, "depends upon genetic characteristics of individuals as well as the amount and kind of genetic variability in the population"(Dobzhansky et al., 1976). With respect to nutrition, Uderwood (1975) is of the opinion, "Natural selection has operated on gene pools of populations subject to chronic undernourishment in favour of genotypes underlying such phenotypic plasticity, eg. by removal of children lacking the ability to respond the nutritional stress through a reduction of metabolically demanding growth needs". But, "Since the process of natural selection is essentially a 'sufficing'one rather than 'optimizing' one, an individual needs only to be sufficiently better adapted to an altered environment...."(Payne, 1992).

With regard to genetic potential of growth, it may be accepted that the children, belonging to the higher economic strata in developing countries, have shown their growth potential corresponding to the international standards, or that the fertility and/or mortality rates among the high socio-economic groups in these countries, are similar to those in developed countries. This might have happened due to relaxation of "Selection Pressure". Nowadays, with the advancement of science and technology, the relaxation of selection pressure is quite obvious everywhere. For instance, natural selection is believed to operate through differential fertility and mortality, but with the improvement of medical facilities, adoption of family planning, etc., selection pressure is relaxed to a great extent (Matsunaga, 1966). Similarly, the high socio-economic groups of a population are supposed to have better dietary intakes, education, child care, medical and sanitation facilities, etc.. As a result, the growth performance of their children is much better than that of their counterparts in the lower socio-economic strata. In this respect, it does look as if the relaxation of selection pressure is, of course, related to the achievement of genetic potential in growth performance of children. But what really concerns us is that among the majority of populations in many developing countries, including India, natural selection is still very active and plays a major role, as most of these populations are living in natural condition. In these populations,"natural selection can either promote constancy, direct continous change, or promote diversification", depending upon environmental variability, or stresses (Dobzhansky et al., 1976). In this connection, we may also recall what Johnston (1973) has said, "Selection operates only when the environment interacts differently with different phenotypes, which themselves are the results of different genotypes. As environments change,or as populations develop alternative ways of response, selection pressure may themselves be modified".

In the light of the above circumstances, it indicates that growth retardation and/or maximal genetic potential is/are associated with the complex interaction between genetical and environmental factors. As far as the present study is concerned, it is also found that the growth performance of children is associated with some bio-social factors. In chapter IV, we have pointed out the problems, regarding the use of international or national population reference as a standard or target for measuring the growth status and/or magnitude of undernutrition in the present population. We have also proposed a simple method of determining the cut-off points and trigger levels for screening the population into different nutritional grades. In view of that, one may suggest that it really warrants a further indepth research to have a better understanding of this problem. Ethnic differences, owing to genetical and environmental factors cannot be ignored while studying the growth performance of children. In this connection, it may be recalled to what Stern (1967) says, "We are different in genes, we received at conception, different in health and disease, intelligence endowment and personality traits. Like all other organisms, we belong to a polymorphic species. We must educate ourselves to accept the many faceted inequalities of man. We must not forget also that an individual person who ranks high in some respects may rank average or below in others. The same multidimensional aspects would apply to sub-populations such as socio-economic layers or racial groups".

Fertility and Mortality

It may be mentioned that the demographic characteristics of the present population - CH and NCH - have already been reported and compared with other populations (Khongsdier, 1991, 1994a, 1994b, 1995). In the present study, special emphasis has been given to compare the present findings with those already reported for other populations in north-east India.

It is seen from the present analyses that the mean number of live-births per ever-married woman of all ages is 4.87 $\pm$ 0.21 in the CH and 4.90 $\pm$ 0.19 in the NCH. These mean numbers of live-births among the CH and NCH War Khasi are slightly higher than those reported for the the Christian and Non-christian Khasi (Nag, 1965; Baruah and Das, 1982), but lower than that among the Pnar or Jaintia (Khongsdier, 1992). It is, however, similar to that found among the Hajong of Meghalaya (Barua, 1983).

In comparison with other populations in the north-eastern region, the mean number of live-births in both the religious groups is found to be higher than that among the Meitei (4.34) and Tangkhul Naga (4.44) of Manipur (Chakravartti, 1986), Digaru Mishmi (3.26), Miju Mishmi (3.74) and Idu Mishmi (4.14), but much lower than that among the Brahmin (6.51), Kalita (6.44), Kaibarta (5.41) of Assam (Das and Das, 1993). It is, however, similar to that among the Kabui Naga (4.83) and Muslims (4.91) of Manipur (Chakravartti, 1986), and Mongoloid populations (4.76) of Assam (Das and Das, 1983).

In brief, according to the studies carried out by Nag(1965), Baruah and Das (1982), Barua (1983), Chakravartti (1986), Buzarbarua (1990), Khongsdier,(1992), Choudhury (1993); the mean number of live-births per ever-married woman of all ages, in the tribal populations of the north-eastern region, ranges from 3.26 among the Digaru Mishmi of Arunachal Pradesh (Choudhury, 1993) to 6.04 among the Pnar of Meghalaya (Khongsdier, 1992). Among the Hindu caste populations of Assam, this mean number of live-births ranges from 4.42 among the Jogi (Das and Das, 1992) to 6.51 among the Brahmin (Das and Das, 1993). So, it shows that the fertility rate among the CH and NCH War Khasi falls towards the middle part of the range for the populations in the north-eastern region.

With respect to infant mortality, some studies (Das and Das, 1982; Barua, 1983; Buzarbarua, 1990; Khongsdier, 1992; Das and Das, 1993;Choudhury, 1993; Khongsdier, 1995) have revealed that the infant mortality rate among different populations in the north-eastern region ranges between 1.58 % in the Brahmin of Assam (Das and Das, 1993) and 31.27 % among the Idu Mishmi of Arunachal Pradesh (Choudhury, 1993). So, it shows that the infant mortality rate among the the CH (7.03 %) and NCH (8.67 %) is moderate in comparison with other populations in the north eastern region. However, thes figures are found to be higher than that reported for the Munda (Buzarbarua , 1990), Brahmin, Kalita and Kaibarta of Assam (Das and Das, 1993), but much lower than that found among the Pnar (Khongsdier, 1992), Hajong (Barua,1983), Digaru, Miju and Idu Mishmi (Choudhury, 1993).

As far as juvenile mortality rate is concerned, it is found that the War Khasi- CH and NCH - have lower rate than that among the Pnar(Khongsdier, 1992), Hajong (Barua, 1983), Kaibarta (Das and Das, 1993) and Munda (Buzarbarua, 1990), but similar to that among the Brahmin and Kalita of Assam (Das and Das, 1993).

Anthropometric Variables and Reproductive Performances

Several studies have been carried out to show the relationship between anthropometric traits and reproductive performances of women (Davenport, 1923; Clark and Spuhler, 1959; Conterio and Cavalli-Sforza, 1960 ;

Bressler, 1962; Damon and Thomas, 1967; Vetta, 1975; Martorell et al., 1981; Brush et al., 1983; Devi et al., 1985; and others). According to Brush et al.(1983), "A focal concern in biological anthropology is the relationship between the biological variation and reproductive performance. Where biological differences have a genetic basis, associations with reproductive performance have evolutionary implications but even where such differences are solely environmental in origin, association with reproductive performance can provide important insights in the ecology of populations".

In the present study, an attempt has been made to find out the possible relationship between some anthropometric variables and reproductive performances with a view to understanding the interaction between genetical and environmental factors. However, no attempt has been made to categorise the different types of selection on the bases of sophisticated statistical analyses with regard to these biological parameters. The associations between reproductive performances and anthropometric variables have been tested by a simple multiple regression analysis, taking into consideration the effect of age. It is found that the live-birth and infant mortality are significantly associated with stature, weight, bi-iliac diameter and body fat, despite the absence of statistical significance after removing the effect of maternal age with respect to body fat.

It may, however, be mentioned that the above anthropometric characters may not be independently associated with fertility and mortality, since they might also be correlated with each other. Moreover, anthropometric traits may also be influenced by the 'reproductive process'. According to Brush et al. (1983), "On the one hand, an association may arise because an anthropometric variable is causally related to reproductive performance. On the other, it may well be that an association between reproduction and an anthropometric trait is the result of a third factor (or factors) which affects both the trait and the level of reproduction. If this third factor is genetic, then the association may simply be a reflection of a genetically based efficiency in building body tissue. If the third factor is environmental, then the association could arise from the effect of a component, such as nutrition or disease, on both the level of reproductive performance and on the magnitude of the trait. Therefore, the importance of an association to the understanding of reproductive performance may be in the use of an anthropometric variable as an indicator of other factors, rather than as an immediate causal explanation for the observed level of reproduction". Nevertheless, the study of the relationship between anthropometric variables and reproductive performances may be very helpful for the genetic and environmental interpretation of human variation. From a genetic point of view, the importance of an association depends on the genetic variation underlying the anthropometric trait. "In this case, the focus of attention is on genetic differences among individuals and the effect that the anthropometric variation has on Darwinian fitness...." From an ecological point of view,"the focus of attention is on environmental and behavioural differences among individuals" (Brush et al., 1983).

In the present study, it is observed that fertility and mortality are also associated with with some socio-economic conditions like religion, education and per capita monthly income. It is also noticed that there is a positive relationship between dietary intake and economic condition.

So, it shows that the reproductive performances of women in this population are associated with many bio-social and environmental factors. As a result, natural selection might have played its different roles in the present populations. It may be worthwile to mention here that the intensity of natural selection with regard to differential fertility and mortality has already been reported for both the CH and NCH(Khongsdier, 1994b). It is found that selection is slightly more relaxed among the CH (I = 0.36) than that among the NCH (I = 0.45). So, these findings are in confirmation with the observation that selection pressure varies with varying environmental conditions (including socio-economic conditions) of the population (Johnston, 1973).

Variation in Adult Body Dimensions

It is already mentioned that the main objective of physical anthropology is to understand the processes of human evolution and variations and the causes of such variations. "Genetically, human evolution may be conceived as occuring through changes in the frequency of genes in the human gene pool"(Motulsky, 1960). It is also considered "Changes in the morphology of organisms through time" (Buettner-Janusch, 1966). Morphological characters include anthropometric measurements and somatoscopic observations. According to Oliver and Howell (1957), "these traits (anthropometric traits) constitute a whole field of human variation in size and shape, furthermore involving modification by environment as well as the relationship and differentiation of populations - in short, all the processes of micro-evolution".

In the present study, it is observed that there are differences in some anthropometric characters between villages. Moreover, it is also found that there are differences between and among income groups in respect of certain anthropometric measurements. This holds good for both sexes of the population. With respect to the Khasi population as a whole, Das (1978, 1985) has reported that "among the Khynriam, War and Pnar, there were differences with regard to morphological characters and not in genetic traits. However, the Bhois deviate from the others in all respects ". In this connection, he (Das, 1979) has pointed out that "It is very difficult to offer an explanation of such behaviour of the Bhois, as not only one, but a large number of factors may be related to it". Considering the geographical distribution of the Bhois, he is of the opinion that "there is a possibility of gene inflow to the Bhois from the neighbouring populations". As far as the present study is concerned, we are not in a position either to support or refute the contention made by Das (1979), since we have no data on the mating pattern and marriage practices of the Bhoi. However, it may be agreable to what Das (1979) says, "Whatever may be the causes, a comprehensive picture of the nature and range of variation in metric and a few genetic parameters in the Khasi population suggests a micro-evolutionary trend".

In addition to the above findings, reported by Das (1978, 1979, 1985), it shows that in the War Khasi population, there are also morphological differences between villages and even between economic groups within a village. In other words, among the War Khasi, there are also inter and intra village variations with regard to anthropometric traits. we have no data on genetic markers, we are not in a position to say whether or not this trend is perceptible in respect of genetic traits. However, it may be worthwhile to mention here that in this population, there is a strong tendency towards village endogamy as well as towards religious endogamy(Khongsdier, 1994a). Such a strong tendency to village as well as to religious endogamy may lead, if not already, to the formation of several **demes**, or small sub-endigamous groups within the blanket War Khasi population. As a result, there could be many social and biological variations between religious groups or villages within this apparently bigger endogamous group,i.e. the War Khasi. From a genetical point of view, there is a strong possibility that each of the villages must have a separate gene pool, which may result in variation between villages with regard to genetic systems. The present findings, with respect to anthropometric characters, seem to support the above observation. However, we need data on genetic markers (like blood groups, serum protien, red cell enzymes, etc.) to strengthen the above contention.

From an environmental point of view, morphological characters are polygenic traits, but they are also subject to the great influence of environmental factors (Shapiro, 1939; Oliver and Howell, 1957). Whatever it may be, the recent genetic studies have revealed the increasing variety of polymorphisms, "first of all the blood groups, followed by the serum and other protiens, enzymes, immunogenetic variables," etc. (Roberts, 1991). It clearly indicates the long term effect of natural selection on the above discontinous traits. Previously. these traits were used to be considered as non-adaptive. Pointing out to this problem, Das (1979) says, "All these works suggest that the blood groups are not free from the influence of natural selection and their gene frequencies in a population may be altered. Thus if a change in genetic composition of population is regarded as evolution, then evolution has been taking place". So, what we like to point out here, is that changes in gene frequencies or morphological characters of a population are not completely free from the environmental influences. However, body dimensions are more sensitive to environmental influence than qualitative traits like hair form, or nasal contour (Shapiro , 1939), or discontinous traits like blood groups, serum protien, etc.

To make this point little clear, it is found, in the present study, that there is a positive relationship between per capita income and anthropometric variables within the same village in which the members are supposed to share a common gene pool. It is also found that the higher income groups have better dietary intakes than the low income group. So, it suggests that the anthropometric measurements are more sensitive to nutrition, economic condition, and other socio-environmental factors. This pattern of intra variation with regard to anthropometric characters have also been revealed in other studies (Shapiro, 1939; Majumdar et al., 1985; Basu et al., 1987; Bharati, 1989).

In the light of the above discussion, it shows that the anthropometric characters are associated with various biological and environmental factors. In other words, it seems that they are not completely free from either genetical or environmental factors. As far as the present study is concerned, it is observed that the intra village variations with regard to some anthropometric variables are mainly due to socio-economic and other environmental factors like nutrition, etc. On the other hand, the differences between villages might have associated with both genetic and environmental factors, since there is a strong possibility that each village is a small sub-endogamous group of the present population and should have a separate gene pool (Khongsdier, 1994a). Moreover, differences in physical environment might have also exerted their influence on the processes of differentiation and modification in morphological characters. In our discussion on the nutritional status of this population, we have already mentioned that selection pressure varies with the varying environmental conditions. We have also pointed out the possible relaxation of selection pressure, owing to the advancement of science and technology. The variation in morphological characters between income groups of the present population may have some implications in this context. In fact, the operation of selection on human population "may be of different natures"(Das, 1979), depending upon the adaptation of population. After all, we hope that further researches will throw much more light on what we have pointed out here.

Physical Growth

According to Brody (1945), "Growth is biologic synthesis, production of new bio-chemical units". It may also be noted that in physical growth studies, the terms 'growth' and 'development' are used simultaneously. According to Garn (1952), these terms "refer to processes common to all living organisms, processes intimately linked in time but partially independent, unquestionably genetically determined, yet uniquely susceptible to environmental modification". So, growth and development refer to the biological processes concerning cell multiplication and enlargement, or changes in shape and size of the whole individual. It is subject to the influence of both genetic and environmental factors (Eveleth and Tanner,1990). In chapter V, we have made an attempt to show the growth performance of children aged 3 to 15 years. An attempt has also been made to show the probable effect of economic condition on the growth pattern of children in the present population. Accordingly, it has been found that most of the anthropometric variables are highly associated with the economic condition.

Before making further discussion on the basis of the present findings, let us compare the weight and height of the War Khasi boys and girls with those reported by the Indian Council of Medical Research (ICMR,1972) for the Indian children, with a view to understanding the extent of inter and intra population variations,i.e. variations between and within populations with regard to growth pattern of children. We shall also make a special reference to those findings among populations in the north-eastern region. It may, however,be noted that, in the north-eastern region, only few growth studies have been published (Das and Das, 1969-71; Das and Choudhury, 1982; Choudhury et al., 1992; Das and Choudhury, 1992; etc.). Moreover, all the studies have been carried out mostly among the Assamese children of Guwahati city. Besides, these studies are also far from being complete either in terms of different ages or in terms of different anthropometric measurements and indices. In fact, most of the studies have dealt with growth in weight and height only. For the purpose of comparison with the present findings, we have pooled all the available data on the mean values of weight and height of the Assamese children (Table 6.1) and we shall concentrate only on these two anthropometric measurements, i.e. weight and height.

Table 6.1. Mean values of weight(kg) and height (cm) among the Assamese and and War Khasi children

Age in (years)	Assamese				War Khasi			
	Height (cm)		Weight (kg)		Height (cm)		Weight (kg)	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
3	98.40[e]	97.75[e]	14.33[e]	14.30[e]	90.68	90.20	12.91	12.21
4	103.98[f]	104.60[f]	15.61[f]	16.04[a]	96.72	96.19	13.86	13.25
5	111.97[f]	108.97[f]	17.79[f]	16.74[a]	102.78	102.12	15.89	15.42
6	114.17[f]	113.73[f]	18.75[f]	18.46[a]	107.98	107.24	17.83	17.00
7	119.90[f]	118.91[f]	20.42[f]	20.19[a]	113.86	111.23	19.69	18.82
8	125.19[a]	124.34[a]	22.29[a]	22.74[a]	118.96	116.0	21.25	20.27
9	130.71[a]	131.06[a]	24.02[a]	24.69[a]	124.20	121.27	23.48	22.65
10	134.20[b]	133.28[a]	27.07[b]	26.34[a]	127.52	127.15	25.40	24.74
11	139.12[c]	141.31[d]	30.01[c]	31.16[d]	132.44	133.17	27.71	27.98
12	145.09[c]	147.45[d]	32.93[c]	35.28[d]	137.75	139.80	30.36	31.58
13	151.42[c]	151.59[d]	37.24[c]	39.26[d]	142.85	142.36	33.67	33.54
14	157.45[c]	152.99[d]	41.66[c]	40.60[d]	149.87	143.42	37.26	35.38
15	161.72[c]	153.35[d]	45.35[c]	41.61[d]	153.11	144.38	40.49	37.22

Sources: a. Das and Choudhury (1992) and Choudhury et al.(1992)

b. Das and Choudhury (1992), Choudhury et al. (1992) and Das and Das (1969-71)

c. Das and Choudhury (1992) and Das and Das (1969-71)

d. Das and Choudhury (1992)

e. Das and Choudhury (1982)

f. Das and Choudhury (1982) and Choudhury et al.(1992).

Table 6.1 shows that the Assamese boys and girls are much heavier and taller than the War Khasi boys and girls at all ages. It can also be observed that the maximum gain in height and weight among the Assamese children occurs at the age of 12 years for girls and 13 years for boys. Among the War Khasi, it takes place at the age 12 and 14 years for girls and boys, respectively. So, it shows that the adolescent growth spurt in the Assamese boys occurs one year earlier than that among the War Khasi boys. However, both the Assamese and War Khasi girls have gained their maximum growth rate at 12 years of age, though the rate of increment is different between them. It can be seen that the increment in height at this age is higher among the War Khasi girls, whereas the increment in weight is higher among the Assamse girls.

In comparison with the Indian children (ICMR, 1972), it is found that the mean weight of the War Khasi boys and girls are above the 50th centile of the ICMR reference standard at all ages, except at 14 and 15 years when the War Khasi girls are below the 50th centile. Again, when compared with children from different regions of India (ICMR, 1972), it is found that the War Khasi boys are heavier than those boys in Kerala, Madras, Poona, Nagpur and Uttar Pradesh, but much lower in weight than those boys in Orissa, and Madhya Pradesh. This is true at all ages. The War Khasi boys are, however, similar in weight to the Punjabi boys from 3 to 11 years of age, though the Punjabi boys are much heavier from 12 years onwards. Similarly, the War Khasi girls are heavier than their coevals in Andhra Pradesh, Kerala, Madras, Nagpur, Poona, Rajasthan and Utter Pradesh from from 3 to 12 years of age. They are, however, much lighter than those in Delhi and Orissa. From 3 to 8 years, they are more or less similar in weight to Madhya Pradesh girls. In comparison with the Jammu and Kashmiri girls, the War Khasi girls are heavier from 3 to 5 years, then they are surpassed by the former from 6 to 10 years.

The period of maximum gain in weight, which occurs at 12 years among the War Khasi girls, is similar to that among the Delhi and Punjabi girls. Among the other girls in different regions of the country, the maximum increment in weight takes place between 12 and 14 years. Among the boys, it occurs at 14 years, which is similar to that among the Jammu and Kashmiri, Madras and Punjabi boys.

With respect to height, the War Khasi boys and girls are taller than the all India boys and girls from 3 to 5 years, but shorter from 6 to 15 years of age. The War Khasi boys are found to be much shorter than those boys in Delhi, Madhya Pradesh, Orissa, Punjab and Rajasthan, but taller than those in Kerala, Madras and Poona. This is true in almost all ages, with the exception of fluctuating trend here and there. On the other hand, the War Khasi girls are taller than their counterparts in Andhra Pradesh, Kerala, Nagpur and Uttar Pradesh up to about age of 6 years, though they are surpassed from 7 years onwards. They are also taller than the Poona girls from 3 to 7 and 10 - 12 years. Again from 9 to 12 years, they are taller than the Kerala and Madras girls. In fact, the War Khasi girls are taller than those in different regions of India from 3 to 4 years of age.

The highest increase in height takes place between 12 and 13 years of age among the War Khasi boys, which is also taking place among the boys in Madhya Pradesh, Nagpur, Poona, Rajasthan and Utter Pradesh. Among the War Khasi girls, the maximum increment in height occurs between 11 and 12 years. So, it is similar to those girls in Kerala, Madras, Poona, Orissa and Punjab.

In the light of the above comparison, it is obvious that there are population variations in growth and development of children. At the same time, it is also observed in the present population that there are also differences between its economic groups with regard to physical growth. In fact, many other studies have also revealed the effect of socio-economic condition on growth performance of children (Smith et al., 1980; Garn et al., 1984; Rona and Chin, 1986; Elwood et al., 1987; Lasker and Mascie-Taylor, 1989; Eveleth and Tanner, 1990; Hauspie et al., 1992; and others). In this connection, Eveleth and Tanner (1990) have observed that "The ultimate size and shape that a child attains as an adult is the result of continuous interaction between genetical and environmental influences (including socio-economic condition) during the whole period of growth. Such interaction may be complex". They are of the opinion that variation in body size among the populations are mainly due to the effects of environmental conditions. They write, "There are many environmental factors which affect growth, and which combine in various proportions to constitute the amount of poverty; but in the final analyses most of them hinge upon the level of nutrition in conjunction with the prevalence of childhood infection".

In our discussion on the nutritional status of children and adults, we have already suggested the importance of ethnic variations in physical growth, whether they are due to genetics or environment, or due to both factors. Therefore, it may be pointed out that growth retardation, which is commonly assumed to be mainly affected by nutrition and/or infection, is also a manifestation of the complex interaction between genetical and other environmental factors, depending upon the nature of population response(s) to the selection pressure. The important role, played by the natural selection in many developing countries, cannot be totally ignored; since most of the populations in these countries are still living in their natural condition, i.e. with little impact of modern science and technology. It is also true that relaxation of selection pressure on a population, owing to the impact of modern science and technology,cannot be ignored. So,it is already pointed out that the differences in growth performance between socio-economic groups in this population may be associated with relaxation of selection pressure.

Haemoglobin Content

According to the WHO Scientific Group (1968), "Nutritional aneamia is defined as a condition in which the haemoglobin content is lower than normal as a result of a deficiency of one or more essential nutrients,regardless of the cause of such deficiency". The Scientific Group has also reported that "nutritional aneamias are important nutritional problem affecting large population groups in most developing countries.

The haemoglobin content among the War Khasi have been presented in chapter V. It is found that the mean values of haemoglobin content among the CH are 13.99 ± 2.25 g/dl and 13.68 ± 2.56 g/dl for adult males and females, respectively. Among the NCH, these mean values are 13.77 ± 2.39 g/dl and 13.00 ± 2.23 g/dl for males and females, repectively. In the north-eastern region, Das et al. (1979) have reported that the mean values of haemoglobin level among the Adult males of Rabha, Rajbanshi, Kachari and Mikir are 10.89 g/dl, 10.70 g/dl, 10.67 g/dl and 9.67 g/dl, respectively. So, in comparison with these populations , it shows that the mean values of haemoglobin content are much higher in the CH and NCH of the present population.

For the non-pregnant adult women, Das et al. (1979) have reported that among the Kachari and Mikir, the mean values of haemoglobin level are 0.11 g/dl and 9.10 g/dl, respectively, which are much lower in comparison with the present findings among the CH and NCH females of the War Khasi.

In comparison with other Indian populations, the mean values of haemoglobin content among the CH and NCH males are higher than those reported for the Mahishya (13.25 g/dl) of West Bengal, Sherpa (12.29 g/dl) of Echay and Lepcha (9.21 g/dl) of Kalimpong (Roy et al., 1983), but lower than those found among the Bengali (15.70 g/dl) of Calcutta (Napier and Das Gupta, 936), Brahman and Kayastha (14.60 g/dl) of Calcutta (Das and Mukherjee,1982) and Medical students (16.60 g/dl) of Madras (Sankaran and Rajagopal, 1938).

The mean values of haemoglobin level among the CH and NCH females are also found to be higher than those among the Sherpa (10.23 g/dl) and Mahishya (11.68 g/dl) as reported by Roy et al. (1983). Among the CH, it is similar to that among the Medical students (13.70 g/dl) of Madras(Sankaran and Rajagopal, 1938), whereas among the NCH, it is similar to that among the Middle class (13.10 g/dl) of Delhi (Benjamin, 1939) and Bombay sample (12.90 g/dl) as reported by Sokhey (1938).

From the above discussion, it is clear that the overall haemoglobin level among the War Khasi is more than or similar to many tribal and non-tribal populations of India. It can also be seen that the dietary intakes, especially iron, in the present population, are better in comparison with other tribal populations. So, the present finding, with respect to haemoglobin content, suggests that nutritional aneamia is not the major health problem in this population. Similarly, the nutritional anthropometry indicates that the nutritional status of the present population is quite normal, considering the low frequency of moderate and severe forms of undernutrition. Moreover, the frequency of infant and juvenile mortality is also quite moderate in comparison with other populations. Therefore, so far as these parameters are concerned, it indicates that the health status of the War Khasi - both CH and NCH - is, to some extent, better than many Indian tribal populations.

Bio-Social Factors : Their Implications in the Present Study

As far as the present findings are concerned, it is seen that health traits and/or biological traits like reproductive performance, nutritional anthropometry, adult body dimensions, physical growth, and haemoglobin content , are associated with some bio-social factors. Similarly, the dietary intakes , which may be considered a bio-environmental parameter, is also associated with economic condition. All these associations are undoubtedly attributable to the variation in biological traits within the War Khasi population. Further, it is also observed that the quantitative aspects of health traits in the present population are different from those, reported for other populations. Furthermore, there are also inter and intra village variations with regard to body dimensions in the present population. So, it is really very difficult to give a straight forward answere, on the basis of these findings, whether (genetics (ethnic and group differences) or environment (mainly nutrition, including socio-economic conditions) is more influential in regulating the variation in health traits of the present population.

From a genetical point of view, our findings with respect to marriage pattern in the present population (Khongsdier, 1994a) indicate that there is a strong possibility for the formation of several **demes** , or sub-endogamous groups, within the blanket War Khasi population. The differences in morphological characters between villages of this population, on the basis of the present findings, seem to confirm the above contention that each village, or a group of villages in this population might have possessed its own biological entity. This contention, we hope, can be tested through further studies with several genetic markers, which will, in turn, throw much more light on what we have suggested here and elsewhere (Khongsdier, 1991, 1994a). Nevertheless, genetic differences with regard to morphological characters between the War Khasi and other populations cannot be ignored, if we take into consideration the growth performances of the War Khasi children with reference to the international or national standard, or the available data on other populations. Despite our findings that the nutritional intake in the present population is much better than those reported for many Indian populations, the nutritional anthropometry, with reference to the international standards, indicates that most of the children in the present population are undernourished. In this connection, it may be recalled to what Harrison and Brush (1991) say, "Unfortunately, as we all know only too well, growth rates and size cannot be simply used as markers of environmental quality. The essential reason for this, of course, is the existence within and between populations of genetic difference in growth potential". Of course, it cannot be denied that growth of children is more susceptible to environmental infuences (especially nutrition and infection), but it is also not free from the influence of genetical factors.

From an environmental point of view, it may be suggested that the differences in biological traits within the War Khasi population are mainly due to the influence of environmental factors (including nutrition and socio-economic conditions). In other words, the differences in environmental quality (like levels of nutritional intake, economic inequalities, etc.) might have resulted in biological variations within the War Khasi population. According to Harrison and Brush (1981), "The environment of even single population can be very heterogeneous in quality. Some segment of a group can be subject to severe environmental deprivation whilst another is environmentally affuent; so overall demographic and epidemiological features may be misleading . (In fact), one aspect of ecological success is the level of well-being people in a society experience". Our present findings on variation in adult body dimensions within the same village, or variation in health traits within the War Khasi population, may be looked into in the light of the above contention, made by Harrison and Brush (1991). If this is the case, it is obvious that human responses (adaptations) to environment vary from individual ,or from one segment of the population to another. The ways how the biological processes correspond to those adjustments to environment, are very complex (Tanner, 1978).

In view of the above circumstances, it seems that both genetics and environment have their respective role in bringing about human variations. Either one of them is sometimes more influential (like environmental influence on variation in health traits within the present population) or both of them are at times interacting with each other (like differences in health traits of the present population, when compared with other populations). In fact, the role played by genetics and environment in bringing about human variations, or changes, is very complex (Eveleth and Tanner, 1990; Baker, 1991). So, what we would like to point out here is that, whatever may be the causes of variations, natural selection seems to operate on human population(s) with a different magnitude or intensity. According to Buettner-Janusch (1966), "Selection may act at any stage of the life cycle. The way in which selection operates may be difficult to determine and may vary enormously in different cases". With respect to differential fertility and mortality in the present population, it is found that selection intensity is more relaxed in the Christians than in the Non-christians (Khongsdier, 1994b). This relaxation of selection pressure can also be seen with repect to other health traits, or "Fitness indicators" (Baker, 1991), which include adult body dimensions, physical growth, haemoglobin content,and other health measurements. In the present study, it is found that the higher income groups have higher values of adult body dimensions, better growth performance and higher haemoglobin content than the low income group. This may be due to the fact that the people in the higher economic strata are supposed to have better dietary intakes, child care, sanitation and medical facilities, etc., thereby having lower mortality rate, better growth performance, etc. In short, they are more adaptable to their environment and, as a result, selection pressure on them is more relaxed. In fact, selection is not simply a process, which eliminates the traits, genes or organisms, but also a process, which regulates vaibility and well-being of Organisms.

In the present study, we have tried to deal with nutrition and health status in relation to some bio-social factors among the War Khasi. Whatever we have presented here is based on our field observations with limited parameters. So, we hope that some future studies with more parameters will throw much more light on the bio-social aspects of the War Khasi population.

CHAPTER VII

SUMMARY

A study of human variation is one of the important themes of physical anthropology. The main objective of such a study is to understand the processes of human evolution. Accordingly, since the middle of the present study, the physical anthropologists have firstly shifted their basic interest from the so-called taxonomic to population genetical researches with a view to understanding the various processes of human evolution and, later the other aspects of human variation like physical growth, environmental adaptation, etc. Recently, attempts have also been made to study the relationship between human biological traits and a large number of physical and environmental factors. In fact, it is now believed that human health and/or biological traits are highly associated with socio-environmental factors. So, though population genetics is still considered the theoretical backbone of physical anthropology (Kirk, 1978), it is quite imperative on the part of physical anthropologists to understand the relationship between socio-environmental factors and well-being of human population(s). Such studies are very few in India, especially in the north-eastern region of the country.

In view of the fact that no study has so far been undertaken in the north-eastern region in general and among the War Khasi in particular, the present study is being carried out on nutrition and health status in relation to some bio-social factors among the War Khasi of Meghalaya.

The Khasi are the matrilineal tribe inhabiting the state of Meghalaya (25°47′ - 26°10′ N and 89°45′ - 92°47′ E). The tribe consists of five major sub-groups, namely, the War, Khynriam(upland Khasi), Pnar(Jaintia or Synteng), Bhoi and Lyngngam. The War Khasi are mostly confined to the southern slopes of the Khasi and Jaintia hills of Meghalaya, bordering Bangladesh. The people who live in the upland region of Khasi hills are known as the Khynriam and those living in Jaintia hills are called the Pnar. The Bhoi and Lyngngam are found in the northern and south-western parts of the Khasi hills, respectively. All these sub-groups of the Khasi have been following the matrilineal system of society. They speak the Monkhmer language which belongs to the Austro-Asiatic group. They also share a common pattern of social structure, though "each group tends to be endogamous and there are shades of differences in respect of dialect, political organisation, economy and in some of the customs and manners between groups"(Das Gupta, 1984).

Objectives of the Present Study

Following are the objectives of the present study:-

1. To describe the dietary/nutritional status of the War Khasi, following as far as possible the recommended dietary intakes, which are given by the Indian Council of Medical Research (ICMR, 1977, 1989).

2. To assess the nutritional status in this population, using anthropometric variables, etc.

3. To find out the relationship between socio-economic condition and dietary/nutritional status.

4. To find out the effect of bio-social factors like age, sex, anthropometric variables, religion, economic condition, education, etc. on demographic parameters like fertility, mortality, etc.

5. To understand the effects of diet/nutrition and other bio-social factors on child growth, adult body dimensions, haemoglobin content, etc.

Materials and Methods

The field work of the present study was conducted in five villages, falling under under the War area in the East Khasi Hills district of

Meghalaya, during the period between 1990 and 1994.

For the purpose of the present study, a 2 % systematic-random sampling of the War Khasi villages was drawn, since it was very difficult to collect data from all the villages (i.e. more than 250 villages). As a result, five villages, viz., Nongkenbah, Mawsiangei, Nongla and Lapalang, were eventually selected for the present study. There are altogether 366 households, of which 58 in Nongkenbah, 41 in Mawsiangei, 24 in Nongla, 33 in Wahumlein and 210 in Lapalang.

<u>Demographic Data:</u> The entire demographic data like name, age, sex, marital status, number of conceptions, number of live-births, number of dead children, age at death, etc. were collected through pedigrees and schedules from all the 366 households in the five selected villages. The nature of demographic data collected, was based on the demographic parameters suggested by the WHO Scientific Group (1964, 1968a).

<u>Dietary Data:</u> One day dietary survey was conducted in each of 184 households, following weightment method. No correction was made for the wastage or loss of the values of foods or nutrients on account of cooking, etc. So, there is a possibility of slight overestimate of the nutritional status of the population.

The nutrient values as well as the edible portion of foods were computed from the Food Composition Tables, prepared by the Indian Council of Medical Research (ICMR, 1977, 1989), considering the War Khasi as moderate by nature of their work. The consumption unit (C.U.) per household was calculated, following the method suggested by Bhattacharya et al.(1981).

Anthropometry (children and adults): Selected anthropometric measurements like weight, height, sitting height, biacromial diameter, bi-iliac diameter, mid upper arm circumference, biceps and triceps skinfold thicknesses, etc. were taken on 434 adult males and females (aged 20 - 50 years), following standard techniques (Weiner and Lourie, 1981, Sen, 1994). For growth data. a cross-sectional sample of 514 children (aged 3 - 15 years) was taken, following standard techniques (Weiner and Lourie, 1981; Sen, 1994). Ponderax skinfold caliper was used for taking the measurement of skinfold thickness as suggested by Sloan and Koeslag (1973). Anthropometric ratios/indices and/or estimates like weight/height, body mass index, ponderal index, cormic index surface area, body fat, weight for height, weight for age, height for age, etc. were also computed.

Haemoglobin Estimation: Standard techniques (WHO, 1980) were followed, using Sahli's Haemometer.

Results

The findings of the present study may be briefly summarised as follows:-

Socio-economic Condition:

1. Distribution of CH and NCH households: Out of 366 households covered under the present study, 152 (i.e. 41.53 %) and 214 (i.e. 58.47 %) belong to the CH and NCH, respectively. So,

it shows that the number of households is higher in the NCH than in the CH.

2. **Family Size:** (i) The mean family size among the War Khasi is 6.67 ± 2.89, which is relatively large in comparison with other tribal populations.

(ii) It is found that the mean family size is higher among the CH (6.97 ± 2.77) than among the NCH(6.45 ± 2.95), though the difference between them is not statistically significant ($z = 1.72$, $P > 0.05$).

3. **Occupation:** (i) It is found that agriculture is the primary occupation of the people in both the religious groups, whereas agricultural labour is their secondary occupation. Some of them are also engaged in business and services.

(ii) The percentage of the heads of households, depending on agricultural activity, is higher in the NCH (34.58 %) than in the CH (26.97 %), despite the absence of significant difference between them ($d = 1.55$, $P > 0.05$).

(iii) The frequencies of families, possessing no land property, are 28.95 % and 33.64 % in the CH and NCH, respectively ($d = 0.95$, $P > 0.05$)

4. **Frequency of Income Groups:** The frequencies of LIG, MIG and HIG among the CH are 34.24 %, 45.39 % and 30.39 % ;respectively; whereas among the NCH, these frequencies are 42.06 %, 41.12 % and 16.82 %, respectively ($X^2 = 2.41$, $P > 0.05$).

5. Literacy: (i) The total literacy rate among the War Khasi of the present study is 53.27 %, which is lower in comparison with other populations in the north-easter region.

(ii) The total literacy rate is higher among the CH (54.17 %) than that among the NCH (52.59 %), though the difference between them is not statistically significant (d = 0.77, P > 0.05).

(iii) It is also found that the total literacy rate is higher in males than that in females for both the religious groups, despite the absence of significant difference between two sexes.

Nutritional Status and Socio-economic Condition

1. Consumption of Foods: (i) It is found that the CH have higher intakes of different types of food than the NCH, though the differences between them are significant only in respect of meat, fish and egg; and milk. On the other hand, the mean intakes of cereals and fats are higher among the NCH, and it is significant in respect of cereals.

(ii) It is found that the consumption of different food groups, except other vegetables, is higher in the MIG and HIG, when compared with that in the LIG. The analysis of variance also shows that the differences among the income groups are significant in respect of the intakes of many food groups, except in the case of other vegetables and fruits in both the religious groups.

(iii) In both the religious groups, the intakes of pulses, green leafy vegetables, milk, fats and fruits are found to be less than the recommended allowances. It is almost true for all the income groups in both the CH and NCH.

2. Consumption of Nutrients: (i) It is found that the CH have higher consumption of many nutrients than the NCH, except in the case of calories, calcium and vitamin B_{12}, which are higher among the NCH. The differences between the CH and NCH are statistically significant only in respect of calcium, iron and vitamin B_2.

(ii) It is also found that the consumption of many nutrients tends to increase significantly with the increasing income level in both the religious groups, except in the case of vitamin B_2 and folic acid among the CH, and vitamin A and vitamin B_{12} among the NCH.

(iii) The consumption of vitamin B_2 and vitamin A is below the recommended allowances in all the income groups for both the CH NCH. With respect to calories, vitamin B_1, vitamin C and folic acid, the consumption is less than the requirement levels in the LIG for both the religious groups.

(iv) The nutrient intakes among the CH and NCH are higher than those reported for many tribal populations in India.

Nutritional Anthropometry

Anthropometry is widely recognised as one of the most useful techniques to assess the nutritional status of an individual, or a population. It is generally agreed that the mild and moderate forms of undernutrition manifest themselves in varying degrees of growth retardation and adult body dimensions. Since these forms of undernutrition are not easy to diagnose, the use of anthropometry is very much essential. Therefore, certain anthropometric standards with reference to well nourished populations like Harvard standard, or American standard known as NCHS standard (Jelliffe, 1966; Frisancho, 1990) have been established to assess the growth and nutritional status of a population. Nutritionists and others have supported the use of international standards for measuring the magnitude of undernutrition in a population in view of the emperical evidence that the growth performance of children below six years of age is more influenced by environment (mainly nutrition), but not by the genetical factors. However, as far as the present study is concerned, it is found that most of the children in the present population are undernourished according to the NCHS standard, but quite normal as per the ICMR standard. But the calorie and protien intakes in the present population are much better than those reported for other Indian tribal populations. Moreover, no cases of severe forms of malnutrition like marasmus and kwashiorkor had been observed in the present study.

In view of the above circumstances, it is considered essential to pay more attention to the methods of estimating the cut-off point (critical limit) and trigger level (distance or interval between two groups or grades of malnutrition and/or growth status) for assessing the growth and nutritional status of the children in the present study. The WHO Working Group (1986) has recommended to maintain the conventional cut-off point - 2SD, for "Comparison of prevalences and for screening of populations". Accordingly, a similar method was used for the assessment of growth and nutritional status in the present population, for which the cut-off point was estimated using 95 % confidence interval based on the t-distribution, i.e. $- t_{0.05}SD$ (for large sample it is equivalent to - 2SD). Since anthropological researches are mostly concerned with micro-studies it is felt necessary to used $- t_{0.05}SD$ as the cut-off point for screening the sample size of children into two groups, i.e. $\geqslant - t_{0.05}SD$ and $< - t_{0.05}SD$. Regarding the method of determining the trigger levels, the cut-off point $+ t_{0.05}SD$ derived from the group $\geqslant - t_{0.05}SD$ (i.e. normal sample size) is taken as another critical limit. As a result, the distance or interval between $- t_{0.05}SD$ of the total sample size and $+ t_{0.05}SD$ of the normal sample size is taken as the trigger level for subsequent groupings.

The same method was followed with respect to the assessment of the nutritional status of adults. The only difference is that, we have taken - 4SD of the total sample size and + 4SD of the normal sample size (i.e. - 4SD of the total sample size) for determining the cut-off points and trigger levels, respectively. We have taken - 4SD as the cut-off point for screening the adult sample size, taking into consideration the fact that the variation in adult body dimensions, owing to various factors, is greater than that among the children.

Applying the above method, it is found that there is no difference between the international and national/local standards in the assessment of growth and nutritional status of children (i.e. provided all standards are having the same device of grouping and data analyses). Therefore, the present method seems to take into account the approximate feature of the population concerned and thereby it is, to some extent, independent of the ethnic differences in physical growth and adult body dimensions, owing to various factors. However, for the purpose of comparative studies of growth, but not for the assessment of growth and nutritional status, the use of NCHS/Harvard population reference standard and that of Z-scores may be essential as recommended by the WHO Working Group (1986).

Nutritional status of children (3 - 5 years): (i) With respect to weight for height, the frequency of undernourished children is lower among the CH (32.73 %) than among the NCH (36.49 %), though the difference between them is not statistically significant (d =0.44, $P > 0.05$)

(ii) In the CH, the frequency of undernourished children is found to be 36.36 %, 38.89 % and 20.00 % in the LIG, MIG and HIG, respectively ($\chi^2_2 = 1.62$, $P > 0.05$); whereas among the NCH, it is found to be 42.86 %, 38.46 % and 25.00 % in the LIG, MIG and HIG, respectively ($\chi^2_2 = 1.68$, $P > 0.05$).

(iii) Similar results are found with regard to other indices like weight/height^2, etc.

Nutritional status of adult males: (i) Among the CH, the frequencies of undernutrition, according to weight for height, are 36.36 %, 41.30 % and 11.54 % in the LIG, MIG and HIG, respectively(χ^2_2=6.55,

$P < 0.05$); whereas among the NCH, these frequencies are found to be 46.67 %, 23.81 % and 30.00 %, respectively ($\chi^2_2 = 5.36$, $P > 0.05$).

(ii) With respect to weight/height^2, the frequencies of malnutrition among the CH are 42.42 %, 39.12 % and 11.54 % in the LIG, MIG and HIG, respectively ($\chi^2_2 = 7.47$, $P < 0.05$). Among the NCH, these frequencies are 46.67 %, 21.43 % and 30.00 % in the LIG, MIG and HIG, respectively ($\chi^2_2 = 6.44$, $P < 0.05$).

(iii) The difference between the CH and NCH with regard to frequencies of undernutrition, according to weight for height and and weight/height^2, are not significant, though the CH have lower frequencies.

<u>Nutritional status of adult females</u>: (i) In both the religious groups, the frequencies of undernutrition with respect to weight for height and weight/height^2 decreases significantly with the increasing economic level.

(ii) No statistical differences were found between the CH and NCH with regard to the frequencies of undernutrition, according to weight for height and weight/height^2. So, it shows that it is not religion, but economic condition which really plays a significant role in regulating the nutritional status in the present population.

Effects of Bio-Social Factors on Health Traits

<u>Fertility</u>: (i) The mean number of live-births per ever-married woman is more or less same in both the CH (4.87 ± 0.27) and NCH (4.90 ± 0.19); whereas the mean number of surviving children is slightly higher among the CH (4.39 ± 0.21) than among the NCH (4.29 ± 0.18).

(ii) It is found that the mean number of live-births as well as the mean number of surviving children tends to increase as maternal age advances. The coefficient of regression on the effect of maternal age (independent variable) on the number of live-births and surviving children (dependent variables) also shows that there is a significant positive relationship between them for both the religious groups.

(iii) It is found that the mean number of live-births among the CH are 5.65, 4.64 and 3.89 in the LIG, MIG and HIG, respectively ($F = 5.23$, D.F. = 2,178, $P < 0.05$); whereas among the NCH, these mean numbers are 5.56, 4.66 and 3.82, respectively ($F = 6.03$, D.F. = 2.235, $P < 0.005$).

(iv) As regards the age at marriage, it is found that the mean number of live-births per ever-married woman decreases with the rise in age at marriage, and it is true in both the religious groups.

(v) With respect to educational levels, the mean number of live-births among the CH are found to be 5.28, 4.71, 4.71 and 3.81 in the illiterate, primary and secondary groups, respectively ($F = 4.56$, D.F. = 2,178, $P < 0.05$). Among the NCH, these mean numbers are 5.35, 4.60 and 3.75, respectively ($F = 4.01$, D.F.= 2,235, $P < 0.05$).

(vi) It is found that the differences in live-births among the educational and income groups are not statistically significant, after removing the effect of maternal age. So, it shows that the maternal age, but not the socio-economic condition, which plays a significant role in regulating the fertility rate in the present population.

Infant and juvenile mortality: (i) It is found that the infant as well as the juvenile mortality rate is higher in males than in females for both the religious groups, though the difference between sexes is not statistically significant.

(ii) It is found that the infant mortality rate is higher among the NCH (8.67 %) than among the CH (7.03 %), despite the absence of statistical difference between them ($d = 1.36$, $P > 0.05$). Similarly, the frequencies of juvenile mortality are 3.17 % and 3.78 % in the CH and NCH, respectively ($d = 0.44$, $P > 0.05$).

(iii) The coefficient of regression shows that there is a significant positive relationship between birth order and infant mortality for both the CH ($b = 1.63 \pm 0.39$, $P < 0.001$) and NCH($b = 1.53 \pm 0.53$, $P < 0.05$), which can be expressed as per the following equations:

CH : Infant mortality rate = 1.73 + 1.63 x Birth order

NCH : Infant mortality rate = 3.87 + 1.53 x Birth order

(iv) The relationship between juvenile mortality and birth order is also found to be positive, but it is not significant among the CH.

(v) The regression coefficient also shows that there is a significant positive relationship between maternal age and infant mortality rate among the CH ($b = 0.14 \pm 0.03$, $P < 0.01$), which is expressed by the equation : Infant mortality rate = 1.28 + 0.14 x Maternal age. Among the NCH, this pattern of relationship is not significant ($b = 0.21 \pm 0.08$, $P > 0.05$).

(vi) The relationship between juvenile mortality and maternal age is not clearly perceptible in the present study.

(vii) The relationship between per capita monthly income and infant as well as juvenile mortality is not significant for both the religious groups.

(viii) The effect of maternal education on infant mortality, unadjusted for age, is found to be negatively significant for both the religious groups. However, this negative relationship disappears after controlling the effect of maternal age.

Anthropometric variavles and reproductive performances:

In both the religious groups, the number of live-births, infant and juvenile mortality was regressed separately with some selected anthropometric variables like weight, height, bi-iliac diameter, body mass index and body fat. Of these anthropometric variables, maternal height and bi-iliac diameter are found to be significantly associated with live-births, even after controlling the effect of maternal age. On the other hand, infant mortality is significantly associated with maternal body weight, body mass index and body fat. No significant relationship is found between juvenile mortality and anthropometric variables.

Adult body dimensions:

As far as adult body dimensions are concerned, attempts have been made to present the findings according to villages and economic condition. It is found that there are significant differences between villages with regard to certain anthropometric characters like sitting height, bi-iliac diameter and biacromial diameter. Consequently, villages belonging to the same cluster, according to Sanghvi's distance analysis, were pooled together to find out the probable effect of economic condition on adult body dimensions. It is found that anthropometric variables are also very much influenced by the economic condition.

Physical Growth:

Anthropometric data, collected from five villages, were pooled together. No attempt has been made to show the differences between villages and/or religious groups as the sample size for the present study is not adequate enough. However, attempt has been made to present our findings according to age, sex, and economic condition. It is found that the boys have higher mean values of many anthropometric measurements than girls at all ages, except during adolescent period, when the girls have higher values than the boys. Generally, adolescent growth spurt occurs between 11 and 12 years in girls and between 13 and 14 years in boys. In most of the measurements the maximum gain in growth occurs at 12 and 14 years in girls and boys, respectively.

With few exceptions, the effect of economic condition on physical growth of children are also found to be clearly perceptible in respect of many anthropometric measurements and indices.

Haemoglobin Content:

Data were presented according to sex, religion and economic condition. Following are the findings:

(i) The mean values of haemoglobin content among the CH males and females are 13.99 ± 2.25 g/dl and 13.65 ± 2.56 g/dl, respectively. Among the NCH, these mean values are found to be 13.77 ± 2.39 g/dl and 13.00 ± 2.23 g/dl, respectively. In both the religious groups, the haemoglobin content for both males and females is above the recommended level (WHO Scientific Group,1968b).

(ii) The difference between the two religious groups with regard to haemoglobin content is found to be significant for females ($z = 2.10$, P 0.05), but not significant for males($z = 0.71$, P 0.05).

(iii) Among the CH, the frequencies of aneamia are 26.67 % and 21.21 % in males and females, respectively; whereas among the NCH, these frequencies are 30.77 % and 30.97 %, respectively.

(iv) With respect to economic condition, it is found that the haemoglobin content tends to increase with the increasing income level in both the religious groups, though the differences among the three income groups are significant only among the CH.

Bio-social Factors:Their Implications in the Present Study:

As far as the present findings are concerned, it is observed that health traits, taken for the present study, are associated with some bio-social factors. It is also observed that the nutritional intakes in the present population are related to economic condition. All these associations are attributable to the variation in biological traits within the War Khasi population. Further, the quantitative aspects of health traits in the present population are different from those reported for other populations. Furthermore, it is also observed that there are inter and intra village variations with regard to body dimensions in the present population. On the bases of these findings, it is really very difficult to give a straight forward answere whether genetics or environment is more infuential in regulating the variation in health traits of the present population.

Genetic differences between the War Khasi and other populations with respect to morphological characters cannot be ignored, considering the growth performance of the War Khasi children with reference to the international and/or local standards. Moreover, our earlier findings with respect to marriage pattern in the present population (Khongsdier, 1994a) suggests that there is a strong possibility that each village and/or religious group might have possessed its own biological entity (i.e. because there is a strong tendency towards village as well as towards religious endogamy). The difference in anthropometric characters between villages of this population seems to support our earlier contention. We hope that future studies with several genetic markers will throw much more light on what we have suggested here and elsewhere(Khongsdier, 1991, 1994a).

From an environmental point of view, it may be suggested that the variation in health traits within the War Khasi population is mainly due to the difference in environmental quality like levels of dietary intake, economic inequality, etc. Our present findings on variation in adult body dimensions within the same village, or variation in health traits within the War Khasi population may have some implications in this context.

In view of the above circumstances, it seems that both genetics and environment have their respective role in bringing about human variation - either of them is sometimes more infuential or both of them are at times interacting with each other. The ways how the biological processes correspond to the interaction between genetical and environmental factors are very complex. So, whatever it may be, natural selection seems to operate on human population(s) with a different magnitude and intensity. With respect to differential fertility and mortality in the present population, it is found that selection intensity is more relaxed in the CH than in the NCH (Khongsdier, 1994b). This relaxation of selection pressure can also be seen with repect to variation in other health traits of the present population like adult body dimensions, physical growth, haemoglobin content, etc. It is observed that the higher income groups have higher values of adult body dimensions, better growth performance of children and higher haemoglobin content than the low income group. This may be due to the fact that the people in higher economic strata are having better dietary intakes, child care, sanitation and medical facilities, thereby having lower mortality rate, better growth performance, etc. In short, they are more adaptable to their environment and, as a result, selection pressure on them is more relaxed. In fact, selection is not simply a process which elimiates the trait(s), but also a process which regulates viability and well-being of individuals.

In the present study, we have dealt with limited parameters relating to nutrition and health status of the War Khasi. Of course, whatever we have presented is based on our field observations. We hope that some future studies with more parameters will throw much more light on the biosocial aspects of the War Khasi.

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