THE GROWTH OF SCHOOL CHILDREN FROM THE SUBCONTINENT OF INDIA LIVING IN LEICESTERSHIRE.

by

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ABSTRACT

Using data from the Leicestershire Growth Study, which was established in 1981, this thesis sets out to evaluate the growth of children in Leicestershire and to highlight any differences which may exist between those children indigenous to Great Britain and those whose families have emigrated from the subcontinent of India. The latter population can be subdivided further, i.e. peoples from the countries of India, Bangladesh and Pakistan, the first group primarily, having either migrated from India directly to this country or having spent an interim period in East Africa, and into adherents of the Muslim, Hindu or Sikh faiths.

Seven anthropometric parameters, selected to represent skeletal and soft tissue components of the body, and whose dimensions reflect best the changing patterns of growth with age and environmental factors, were measured on 3775 children aged from 3-10 years inclusive.

There are distinct anthropometric differences between the indigenous population and that from the Indian subcontinent, with the indigenous population having greater skeletal dimensions, e.g. stature, head circumference, and differences in body composition, reflected in greater weight. These ethnic differences appear to have been exacerbated by religious factors which impinge upon both genotype and phenotype by imposition of their respective individual cultures, involving such factors as dietary intake and marriage customs, resulting in the Indian Sikh children resmbling more closely the indigenous population than do the Hindus and Muslims. Other environmental factors such as length of time of residence in this country, or period of time spent in East Africa appear to have had some impact upon growth, since the Indians in Leicestershire are taller and heavier than their counterparts still resident in India.

(ii) Finally, it is recommended that some of the growth charts in current use in Great Britain be modified for use with certain groups of children from the Indian subcontinent.

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CHAPTER 1

INTRODUCTION

INTRODUCTION

Growth is a complex process with wide variability in its normal manifestations and every child having a unique pattern of growth. An understanding of both the general pattern of growth within a community and the specific pattern within an individual, plus the normal variation that can be expected in both cases, can enable us to identify and evaluate biological differences between and within different populations and to analyse the contribution of the various environmental and genetic factors to growth, or, alternatively, to detect whether the growth of any one individual is specifically deviant from that of his peers. In order to monitor the growth of an individual or a population, growth studies are carried out. Growth studies have been in use for many years, although some of the earliest ones were more concerned with obtaining information for subsequent identification of the subject, as and when necessary, e.g. the Marine Society measured their new recruits so that they could be more easily identified if they subsequently deserted (Tanner 1981), rather than a concern for the current welfare of the person concerned, or of the population from which he/she came. They have subsequently become a tool for the evaluation of growth and consequently, more specifically, for the assessment of the health and nutritional standing of the individual and of the community.

In order to monitor the growth of children in Great Britain, there are national growth standards in use, chiefly for height and weight, for children aged from birth to eighteen years, (Tanner, Whitehouse and Takaishi 1966a,b; Tanner and Whitehouse 1976), but also for triceps and subscapular skinfolds, for children from birth to nineteen years of age, (Tanner and Whitehouse 1962, 1975), and for head circumference for children from birth to sixteen years of age (Tanner 1978) as well as other standard data, e.g. Tanner, Goldstein and Whitehouse 1970; Tanner and Whitehouse 1973. But some of the standards were derived from childrens' measurements taken in 1959 (Tanner et al 1966a,b). The phenomenon of secular trend indicates that growth is not a constant feature but a dynamic occurance that shows changes over the years in certain anthropometric parameters. These changes are usually in the form of increased size at a given age and increased growth velocity, mainly due to an increased rate of maturation and probably in response to inproved socioeconomic conditions and nutrition. This secular trend occurs in developed countries, e.g. Greece (Hauser and Pentzos-Duporte 1985) as well as developing ones such as India (Madhavan, Singh and Swaminathan 1964), although evidence suggests that it may now have ceased in some developed countries, e.g. England, Japan, Norway and the United States (Cameron 1979; Roche 1979a).

Furthermore, the standards of Tanner et al (1966a,b) were based for the most part on measurements taken on London children, predominantly children of European origin. There is evidence that children living in the north, e.g. Scotland are not as tall for a given age as those living in the South (Rona and Altman 1977), although the data for this study may not be totally representative of the Scottish child population as the subjects were from 6 centres only, predominantly in the south of Scotland. The study of Rona and Altman (1977) measured children from 22 selected areas in England and 6 in Scotland and they found that their population in England matched that of Tanner et al's London sample (1966a,b) for height and weight but there were some differences in the triceps skinfold values. Similar differences for height have been found in adult populations in Great Britain, with persons living in Wales being the shortest, those from Scotland, the second shortest, and persons living in the south of England being approximately one centimeter taller than those living in the north of the country (Rosenbaum, Skinner, Knight and Garrow 1985).

With documented evidence of a positive secular trend in some anthropometric parameters, the length of time that has passed since the compilation of the reference standards and the fact that these standards were compiled from London children predominantly, the supposition that the

Leicestershire indigenous child population of the 1980's is similar in size to that population from which the standards were constructed, over two decades ago, is now reviewed.

But Leicestershire also has, resident in that county, especially in the city of Leicester and town of Loughborough, a large ethnic minority group of immigrants from the subcontinent of India, (for a definition of 'ethnicity' see Appendix A). These people have either emigrated directly from the Indian subcontinent or have come via East Africa (see Chapter 2) and many have settled, as families or extended families, in the inner areas of Leicester (percentage of persons in a house with a New Commonwealth or Pakistan born head is 41.2% in the inner wards and 10.3% in the outer wards of Leicester - Redfern 1982), and Loughborough. Figure 2 indicates those areas of Leicester where the population consists of 45.1% or more Asians (Leicester Report 1983) and figure 3 details the areas of Loughborough where the majority of the Asians immigrants have settled (Blair, pers.comm). Here they have created their own small communities in areas of older housing, sometimes of a poorer standard than that of the suburbs, with lack of space, (percentage of households with more than one person per room in the inner wards of Leicester is 9.3%, in the outer wards 4.7% - Redfern 1982), (average household size in Leicester for White households is 2.5 persons per household, for Asians 4.3, - Leicester Report 1983) and lack of other amenities. Both Tanner et al's (1966a,b) and Rona and Altman's (1977) standards were derived from white children, but paediatricians in a number of areas in Great Britain, including Leicester, e.g. Birmingham, Wolverhampton, Bradford, are monitoring the growth of increasing numbers of children who have originated from the Indian subcontinent, e.g. of the children aged 0-19 years in Leicester, 67% are White and 29% are of Asian origin (Leicester Report 1983). It is hypothesised that the reference values compiled to describe the growth of British children may not be adequate to describe the growth pattern exhibited by children of Asian origin.

On the other hand, the use of information derived from studies of growth of children living in the Indian subcontinent is also debatable. Genetic factors might be similar, but not necessarily, as India is a large geographical area and contains a diverse genetic mix of peoples. The other major difficulty in laying down 'norms' in India is the heterogenous nature of the population with regard to economic, social, cultural and nutritional factors, so that data collected in one part of the country cannot be applied all over India, i.e. overall the stature of Indians appears to decline from the north west to the south east of the subcontinent for reasons which are as much genetic as environmental (Majumdar 1961). So, even if for genetic reasons, growth data derived from British children is unsuitable for monitoring the growth of children from the Indian subcontinent now living in Great Britain, growth data derived from Indian, Bangladeshi and Pakistani children, inhabiting those countries may also be inapplicable, even if it exists. Such information is available for Indian children, although the most comprehensive study, the All India study (I.C.M.R. 1972), which attempted to cover most of India, was also published a considerable time ago, (and was based on measurements mostly taken from the lower socioeconomic groups which form the majority of the Indian community in India, but is not necessarily representative of the immigrant population from that country). India, like the rest of the world, except perhaps some of the industrialised areas of the affluent West, e.g. Stockholm and London, shows a secular trend in its growth pattern in adults (Madhavan et al 1964) which probably originated in childhood. Other studies of growth in Indian children and attempts to produce standards have their own limitations, e.g. Ghai and Sandhu (1968) used only 100 children and mixed longitudinal and cross-sectional data, which was treated cross-sectionally, and yet other studies have been limited to, e.g. middle class families (Hauspie, Das, Preece and Tanner 1980) or Indians from one area only (Rao, Satyanarayana and Sastry 1976) which is not in itself invalid, but maybe the wrong area with which to compare Leicestershire's immigrants. Immigrants from the subcontinent of India to this country have come from a limited number of specific areas only (see figure 1) and growth data does not necessarily exist for these specific populations. Secondly, any growth data used as a standard must be extremely reliable, acquired using accurate scientific equipment and trained personnel and sometimes information about accuracy is not available for the Indian data. One other important source of error in growth studies in India is the difficulty in obtaining the correct age of the subject (Seth 1972). Thus, it is hypothesised that available data on the growth of children in the subcontinent of India may also not be applicable to the present immigrant population from that area who now reside in Leicestershire.

Some comparison has been made between the growth of Indians in their own country compared with data derived from British or American reference data (Rao et al 1976) but there is little information upon the differences or similarities in terms of growth between Indian children who are newly resident in this country and the current indigenous population. Goel, Thomson, Sweet and Halliday (1981) considered the growth of a number of different ethnic groups, resident in Scotland, including an Asian sample. Nearer geographically to Leicester, but with a slightly different Asian population, Ulijaszek and Nicoll (1983) compared the Asian and indigenous children in Nottingham aged 3 - 12 years. The most recent study, that of Rona and Chinn (1986) measured children aged 5 - 11 years of Indo-Pakistani origin among others, resident in 20 areas in this country, one of which was in Leicester. In all cases it was found that the Asian children showed some differences from the indigenous population but in addition, there were also differences within the Asian subgroups.

Furthermore, there is no information as to whether the characteristic growth pattern of the Asian child has become modified or shows some variation compared with the pattern established in the country of origin, because of residence in this country and the associated consequent change in environmental circumstances. Although growth potential is influenced by genetic factors this does not imply that environmental factors may not, in some circumstances, be of as great or even of greater importance. It has been suggested that genetic factors set a ceiling on growth, but become effective only when nutritional and other factors have reached an optimal level (Dugdale, Chen and Hewitt 1970). Since environment plays such an important role in growth, it is possible that the genetic growth potential of children in India has not always been achieved because of inadequate diet and unfavourable health conditions. Migration to Great Britain, will affect dietary and health factors along with other environmental conditions such as climate, habitation, socioeconomic circumstances, plus the whole structure of family life.

By developing norms for various anthropometric parameters, using the appropiate study technique, and thus describing growth patterns for different populations, we can see how individuals within a group, or members of one group compared with another group, can be expected to differ in body size, build, relative amount of different tissues or rates of growth, over given periods of time. Detection of differences from expected patterns of growth in given populations then has a number of applications. It is a mechanism for early diagnosis and control of disease in childhood. It is also an indication of nutritional status at that point in time, of either an individual or of the community from which he or she comes. Knowledge of the pattern of physical development in populations can aid in pinpointing differences in growth between communities as well as within them and consequently identify sectors of a population that might be at risk, for various reasons, and enable governments to take action where necessary. Conversely, the knowledge can be used to detect improvements in growth in a community when medical aid and or food supplement programmes are run, e.g. Rona, Chinn and Smith (1979) monitoring growth in children on free school meals.

Finally, using different ethnic groups that share some similarity of environment, the opportunity is available to attempt to analyse and evaluate the factors that contribute to differences and similarities in the growth patterns of the different ethnic populations.

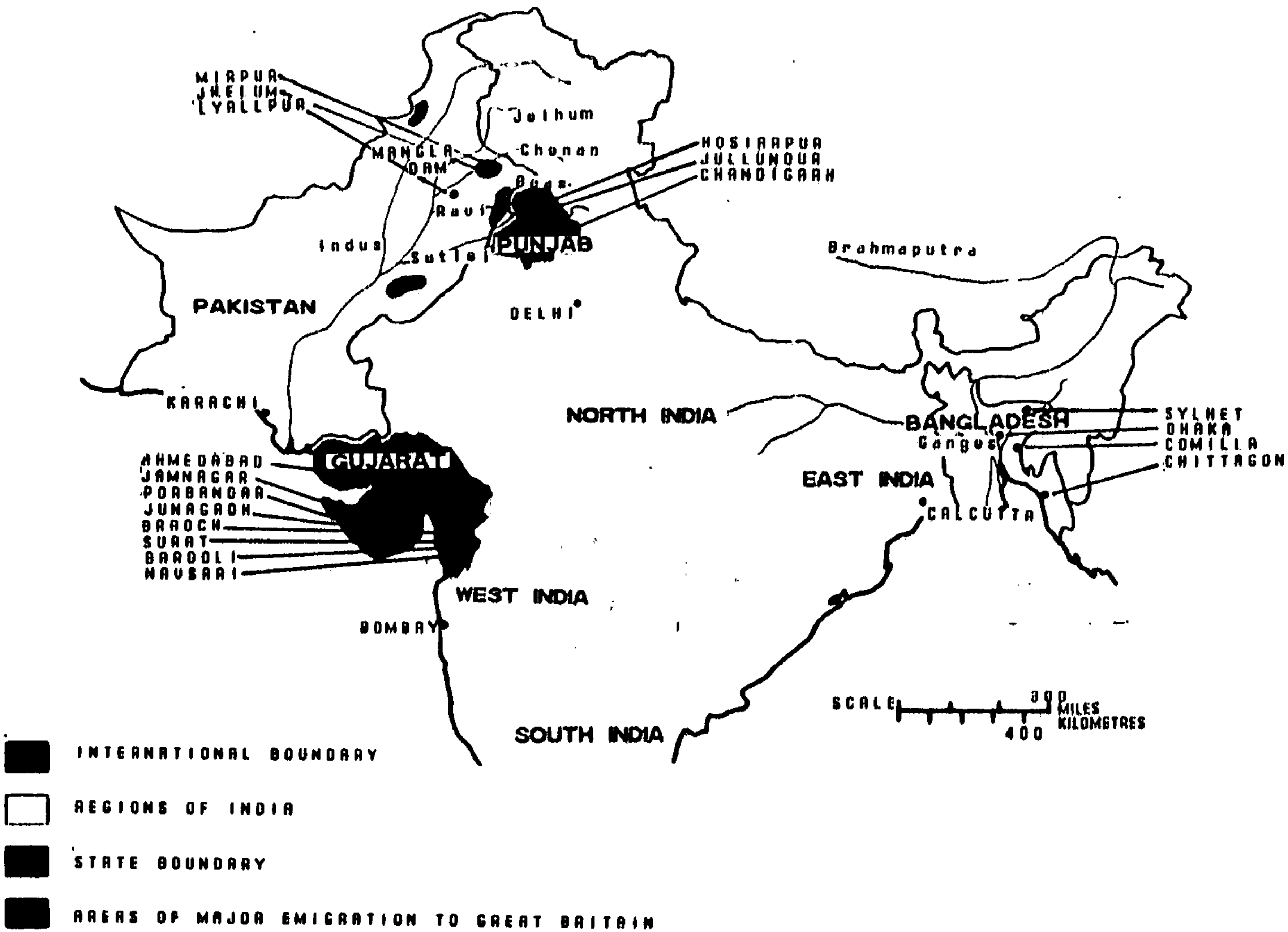
This thesis therefore, examines the growth of the children from the Indian subcontinent, who now reside in Leicestershire, using anthropometric techniques and a limited number of growth parameters, to determine how the pattern of growth and overall size of such children compares with that of the indigenous population and with the population still resident in the country of origin. Secondly, an attempt is made to evaluate the factors that may have contributed to or influenced any of the differences or similarities in growth that occur between the indigenous and the immigrant Leicestershire child population and within the immigrant population. Finally, to detect any trend or absolute change in growth pattern due to the impact of the new environment, the growth of the longer resident immigrant children has been compared with that of the most recent arrivals.

CHAPTER 2

THE INDIAN SUBCONTINENT

FIGURE 1

INDIAN SUBCONTINENT - MAIN AREAS OF MIGRATION TO GREAT BRITAIN



THE INDIAN SUBCONTINENT

India is the seventh largest country in the world with 2.4% of the world's land area and 14% of the world's population (Morrish 1971). The subcontinent is the size of the whole of Europe excluding the Soviet Union and its population in 1984 consisted of;- in India 734m., in Pakistan 77m, and Bangladesh 85m. The population in India is now estimated at 767m (the last census in 1981 produced a figure of 685,184,692 people). The geographical variation is tremendous with the mountain zone of the Himalayas to the north, a level Ganges plain and a southern Deccan peninsula plateau.

India's population has not always been large. In 1901-21 the growth rate was very slow. It increased moderately between 1921-51 but after 1951 the growth rate accelerated. Between 1961 and 1971 the population increased at a rate of 24.8%, due more to a decline in the death rate rather than a sudden increase in the birth rate. There are also considerable differences in fertility between the rural and urban areas, with fertility rates found to be lower in the urban areas and big cities, compared with rural areas and small cities. The increase in population in the 1960's has resulted in children forming a large proportion of the current total population, e.g. in 1984 the percentage of children aged 0-14 years in India was 41%, Bangladesh 44%, Pakistan 44% compared with the United Kingdom 23% of its 56m population.

The population of India is basically rural although this is now changing. In 1921 the urban population accounted for 11.2% of the total. This increased by 4 times due to a natural increase in urban areas, rural-urban migration and inclusion of new towns due to changes in definition of location, and by 1971, the urban population comprised 19% of the total population.

The population of India, Pakistan and Bangladesh are racially varied and contain a complex mix of many of the racial elements of mankind. The plateaux of north-west India contain a population with diverse ethnic elements and this ethnic variation is further compounded by the social restriction in mating enforced by a highly complicated system of inter-regional caste groups which seem to date from about 500 B.C.. Qualitative anthroposcopic and anthropometric studies show that the southern peripheral region of north-west India, i.e. Madhya Pradesh has a considerable proportion of an original autochthonous element - Dravidian and proto-Australoid in contrast to the generally fair peoples of the northern states - the Indo-Aryan, although current archaeological data do not support the existence of an Indo-Aryan or European invasion into South Asia at any time in the pre- or proto-historic periods. Instead, Shaffer(1984) claims that it is possible to document archaeologically a series of cultural changes reflecting indigenous cultural development from prehistoric to historic periods. The other foreign influx into north India was Mongoloid, mainly concentrated in the hills and valleys of eastern India but also penetrating the North West states. The mix of these ethnic elements is further indicated by the large number of languages and dialects prevalent in this region (Papiha, Mukherjee, Chahal, Malhotra and Roberts 1982).

So the Asians from the subcontinent of India, Pakistan, Bangladesh and Sri Lanka are not a homogeneous group. They come from a background of approximately 12 - 15 major languages with separate scripts and approximately 8 major religions, 4 major castes and hundreds of subcastes. There is great distinction between North and Central India and the South (mainly Dravidian) with three quarters of the subcontinent speaking Hindi and its variants, and the majority of the south speaking the Dravidian languages of Tamil, Kannada, Malayalam and Teluga. In the East, Bengali is spoken, whilst the Jain teachers in the West, use Gujarati. Hindi developed around Delhi and Urdu was the language developed by the Moslem conquerors and their subjects. Urdu became the official language of West Pakistan by 1974 and Hindi became the official language of India in

1965 (Morrish 1971). Bengali is the language of Bangladesh.

But the areas of migration to this country from India, Bangladesh and Pakistan are very limited (see Figure 1). Emigration has been confined to people from:-

a) border areas of Punjab state (India), (Punjabis - Sikhs and Hindus),

b) central and southern areas of Gujarat (Gujaratis and Kutchis - Hindus and Muslims),

c) half a dozen areas on what was the West and East wings of Pakistan, and is now Pakistan (Punjab, Pushtu, Kashmir and Sind - Muslims) and

d) Bangladesh, (from the areas around Sylhet and the maritime East Indian areas of Comilla, Dhaka and Chittagong - Muslims),

e) East Africa, predominantly from Kenya, Uganda, Tanzania and Malawi.

2.1 BACKGROUND TO IMMIGRATION.

The earliest immigration of people from the subcontinent of India into this country occured last century, when Indian seamen, mainly from the maritime areas of East Pakistan settled in small numbers in British dockland areas together with other Asians and Africans. Also, for many years, the Indians have been represented in this country by their business men, middle class students and doctors (Krausz 1971) although many of the latter arrived during the second world war and stayed on afterwards, e.g. there were approximately 1000 Indian doctors practising in Great Britain in 1949 (Rose 1969). A third group of settlers from the Indian subcontinent, whose origins date back to the first world war, were the Sikh and Muslim pedlers (Rose 1969).

The origins of increased migration from India and Pakistan are found during the second world war and after partition in 1947. During the war, large numbers of Indian seamen jumped ship in Great Britain and moved inland, where they were recruited as unskilled labour, to work in the factories. The Indian population in some British towns increased considerably at this time, e.g. Birmingham had an estimated population of Indians in 1939 of 100, and 1000 in 1945, largely because of the movement of seamen into the city. After partition, jumping ship continued to play a part in the migration from Pakistan (Rose 1969).

Political differences between India and Pakistan brought about partition and independence between these two countries and later, after civil war, in 1971, the creation of Bangladesh from East Pakistan. Partition in 1947, amid bloodshed, resulted in the migration of 15 million Hindus, Muslims and Sikhs across the boundaries of India and Pakistan (National Geographic Society 1984). In an exchange of population, over 4 million refugees flooded into East Punjab, (India) where they took over the generally smaller and sometimes poorer holdings of the Muslims. Most of the refugees went to Malwas, south of the Jullundur Doaba but migration affected East Punjab and all land holdings were reduced by legislation to a maximum of 30 acres. The Sikhs have no system of primogeniture, so land tenure became fragmented through inheritance and migration after Partition greatly added to the already existing population on the land. Jullundur district, where a quarter of all land holdings were less than one acre, had the highest percentage of uneconomic landowners and also the highest population density in the Punjab, so it was not surprising that the villages and towns of this area were the source of emigration to Great Britain. In some of the villages in 1965, more than one in ten of the population had migrated and more hoped to follow. Remittances from relatives in the United Kingdom brought great improvements to the land and villages (Rose 1969).

The joint family system of the Sikhs enabled the sons and fathers to emigrate and leave the wives and daughters at home. This pattern began to be broken when control of immigration was seen to be imminent in Great Britain, and from 1958 onwards, the Sikhs began to bring their wives and families to this country.

Many Sikhs who emigrated were from large villages but some were from small farms and some were educated urban Sikhs in professional and white collar jobs in the Punjab, who accepted more money as labourers in the United Kingdom. Also many of the blacksmith and carpenter castes emigrated to East Africa and Great Britain, with the Jats (the earliest converts to Sikhism) predominating in the early migration as they could raise a mortgage on their property to pay for their passage. The town migrants settled and worked with the peasant migrants (unlike the Pakistanis where there was very little mixing, Rose 1969).

Many Muslims from all over India took refuge in Pakistan after Partition and a large number of refugees settled in the Punjab, causing overcrowding and subsequently, emigration. So, loss of farms with Partition, and poor prospects of jobs in their own cities made many Asians emigrate to Great Britain where high wages for unskilled labour, the National Health Service and Welfare State were all highly attractive. Thus the majority of the early migrants from the subcontinent were from rural communities, with men aged between 16-40, migrating first, and relying heavily on the previously settled members of their community to assist them in finding jobs and accommodation in Great Britain. The wives, children and other relatives in the extended family were supported in their country of origin by remitted savings. In time, they joined the husband. This pattern of migration minimised the demands made on British society by the immigrant, who expected little except a chance to earn sufficient money to support his dependents and a good education for the children when they eventually joined him.

In the early 1950's, pioneer settlers from India and Pakistan who had prospered in British industry, this being the main inducement for migration - the phenomenonally high incomes that could be achieved compared with incomes in Pakistan and India, sent for their kinsmen and fellow villagers. The migrant had to have some contact or direct sponser in Great Britain, but travel agents began to be active, at an early stage in parts of large towns, and operating in country towns as well within a few years, and the scale of operations of the travel agents was the main reason why Indian and Pakistani migration was able to attain, so suddenly, the high levels it reached in 1961 and the first half of 1962. From the time the Home Office began to maintain records in 1955 until the end of 1960, the number of net arrivals from India and Pakistan remained at a comparatively low level, but in the 18 months prior to the initial measures of control, (Commonwealth Immigrants Act 1962), the figures showed a dramatic increase. The agents also helped intending migrants to evade restrictions imposed not by Great Britain, but by their own Governments to discourage emigration (Rose 1969).

Migration from India and Pakistan therefore did not develop into a substantial mass movement until 1961, when there was a sudden change in migration and the net flow increased nearly six times over the previous year. This sudden change in the migration pattern is explained in terms of three factors,

a) the fear of control in Great Britain,

b) this led to widespread avoidance and removal of controls by the Indian and Pakistan governments,

c) labour demand in Great Britain.

So the effect of control led to a distorted pattern of migration, and produced a far higher rate of migration than had ever occured before. Thus, the Commonwealth Immigrants Act (1962) which restricted right of entry of immigrants, under a regulated system of work vouchers, not only increased the number of immigrants to this country, including dependents, who followed much later, but also increased the rate of arrivals to such an extent, that in eighteen months, the net inflow was almost as great as that of the previous five years and the massive increase compounded the real problems (Rose 1969). The system of employment vouchers was finally abolished by 1972 (Immigration Act 1971).

Construction of the Mangla Dam in Pakistan produced a group of approximately 100,000 displaced people - the Mirpuris, in the early 1960's. The villagers were given compensation and some bought land in the Punjab, others settled in other areas of Pakistan but some emigrated to Great Britain. So the period of mass migration from Pakistan was the early 1960's (Anwar 1979).

Finally, emergence of African Nationalism in the 1960's, in East Africa, which led to severe economic and political pressures on the large community of Asians resident there, who had originally come, predominantly, from Gujarat, forced the Asians to leave as refugees, abandoning their extensive properties and businesses and looking to England, if they held British passports, and the rest, to India, for their safety. During the same period, the problem was compounded by speculation that Britain was considering closing the door against British citizens of Asian origin.

Sociologists describe the process of migration in terms of push and pull factors. Push factors are wars, religious persecution, political unrest and unemployment. Pull factors are good employment, prospects of a booming economy, good social and health services, political reliability and peace. All of these factors are present, in varying degrees, in the history of emigration of the people from the subcontinent of India and their immigration into Great Britain.

2.2 THE PEOPLE.

The Indian people can be divided into several distinct groups - using geographical area of origin, or religious adherence. There are three main geographical centres in India - central and southern areas of Gujarat, border areas of the Punjab and Bombay (Maharashtra) plus East Africa, (Kenya, Uganda and Tanzania), from which the Indian people have emigrated to the United Kingdom, and Sylhet, Chittagong and Comilla in Bangladesh and the Punjab, Pakistan, (see figure 1 for a map of the geographical areas involved). These people are mainly followers of three religions, Hinduism, Sikhism and Islam and cover the five language groups, Gujarati, Punjabi, Urdu, Bengali and Hindi (Community Relations Commission 1977). In Leicester city, the major languages/religious groups within the Asian population are estimated to be;-

Gujarati-speaking Hindus 36,100
Gujarati-speaking Muslims 5,200
Punjabi-speaking Sikhs 9,600
Kutchi-speaking Muslims 2,900
Urdu-speaking Muslims 1,200 (Leicester Report 1983).

In Loughborough:-

Gujarati-speaking Hindus 2,250,
Gujarati-speaking Ismailis (Muslims) 50,
Punjabi-speaking Sikhs 175,
Punjabi-speaking Hindus 375,
Bengali speaking Muslims 475,
Bengali speaking Hindus 25, (Borough of Charnwood, Community Relations Council 1980: Blair pers.comm.).

Thus we have for example, Hindus and Muslims from Gujarat, East African Gujaratis, Sikhs and Goans from Bombay, Sikhs and Hindus from the Punjab, Muslim Bengalis from Bangladesh, East African Parsees and Anglo-Indians. They also cover a wide range of literacy, with one third of the population of India, literate, but only 15% of the population of Pakistan (Krausz 1971).

Hindus

The Hindus are mainly from the border areas of Punjab state and from the central and southern areas of Gujarat. Unlike the Sikhs, who come mainly from the districts where they were born, some Hindus have already been uprooted once before when they fled from West Punjab at the time of partition.

85% of India is Hindu by religion and this sanctions the caste system (Krausz 1971). This Hindu caste system splits the Hindu community into several hierarchial groups, - varnas, castes and subcastes, each with its own rights, duties and privileges. Regardless of the origin of the Hindu caste system, each individual belongs by birth, to one of four hierarchial groups known as varnas, with the Brahmin at the top, followed by Kshatriyas (warriors), Vaishyas (craftsmen), and lastly, the Shudras (peasants). Each varna is subdivided into castes or jati. The various caste names are derived from the principal professions or crafts practised by their members. With the people of India estimated to consist of over 40,000 Mendelian populations, and with an estimated 37,000 endogamous groups or jati structured in the Hindu caste system and intercaste marriages on a large scale not permitted, the gene pool of each caste has evolved over at least the last 3000 years (Malhotra 1984). In recent years, the lower castes have shown an increasing desire to free themselves from the control of the locally dominant castes and they have been assisted by political forces, operating at higher levels. However, the social status of an individual is still dependent upon his or her caste. Hindus are also members of a gotra, a parallel system, that is exogamous, in terms of marriage, and therefore counteracts the endogenous influence of caste. People of one gotra may belong to many castes. Caste and gotra are transmitted through the male line (Rao 1984).

Orthodox Hindus believe in the doctrine of ahimsa (non-killing) and this together with the sanctity of the cow forms the basis of their vegetarian food habits. Travelling across the sea also involves ritual impurity and may inhibit some Hindus from migrating although this did not stop the Hindus of Gujarat. Consequently, the Hindu background is one of a social structure characterised by village kin and caste. Being predominently an agricultural country, the village community with its close unity and control is the mainstay of society. Industrialization, particularly in the last two decades has developed rapidly and urbanization is in evidence, but this is still secondary to the village life. The kinship system, with the patriarchial extended family, is extremely suited to traditional agriculture, with all the living members of the family of all generations in the male line, living communually and sharing everything.

In the joint or extended family, the eldest living male, who has controlling power, takes charge of the whole household or group of homes and makes any vital decisions concerning its members. There is a communal attitude to property, which is shared and, if the house is large enough, the joint family will live together. If not, they will live close together in the same village or town - a practice that is continued in this country by the Indian Hindu immigrants. Within the home everything is arranged, even the future of the children, so there is very little training in actual decision making for the younger members if the head of the house lives to an old age (life expectancy in India is approximately 40+ years). The family head may arrange marriages, control the family finance, consult oracles etc., to decide the future of his kin, even when he is economically dependent on his children and perhaps, grandchildren. The aged in the joint family are the responsibility of the remainder of the family. The daughters of the family are sometimes regarded as a liability since they have no economic value, as, in many cases they are not in a position to earn money and must be protected until marriage. This removes the liability but requires the provision of a dowry. However, the Hindu religion and culture does not dictate that they cannot earn money and with the changing times, especially with education for women, and increased urbanisation, the extended family is becoming smaller in size, some of the traditional kinship groups are breaking up, and this is resulting in the development of the nuclear family (a Western concept), with all its implications. This change is accelerated by emigration, travel and increased cultural contrasts.

The Hindu female from Gujarat wears a saree over a long petticoat (chunia) with a choli (blouse), from puberty onwards to cover up the developing physique. The Punjabi Hindu female wears the salvar-kamiz (an oriental trouser suit).

Emigration of the Hindus followed a similar pattern to that of the Sikhs - migration of the men first, with the wife and family sent for when the men were established.

The Hindus in the Leicestershire growth study originate mainly from Gujarat either directly or via East Africa.

Sikhs.

The Sikhs, who comprise 2.3% of India's population (Krausz 1971), combine the concepts from Hinduism and Islam. They were founded 500 years ago by the Guru Nanek (1469-1538) who was originally a Hindu, joined a Muslim sect for a while, before, at the age of thirty, declaring that "there is no Hindu, there is no Muslim, but only one human being and he is a Sikh", (Sikh meaning disciple of God)(Morrish 1971). The Sikhs believe in one God, with all men equal. All Sikhs have the same suffix to their name - Singh (meaning - lion), for males and Kaur (princess) for females, and they often drop the use of their surname to prevent the identification of their caste or group (which may be indicated in the Hindu surname, although some Hindu surnames denote geographical location).

Sikhs have 5 visible signs of membership of their religion, (a) the men have beards, and uncut hair (Kes), which they tie up in a turban and the women also have uncut hair,

(b) both sexes carry a comb (Khanga) to keep the hair clean,

or to secure the hair on the head,
(c) both sexes wear a steel bracelet (Kara) round their right wrist (to signify strength of their faith),
(d) both sexes carry a sword or symbolic little knife/dagger (Kirpan or Khanda) to defend their belief and their religion. Sometimes this is worn as a brooch or pendant,
(e) the men wear special underpants (Kaccha) to symbolise clean and chaste habits.

Sikhs have fairly liberal views especially with regards to eating and adapt easily to their new surroundings. Eggs and meat are not prohibited, but some Sikhs are vegetarian as they believe in reincarnation. They are not forbidden to eat beef but very few do so, they may not eat pork and their meat has to be killed with one blow to the head, (Khatka meat) not bled to death as with the Muslims. They eat chapattis, rarely smoke cigarettes and the orthodox Sikh takes no alcohol although it is not forbidden.

The women wear salvar kamiz (trousers and tunic) and they have considerable freedom. They are allowed to worship with the men, have the same education and many go out to work. The adolescent females do not have to wear traditional dress for school but are expected to return home directly after school and wear it in the evenings. The girls spend the evenings helping with the housework and cooking. They have considerable freedom but their style of dress limits exposure to sunlight. Sikh boys often wear turbans from their teens (their long hair tied in a top knot in young boys causing some problems when measuring stature). They are good at sport, play in the school teams and consequently get good exposure to sunlight. The men are tall and strong, with a well-earned reputation for courage and strength.

Although only 2.3% of the Indian population are Sikh, they constituted four fifths of the early direct migration from the Indian subcontinent to Great Britain (Morrish 1971). They come from two main districts in East Punjab, - Jullundur and Hoshiarpur, in an area known as Doaba, a mesopotamia that lies between the two rivers, Beas and Sutlej (Rose 1969). The Sikhs are the men of the Plains, some of the most fertile plains in India and the bulk of the Sikh migrants are villagers and small farmers. They are also great wanderers and have settled in many places of the world, e.g. Fiji, East Africa.

There are some Sikhs from Kenya in the United Kingdom but most of the Sikhs in the Leicestershire Growth study originate from the Indian State of Punjab, with only a few from East Africa.

Muslims

Muslims follow the teaching of Mohammed and the five pillars of Islam, the creed, prayer, charity and almsgiving, fasting and pilgrimage. There are a number of different sects, showing various degrees of orthodoxy, and these range from the strict Sunnie, found in Pakistan to the westernised Ismailis of East Africa. The Muslim religion governs diet, hygiene and social relationships as well as religious practices and morality.

Their way of life is similar to that of the Hindus, in that they live as extended families but their concept of the female role is much more restrictive. Traditionally, the men eat first, with the wife and children eating later, and unseen, although that tradition is now less observed. The adult and adolescent females wear purdah in the strict Muslim family and rarely venture outside their homes. Consequently the females have limited exposure to sunlight. The males do not have the same restrictions and often the men will do the shopping. In the evenings, some Muslim children attend mosque school (instead of playing outside), which also limits the exposure to sunlight.

The Muslim diet is not confined to vegetarian food, but pig products are forbidden and meat must be 'halal'. Poultry is frequently eaten. In addition, older children observe the practice of fasting during the period of Ramadan.

The relatively small (14%) Muslim minority in India has a decidedly higher fertility rate than the Hindu majority - this is perceived as a threat by some Hindu politicians in India. Muslim migrants to Great Britain have a higher fertility rate than West Indians, Hindus or Sikhs - but this may be due to their more recent pattern of immigration (Bhattacharjee and Shastri 1976).

The Muslim children involved in the Leicestershire growth study come from Gujarat, in India, a few from East Africa, and some from Pakistan and Bangladesh.

Gujarat and the Gujaratis

The State of Gujarat, which came into existance as a result of reorganisation of the former Bombay State, on May 1st 1960, lies between 20.1 and 27.7^{0}N and 68.4 and 74.7^{0}E and covers 187,091km^2, which comprises 6.14% of the area of the Indian Union, although it contains only 4.7% of the population of the Indian Union. It is the ninth largest state in India with a population density of 136 per km^2 (average for all India is 182 per km^2). With the Tropic of Cancer passing through the north border, the state has an intensely hot/cold climate, but the Arabian Sea and Gulf of Khambhat help to reduce the temperature. The rainfall ranges from 33-152cm. with a moist southern area and a dry northern region.

Due to its geographical location along the Western coast of India and also due to its inland connections, Gujarat has been assimilating and absorbing various populations and cultural strains, which have come into this region in the course of its history (Bhasin, Singh, Sudhakar, Bhardwaj, Chahal, Walter and Dannewitz 1985). It has given shelter to many a race who crossed into it and since it is an area of exchange in commerce and culture, this has resulted in a synthesis of many races and cultures. These manifold connections and contacts with other populations coming into Gujarat must certainly have affected the genetic components of the present day inhabitants of the state of Gujarat.

By about 2000 B.C. the Indus valley civilisation had already entered into the peninsula Gujarat and south Gujarat. The Aryans came to Gujarat relatively late. Other ancient faiths of Shavism and Vaishnavism reasserted themselves as Buddhism declined and Jainism also became established. The ninth century records the start of the period of history proper rather than a legendary haze. This was the Solanki era, 942-1297, the flowering of Gujarati culture, manifested in its architecture, language and script. Towards the end of the thirteenth century came the advent of Muslim rule with the defeat of Gujarat by Allauddin Khilji in 1297. Before establishing their political sway over Gujarat, the Muslims already had colonies in Broach and Khambhat. Following Allauddin, the Turks and the Afghans conquered the area, one after the other, until the Muslim rule ended in 1758 with the surrender of Ahmedabad (a city founded by the Muslims) to Maratha. Maratha power came to an end in Gujarat in 1819, but during their rule and prior to it, the Europeans and Portuguese were establishing their colonies (Bhatt 1972).

The Gujaratis have a long tradition of migration, and for centuries have been trading with East Africa, where many have settled, to become traders and merchants in that country. The Hindus from Gujarat who have settled in the United Kingdom belong mainly to the agricultural castes, agriculture being the main occupation of the people in Gujarat. Gujarat has 54.52% of its total area under cultivation, with 1.17 acres per capita, and 68.12% of the working population engaged in agriculture (compared with an all India average of 69.51%). 71.87% of the population is rural and 28.13% urban compared with the rest of the country which has 80.00% rural. The remainder of the immigrants to Great Britain are usually village craftsmen. Gujarat lies third in the industrially advanced states of India, with Ahmedabad, Baroda, Surat, Jamnagar, Bhavnagar and Rajkot being the main centres of industry and accounting for 50.09% of the total working factories and 60.60% of the total number of workers, employed in the state. The largest city in Gujarat is Ahmedabad and the other major cities are Baroda, Surat, Rajkot, Bhavnagar and Jamnagar (Government of Gujarat 1967).

The motive forces behind emigration are the pressure of land and unemployment, and the migrants are drawn mainly from central and southern parts of Gujarat, particularly from the districts of Surat and Charottar (Rose 1969).

The Gujaratis who have emigrated appear to be a highly literate group (with the literacy rate higher for this group than the average for all India. Literacy in Gujarat in 1971 was 46.1% for males and 24.5% for females (all India 34%,). The Gujarati literacy rate in English - 20%, is higher than the average for all India and for the Punjab, the other main area of migration to Great Britain. Almost all male Gujarati immigrants are literate, many have been to a college or university. Almost all the female Gujaratis are literate, but few have been to university (Morrish 1971).

The majority of the migrants are Hindu, as Hindus comprise 88.96%, Muslims 8.46%, Jains 1.99%, rest 0.59% of the Gujarat State population, but Gujarati emigration also contains a minority of Muslims. These appear to have come from the three administrative districts of Baroda, Surat and Broach, drawn from some twenty villages and from the towns of Baroda, Broach, Surat and Bardoli, all within a distance of approximately 100 miles and many from within the coastal area, which is well known for its commerce and wealth, mercantile and marine activities. Of all the states in India, Gujarat has the longest coastline, with nearly one third of the total coast of India, and consequently has a large proportion of the total number of ports in India, 45 of the total of 71. Many of the migrating Gujaratis had relations in East Africa and the majority came to Great Britain as complete families (Rose 1969).

The general health standards in Gujarat are comparatively better than the all-India standards. Infant mortality is steadily decreasing with improvement in medical and health facilities provided by the state and was 54-64 per 1000 births (1968). The birth rate was 27.28 per 1000 and the death rate, 9.9, compared with the all-India birth and death rates, in 1961-65 of 41.0 and 17.2 respectively (Bhatt 1972).

Most of the Gujaratis in Leicester lived, initially in one area - Belgrave (Mercer, Mercer and Mears 1979), but they now account for more than 50% of the total population in four areas of the city of Leicester and are the largest Asian group in all areas of Belgrave and Rushymead. Both Gujarati-speaking Hindus and Muslims also live in and around the area of Highfields (Leicester Report 1983). The children involved in the Leicestershire growth study originate mainly from Navsari, Surat, Porbandar and Jamnagar.

Punjab and the Punjabis

The earliest traces of human habitation in the Punjab were from 5-6 lakh years ago (lakh=100,000) in the Soan valley between the Indus and Jhelum rivers (an area now part of Punjab, Pakistan). The people of the Punjab were then invaded by the early Aryans who wandered down from the Caucasus mountains with their herds of cattle, and further expansion followed across the Sutlej river to the vast plains of Malwas, in approximately 2000-1500 B.C. The Vedic Aryans with their fair complexions, regarded the native Dravidians, who were probably part of an earlier invasion, in about the 4th. millenium B.C., as their servants. So ancient Punjab formed part of a vast Aryan region with an incessant traffic of people and cultures between Iran and India, and it was obviously the meeting point of many cultures and peoples in Asia.

The greatest impact to its culture probably occurred in 960 A.D. with the establishment of the first Muslim dynasty as Muslim warriors surged into India from the north west and formed kingdoms for themselves in northern India, in the Punjab and in the Ganges valley, especially. Islam made a more profound impact upon the religious beliefs, social life and diet of the people than the previous cultures, although many of the Indian cultures and religious beliefs were adopted by the invaders, even though the Muslim kings and their followers appear to have remained as a separate class of rulers in their own kingdoms and their subjects remained Hindu. Much later, in the fifteenth and sixteenth centuries there was a period of religious revival and conflict between the Muslims and the Hindus, which culminated in the birth of Sikhism, founded by Nanek (1469-1538) (Gupta 1971). Consequently, the racial composition of Punjab state owes its variety and vigour to the many elements which came into India from the north west.

In 1947, Partition of India occurred and over five million refugees crossed from Pakistan into India. New towns and cheap housing colonies were constructed and all this activity contributed to the final formation of Punjab State, India, in 1970 (a modification of the original creation of the state in 1956). New Punjab (India) covers an area of 50,376km^2 and has a population of 13.6 m (1971), i.e. 1.6% of the area of India with 2.5% of the country's population. Its birth and death rates are among the lowest in the country, with a birth rate of 34.4 per 1000, and a death rate of 11.3 per 1000 (Gupta 1971). Life expectancy for both sexes in 1971 was 47.5 years (Gupta 1971) but by 1976 it was 63.5 years for males and 58.6 years for females compared with the all-India average of 53.2 for males and 51.9 for females (Public Relations, Punjab 1976).

Per capita income is the highest in India (approximately 1.6 times the national average). The average yield per acre of nearly all the principal crops grown in the Punjab is higher than the All India average and this is partly because the land is fertile and well irrigated (Punjab has three major rivers, Ravi, Beas and Sutlej). But the land is well worked, (76.97% of the population are rural) with good implements and techniques. Punjab has the highest number of tractors, the highest wages for a farm labourer and the highest road mileage for a state proportional to its area. It also has the highest per capita number of small industrial units in the country. Coupled with this, all villages are accessible by road, all villages have been electrified and all villages have tube wells or tap water. These facts, plus the fact that the Punjabis' per capita consumption of milk and cereals is the highest in the country must contribute towards the healthy growth and welfare of the Punjabis. The Punjab population as a whole, is by far the best nourished population in India (Sharma and Kaul 1970) with the calorie intake of the average Punjabi individual of approximately $3000 cal.day^{-1}$ and a total protein consumed of approximately $90 gm.day^{-1}$ per individual - the highest figures for any population in India although a nutritional assessment survey conducted by the Punjab Health Department revealed that nearly one third of children in the Punjab villages were suffering from malnutrition and a large number of children between the ages of 5-10 years, also in the villages, showed signs of rickets (Gupta 1971).

Within a short geographical distance, Punjab communities cover the entire spectrum of persons, from completely urban, modern, sedentary, professional and social levels to immigrant labourers and farmers, usually living just outside the city, in reduced circumstances that are typical of the isolation in the countryside. The literacy rate in the Punjab is the same as the average for all-India, 34%, with literacy in English 1.5% and few Punjabi women are literate, compared with the Gujaratis (Rose 1969).

The largest towns in Punjab are those of Amritsar, Jullunder, Ludhiana, Patiala and Ferozepur and there has been rapid urbanisation in the last twenty years. It is predicted that by 1991 the rural-urban ratio might be as high as 40:60 (Gupta 1971). The capital of Punjab is Chandigarh - the only city in India which has been completely planned. It was designed by a French architect, Le Corbusier, and was started only thirty five years ago as a capital for the new Indian state of Punjab and to rehabilitate the immense displaced population from West Punjab (now Pakistan) after the Partition of 1947. Chandigarh has a relatively high per capita income and the higher socioeconomic strata includes children that have always known a cosmopolitan urban environment, including many that have been abroad. The lowest strata, on the other hand, is composed largely of labourers and recent immigrants from rural circumstances who tend to retain their original dietary and residence habits (Kaul and Corrucini 1984). But to whichever social strata the people of Chandigarh belong, they cannot be regarded as undernourished in comparison with the poor and the worker sections of India, who are on the verge of starvation level (Garg 1978).

Punjabi-speaking Sikhs are currently found in the areas on the edges of Highfields, in Leicester city (Leicester Report 1983) and most of the Punjabis involved in the Leicestershire Growth Study have migrated to the United Kingdom from Jullundur and Hoshiarpur.

East African Indian Asians

Trade between India and the East African coast has flourished for centuries, although only sporadically. Most of the twentieth century Asian immigrants to East Africa came from Kathiawar, and Cutch in Gujarat - areas which produced the early traders, and they settled to become traders and merchants there (Rose 1969). They came largely from rural farms or a village environment in India and were mainly Gujarati speaking Hindus and Ismailis (70%), although there were also Punjabi speaking peoples, Sikhs (6%), Hindus (10%), and Muslims (10%) plus some Goans (Tandon 1973). The Goans are a westernized group originating from a former Portuguese enclave, Goa, on the west coast of India. They are of mixed descent, Portuguese and Indian and are mainly Roman Catholics and English speaking.

However, the main reason for emigration of many of the Indians to East Africa was the promise of work and financial benefit when the British started to build railways in East Africa. The British could not take English workers to East Africa because they were needed in the British factories to manufacture such items as railway engines, as well as goods suitable for trade with the native population, once the railways had penetrated the African hinterland. The indigenous population, at that time, was not motivated by the financial incentives available, so 32,000 Indians were brought to East Africa in the 1890's to build the railways, the first settlers establishing themselves in Nairobi. However only a quarter of the railwaymen made any permanent settlement in East Africa.

But the numbers of Indian railwaymen in East Africa was soon supplemented, especially after the first world war, by other immigrants from India, the traders and the younger sons, mostly from Gujarat, but also from the Punjab. The railways, plus the demands of British industry by the indigenous population led to the development of Indian dukawallahs (duka - the Swahili word for shop, developed from the Hindu word - dukan). Petty traders established themselves all along the railway line and in the interiors, selling the new necessities, salt, sugar, silk, sandals, soap, etc.. The range and sophistication of the commodities increased as the money economy expanded and eventually resulted in the build up of an Asian population in East Africa, who were a powerless middle class, but who owned some of the largest industrial enterprises, most of the retail distribution and provided the necessary middle level professional and artisan skills (Tandon 1973).

Thus, the Indian Asians become urbanised in East Africa, better educated, with a much higher standard of living in Africa than in India and many with business experience. They became immigrants to Great Britain not out of choice but out of necessity, following their expulsion from various African States, e.g. Kenya, Uganda. The Kenya government applied a time limit of two years from independence, within which aliens had to make their application for citizenship. Legislation passed by the Kenya authorities in 1967 created a situation in which those aliens who had not opted for Kenyan citizenship were permitted to work and live in Kenya only on a temporary basis. Six thousand Asians possessing British passports, who were not subject to immigration control, entered the United Kingdom in 1965, 6,000 in 1966 and after Kenyan legislation, the number rose to 1,500 in August 1967, 2,661 in September, 1,334 in November and 2,294 in January 1968 (altogether, 13,600 Asians entered Great Britain in 1967 and 12,800 in the first two months of 1968, and most of these were from Kenya). These figures caused some alarm in this country and led to the Government special envoy in East Africa asking President Kenyatta for a slackening of the Kenya policy. The answer was negative and this finally resulted in the Commonwealth Immigration Act on race relations on March 1st. 1968 (Rose 1969). Further expulsion by General Amin of some 50,000 Asians from Uganda occurred in 1972 and Great Britain, along with a number of other countries, received a considerable proportion (approximately 28,000) of these. Between March 1968, when controls were instituted and June 1975, 83,272 people from East Africa were admitted to the United Kingdom (Rees 1982).

Below are listed the countries in East and Central Africa in which the Asians had predominantly settled, the overall population of the country, the population of Asians in 1969, and the estimated number in 1972:-

Uganda total population 10m., Asians 74,300(1969), 1,000(1972),

Kenya	11m.,	139,000	105,000
Tanzania	13.6m.,	85,000	52,000
Malawi	4.6m.,	11,300	13,000
Zambia	4.5m.,	11,700	7,000

(Tandon 1973)

The East African Indians involved in the Leicestershire Growth study originate predominantly from Kenya, with smaller numbers from Uganda, Tanzania and Malawi. The majority of them have lived for one generation in Africa, the previous generation having migrated predominantly from Gujarat, mainly from Surat and Porbandar.

The newer the generation of Indian, the more likely that its members have been exposed to an European style education either in East Africa or in Great Britain with the resulting consequences. Finally, the variation in acculturalisation from community to community is substantial among the Asian Indians in Great Britain. The Khaja Ismailis - Westernised Moslems from East Africa, lead in the degree of their acceptance of Western models of life style. The other Muslims, Jains and Shahs show the lowest degree of acculturation. The Gujarati Hindus who comprise a large percentage of the Asian population lie in the middle (Swinerton, Kuepper and Lackey 1975).

Pakistan and the Pakistanis.

The Pakistani people are Indo-Aryans from around the Indus river, many of them people of the plains. They consist of a number of relatively isolated tribes and groups with very different racial origins. People of the North West frontier of Baluchistan (Pathans and Baluchis) are a mix of Turks and Iranians, with fair complexions, long pointed noses and usually dark piercing eyes. The Pathans are tall and heavy, the Baluchis are comparatively short with oval faces and curly hair. South of Baluchistan, the group of people - Brachuis - are descendents of Dravidians. In the border area with India, are the Punjabi Muslims who are tall or medium in height, with long heads, prominent noses, black and wavy hair, black or very dark eyes and brown or fair complexions.

The people are brought up in small villages (1961 census 66% of the working population were employed in agriculture). The men wear western clothes, often with a typical fur hat. The women are pale skinned, often with grey-blue eyes and dark brown hair. They wear the oriental trouser suit, the Salvar-Kamiz with a long scarf or Dupatta, Shalwar (trousers - full on the leg and narrow at the ankle) with a Gemuz or Kurta (dress or shirt) worn loose over the shalwar. Most women also wear the burqa (purdah), outside the home (Jeffrey 1976). Such persistence in retaining almost total body cover in the immigrant female adolescent and adult, in this country, has contributed to the increased vitamin D deficiency and rickets cases, seen in the 1960's and 1970's, and prevalent in this ethnic group (Ford, Colhoun, McIntosh and Dunnigan 1972, as well as others, e.g. Punjabis, Hodgkin, Hine, Kay, Lumb and Slanbury 1973).

The Kashmiris are rice eaters but the rest of the people in Pakistan are wheat, maize and meat eaters. Meat is relatively expensive, so although the muslims of Pakistan like to eat meat, in practice, many Pakistanis are practically vegetarian (Jeffrey 1976). Their preference in meat is for chicken first, with goat or mutton as less desirable alternatives. Chapattis are made with coarse brown flour and eaten with vegetable or lentil stew. Occasionally rice is consumed instead of chapattis.

The Pakistan people are muslims but the communities are further divided by religious sects into Sunnis 90%, Shias 10% and a few Ahmeddiyas, with no marriage across the Shia-Sunni and other sectarian boundaries. (Rose 1969; Jeffrey 1976).

The majority of Pakistani migrants to Great Britain have come from Mirpur - a border area with Kashmir, formerly part of the state of Jammu and Kashmir. Under the Maharajah's rule the people were taxed heavily and were very poor. There were few schools, so the people were mainly uneducated and even illiterate. High unemployment, very infertile soil and consequently, considerable poverty in the region led to a general tradition of emigration. Added to that, the 1960 Pakistan Government announced a decision to build a dam at Mangla, which involved the submerging of 250 villages in the Mirpur district, and most of the emigrants from Mirpur came from families connected with that land (Rose 1969).

Other poor farming districts around Rawlpindi and Jhelum have contributed to emigration and also from the plains of Punjab around Lyallpur. There are some urban educated middle class in the migrants but this is only a small fraction of the whole, and most are farmers and village orientated.

Another large group of people from Pakistan are the Campbellpuris, also land-working villagers (Rose 1969).

The poverty of Pakistan is reflected in the low literacy rate in 1969 - approximately 15%, so many of the immigrants from Pakistan are illiterate (Rose 1969).

Being a muslim state, migration in the early phases was predominantly male. Seclusion of the female from the age of puberty from men who are not related is rigidly enforced among the Mirpuris and Campbellpuris, although not as rigidly as in the Sylhetis (from Bangladesh), but the close relationship of the men of the household with the male kin and with other villages is carried through into emigration into the United Kingdom and it has an influence on the pattern of settlement in this country (Rose 1969).

The Leicestershire Growth Study involved very few children originating from Pakistan.

Bangladesh and the Bangladeshis.

Bangladesh is an alluvial country within the delta of the Ganges-Brahmaputra. It is a tropical rice producing area.

The people are predominantly a mixture of Mongolian and Dravidian with short or medium height, dark skin, black hair, broad noses and broad foreheads (Morrish 1971: De H.Lobo 1978), although Aryan influence can also be seen in some of the population who are tall and fairer of skin (Bardhan pers.comm.). They are followers of Islam with all the practices and limitations this imposes upon dress and diet. Clothing consists of saris for the women.

The language spoken is Bengali. The people eat rice with their fish and vegetables and the 1961 census found 80% of the working population was engaged in agriculture.

Immigration to the United Kingdom is from two main areas - Sylhet on the border with Assam - this area has very poor soil and the bare subsistence drove the farmers' sons into the towns and the Merchant Navy. They have settled in the United Kingdom in the port towns and influenced the migration of the 1950's. Fairly large numbers have also come from the port towns of Bangladesh - Chittagong and Comilla. Sylhettis have a low literacy rate. The Leicestershire Growth Study included some Bangladeshi children, mainly from Sylhet and Comilla.

Since the Asian immigrants have come from a few areas only of the subcontinent of India, and predominantly from the social groups which include self employed proprietors, shop keepers, artisans and farm owners, (Heath and Ridge 1983), the children measured in the Leicestershire Growth Study may not be a representative sample of all the immigrants. Although an ongoing study in Leicester has found that the Asians from the Indian subcontinent are represented in all the socioeconmic classes i.e. in a control group studied from 1972-1985, social class I - Asians 2.5%, non-Asian 7.8%; social class II - Asians 10.8%, non-Asians 17.7%; social class III - Asians 49.8, non-Asians 53.0; social class IV - Asians 27.1%, non-Asians 14.3%; social class V - Asians 4.4%, non-Asians 2.5%; others/unclassified - Asians 5.4%, non-Asians 4.7%; (Clarke pers.comm.). Coupled with the fact that the immigrants may not be a representative sample of the state from which they have migrated, the genetic mix of the migrants may also be unbalanced and not heterogenous.

Besides a possible genetic inbalance due to selective migration, an additional factor that affects the distribution of genotypes in the population is, India is one of the countries in the world today where consanguineous marriages are still practised. The custom varies among the multitude of subgroups with their individual populations, and can be traced back to ancient cultures and traditions. Social and economic changes, migrations and newer religions have all had some influence in shaping the present levels of consanguinity. Hinduism, which is followed by 85% of the population of India forbids consanguinous marriages although some tiny groups of Hindus are an exception to this (Bardhan pers.comm.). Some of the earlier reasons for preferring such marriages may no longer be valid, but, nevertheless, they remain popular in various sections of the country. Such inbreeding affects the gene pool by producing an increased homozygosity, recessive genes are expressed much more and, when deleterious, the fitness of an individual may be affected (Rao 1984).

During the 1961 dicennial census of India, an attempt was made to assess the incidence of inbreeding in rural areas through a survey of 587 villages, spread all over the country. The survey confirmed that inbreeding was practically non-existent among the rural Hindus in the North whereas other religious groups showed some practice of inbreeding and within any geographical boundaries, there were variations in inbreeding due to affiliations, social status and education levels (Roychoudhury 1976).

So the picture of inbreeding in India is kaleidoscopic, with the custom of consanguineous marriages still quite popular in South India and relatively rare in the North - but there exists significant variation between the different regions and within each region and a pattern and variation of consanguineous marriages which has shown little change over the past few decades in the various religious and social groups. The effects of inbreeding in India depend upon a history of such practices over past generations, and where there is a long history, the effects tend to be marginal. Both Gujarat and Punjab states showed a frequency of inbreeding of less than 0.002, which was amongst the lowest in the country (Rao 1984). Since the majority of the immigrants from India to the United Kingdom come from these two states, it can perhaps be assumed that the immigrants are represented by a heterozygous gene pool.

Further evidence for heterozygosity has been found. A study of genetic heterogeneity in North West India (Rajasthan, Punjab and Himachal Pradesh) using blood groups and red cell enzyme systems, showed considerable ethnic diversity in this region, and suggested that the differences in genetic structure are likely to be due to the breeding structure, differential migration and ethnic affiliation (Papiha et al 1982). More specifically, Bhasin et al (1985) found that the allele frequency showed considerable heterozygosity among four tribal populations in Gujarat State and the major portion of gene diversity was due to the genetic variation within the four. So if there is genetic diversity among four tribes in Gujarat, there will be considerable genetic diversity in Great Britain among the Gujarati population, who will be representative of far more than four tribes from Gujarat.

2.3 PROBLEMS FOR THE IMMIGRANTS IN GREAT BRITAIN

In 1984, the population in private households, ethnic group by region of residence, for Great Britain and the East Midlands was as follows:-

People	Great Britain	(%)	East Midlands	(%)
All groups	54,084	100	3,830	100
White	50,895	94	3,647	95
West Indian	529	1	24	0.6
Indian	807	1.5	27	0.7
Pakistani	371	0.7	12	0.3
Bangladeshi	93	0.2	0	0
Chinese	109	0.2	4	0.1
African	109	0.2	2	0.05
Mixed	205	0.4	4	0.1
Other	138	0.3	5	0.1
Not Stated	829	1.5	61	1.8

Numbers are in 1,000's, (Central Statistical Office 1986).
All coloured groups together: 3.7% of population.

So the overall numbers of Indians, Pakistanis and Bangladeshis in this country are fairly low, but the distribution and concentration of these ethnic subgroups show that they are unevenly distributed among the British population, e.g. (Rose 1969) in 1961, 71% of coloured immigrants were in 6 major connurbations, with London holding 47% and the Midlands 14%. Forty four percent of the total British population live in the 7 largest connurbations and 53% in towns of 50,000+ but 89% of West Indians, 84% of Pakistanis and 77% of Indians live in such towns (Krausz 1971). Consequently, these large towns and connurbations contain a disproportionately large number of immigrants, with their associated problems as they establish their communities within an area. In 1980, the county of Leicestershire had approximately 840,000 people, with $^1/_3$ of these residing in the city of Leicester. Of these, approximately 60,000 were Asian of Hindu, Muslim or Sikh origin and they made up 25% of the city population (Dhariwal 1982).

Most of the Pakistani immigrants have arrived here since 1958, so by 1966 the family building stage among Indians and Pakistanis groups was occuring with high birth rates among these groups, e.g. in 1963, 75% of Pakistanis were males, 8% females and 13% children. In 1969, 2.5% of all births were to mothers from India and Pakistan. By the 1980's the numbers of second generation children born in this country to immigrants from the Indian subcontinent had increased. The estimated present number of coloured people in the total population is 3.7% and of these, over 45% are British born.

Household projections have been predicted for 1986-2001 (Central Statistical Office 1986):-

	1981	1986	1991	1996	2001
England	17183	17879	19661	19205	19481
East Midlands	1405	1477	1559	1620	1657

(Data for 1981 are midyear estimates, data from 1986 onwards are 1983 based household projections).
(East Midlands = Derbyshire, Leicestershire, Lincolnshire and Northamptonshire). The population in the East Midlands rose by 1.5% between 1979 and 1984, which is higher than the United Kingdom average of 0.5% and it is projected to increase by 6.3% between 1983-2001.

Of the Asians born in Great Britain, approximately nine million, the main groups are the Hindus, Sikhs and Muslims, with the main language groups, Gujarati, Punjabi, Urdu, Bengali, Hindi. In Leicester city, of the Asians born outside the United Kingdom, (and 21.3% of the population live in households whose head was born outside the New Commonwealth or Pakistan (O.P.C.S. 1982)) they are approximately equally divided between those born in the Indian subcontinent and those born in East Africa, but over a quarter of the Asian population were born in the United Kingdom (Leicestershire Report 1983).

Studies in the past two decades have shown that immigrants from the Commonwealth countries have tended to settle in the slums of the inner wards of industrial cities and towns. The reasons for the development settlements in this now familiar pattern and the immigrants overall behaviour can be explained in terms of the early immigrant's perception of his situation, the context of his socioeconomic background, his motive for emigration and his ideology i.e. the myth of the return. Plus the fact that external constraints such as racial discrimination practised by various socioeconomic and political institutions of the dominent society also impinge on the immigrant, so they did not plan to stay (Dahya 1974).

The Pakistani and Indian emigrated not in order to earn a livelihood but to supplement the economic resources of their families in their place of origin, so that their land holdings remained intact and their remittances could be invested to improve the existing land holdings and/or extend them, to improve the family homestead, etc.. From the immigrants and family point of view, migration was an economic investment. The money which the family spent on financing the immigration was repaid substantially e.g. 1960-1965 passport and fares £800, per capita income £30 p.a. so this was an indication of the family expectations in the form of remittances, i.e. migration was undertaken for raising the immigrant family's socio-economic status back home and not for the immigrants immediate gratification in the receiving country. So the immigrants behaviour patterns in Great Britain, especially with regard to living conditions, consumption etc., were influenced by this motive for migration. To that extent, the motive provided the immigrant with a scale of values and preferences which differed from those of other coloured immigrants and from those of the host society in general.

Closely related to the motive for migration was the myth of the return - the immigrants came with the firm intention of returning home where they hoped to enjoy the fruits of their labours in retirement. This myth therefore influenced their endurance of hardship in work and living conditions and emphasised the need to save, so that the remittances could be sent to India, Pakistan and Bangladesh e.g. the immigrants were known to remit £60m sterling per annum (Dahya 1974).

Over the last decade, in towns with large immigrant populations, such as Bradford, Leicester, Birmingham, the immigrant community has grown to several thousand and this growth has been accompanied by parallel growth of ethnic-socio-economic institutions which keep the immigrant community a relatively closed one as the immigrant does not have to cross the ethnic boundaries to satisfy most of his every day needs. The ethnic institutions emerge to provide the immigrant with a wide range of goods and services - and thereby - part of the resources earned by the immigrant in the host society's economic organisation are channelled into the hands of the ethnic entrepreneurs and kept within the bounds of the ethnic group. Since the ethnic constituents depend upon ethnic patronage they acquire a vested interest in the immigrant as their clientele and one role of the entrepreneur in the immigrant community is to remind the immigrant of their traditional culture and values i.e. to perpetuate and defend their ethnicity. Some of the entrepreneurs and religious functionaries act as a pressure group e.g. on local education authorities and emphasise their religious and cultural traditions in order to seek concessions with regard to female dress and content of education, especially physical education.

The immigrants are particular in their own socio - cultural activities and patronage of ethnic institutions reduces the chance of meeting non-immigrants. The immigrants' support for ethnic and their avoidance of native institutions is not simply a matter of voluntary decision on their part - it is an obligation - an expression of one's loyalty to the homeland. Participation in ethnic institutions increases their pride in their traditional culture and nationality and is an expression of their ethnicity. So Pakistani and Indian shops fulfil extra economic functions which could not be fulfilled in British shops i.e. talk in own language, information on matters of community interest, etc..

The above does not apply to the East African Indians, they are not preparing to return because they cannot. It also does not apply quite so rigidly now to the Pakistanis and Indians because the Immigration Acts had the effect of controlling the incoming numbers and resulted in more families being resident in Great Britain from the Asian subcontinent, less single men coming into the country, but more dependents (Dahya 1974).

Housing.

The immigrants choice of living area is dictated by the choice of housing he wants. He does not want to be a tenant with a landlord, he does not want a modern house on the outskirts of the town or city and he needs to live on a bus route in order to get to work. The immigrant has tended to accept short lease, cheap property which suited his short term interests and at the same time earned him money in rent from other lodgers. The house in Great Britain was not regarded as a home but as a short term expediency related to a particular goal or goals for the early migrants.

The immigrant's attitude towards his physical environment, overcrowding and sharing rooms, differed from that of the local people. Since the immigrants all live in more or less similar circumstances, and since from their perspective, settlement in the inner wards of industrial cities and towns is a tremendous improvement over what the immigrants direct from India have been accustomed to in their villages at home in the Indian subcontinent, they do not feel deprived nor do they experience "status dislocation". So on the whole the living conditions of the immigrant are not imposed upon him by racial discrimination practised by the indigenous population although there is a certain amount of channelling towards this end, but a matter of choice, although not entirely, by the immigrant himself. The immigrants who have come via East Africa are far more likely to feel status dislocation because they were forced to move from very good housing and standards of living in East Africa, to Great Britain, with a limited choice when they arrived here because much of their capital was tied up by Government policy in East Africa and unavailable.

A higher proportion of Asian skilled, semiskilled and unskilled manual workers own their own homes, but fewer non-manual workers are owner occupiers, than in the general population. Very few Asians of any class are council tenants and fewer Asians than in the general population privately rent accommodation with the exception of non-manual workers. In 1966, 21% of all coloured immigrants in the West Midlands lived in rented accommodation compared with 1% of English (Community Relations Commission 1977). In the West Midlands 21.4% of coloured immigrants rent furnished accommodation but only 1.3% of the English do. However, very few immigrants rent their accommodation from the Local Authority - 8.2% of coloured immigrants in the West Midlands and 39.1% of the English (Krausz 1971). In Leicester city, a similar practice occurs, with just over half (52.7%) of the residential properties owner-occupied, and nearly one third (31.1%) rented from the Council, but only 48.2% are owner-occupied by White, whereas 81.7% are by Asians, and conversely, 34.8% of the residential properties are rented from the Council by Whites and only 9.0% by Asians (Leicester City Report 1983).

However, the ethnic minorities are at a disadvantage in terms of housing when this is considered by age and condition of the property, overcrowding, housing amenities and costs of housing. 70% of the ethnic minority population are concentrated in 10% of the enumeration districts, in Great Britain, in which they constitute over one fifth of the total population. When these 10% of enumeration districts are compared with others on indicators of housing deprivation, it is found that they contain nearly three times the mean for Great Britain of households which share or lack hot water, and two times the mean for Great Britain for sharing a bath or lacking one. Also, three times as many households live at a density of over 1.5 persons per room (the statuatory overcrowding level) and two times as many households lack exclusive use of all basic amenities, half as many in local authority accomadation and two times as many in private furnished accommodation (Community Relations Commission 1977). In Leicestershire, 2.6% of households lack or have to share with another household, the use of a fixed bath or shower but in Leicester and Charnwood the two areas of the county with the highest immigrant population, the numbers are 3.5% and 2.5% respectively. With respect to overcrowding, the percentage of households with over 1.5 persons per room is, for Leicestershire 0.56%, for Leicester 1.25% and for Charnwood 0.28%. For more than one person per room, 3.4% of the households in the county were overcrowded, 6.3% in the Leicester district, 2.4% in Charnwood (O.P.C.S. 1982).

The average household size in England and Wales contains 2.86 people while for the Asians it is 5.19. Less than half of all households in the United Kingdom contain children, (47%), but 77% of ethnic minority households contain children. The average number of children in white households with children, is 1.93, for Asians and West Indians, the average is 2.86. Asian households contain, on average, three adults compared with 2.25 for the general population (Community Relations Commission 1977). In Leicester, the average household size is 2.5 persons per household for White families and 4.3 for Asian (Leicester City Report 1983).

The household size naturally affects the living density of the family and possibly the type of housing available for that number of people. 22% of Asian households live in shared dwellings and 1.83 persons per bedroom compared with the white ratio of 1.25. Only 1/4 of white households live at a density of 1.5 persons per bedroom, 65% of Asians live at this density. One in five Asians live at a density of over 2.5 persons per bedroom compared with 2% of white households. The number of persons per room is the most useful single diagnostic factor of housing conditions (Rose 1969) and immigrants average one person per room compared with the control of 0.6 per room. The average household size is also larger in the immigrant population, they do not necessarily live in smaller houses with less rooms. Also, the immigrant households tend to take in lodgers to help pay the high mortgages, and the extended family network means shelter and hospitality is available for people just arriving in Great Britain from abroad. This results in the immigrant households in the West Midlands being 57% larger than those of the English population.

One other aspect of the housing situation is that many of the bad landlords of the houses in which the immigrants live are also immigrants themselves, e.g. in Birmingham 1962-1964, 70% of the summonses for poor housing were issued to Pakistani landlords, 27% to Indian and 3% to others, although some prosecutions do arise out of misunderstandings between immigrant landlords and the Public Health Authority (Krausz 1971).

Employment

From the 1971 census, 2.5% of the total population were unemployed (3.2% males and 1.8% females) and unemployment among the Asians closely approximated to the rates for the general population. However in Leicester city in the early 1980's, there were some differences, with higher unemployment rates amongst the West Indians and the Asian people than amongst the White people, especially amongst the young, e.g. overall unemployment, 12.9% White, 21.7% Asian, 23.7% West Indian; people 16-19 years of age, 23.6% White unemployed, 38.5% Asian and 45.5% West Indian (Leicester City Report 1983).

But differences also lie in the type of employment held by the Asians compared with the Whites e.g. 40% of the white population are employed as professional/managerial/white collar workers, only 8% of Pakistani/Bangladeshi, 20% of Indian and 30% of East African Asians hold similar posts. 18% of the White population are employed as semiskilled/unskilled whereas 58% of Pakistani/Bangladeshi and 36% of Indians are. So a high proportion of Pakistanis are involved in manual work - approximately 86% compared with 76% of Indians and 51.2% of the total population in Great Britain, but the rates for clerical work are fairly similar, i.e. 5% for Pakistanis, 4% for Indians and 6.6% of the total British working population (Morrish 1971). Two times as many ethnic minority men also work shifts than do White. Generally, the immigrant worker is more likely to be found in the manufacturing industries than the population as a whole and less likely to be in a service industry (Rose 1969). There are also differences among the female working population with 72% Muslim Asian and 89% non-Muslim Asian working full time compared with 61% of women in the general population.

Education

Children are disadvantaged in their education by their migration and the need to learn a new language before being able to benefit from schooling in the United Kingdom. Nor are the children assisted by the educational system to understand their position and responsibility in the extended family. The parents, often not well educated themselves, are not always able to help their children understand their religious and cultural ideas. As a result, children are poorly equiped to continue in their traditional lifestyle, yet unable to relate to their wider society, without having to face misunderstandings, hostility and prejudice (Community Relations Commission 1977).

In January 1968, the total number of immigrant pupils in maintained primary and secondary schools in England and Wales was 200,742 = 2.7% of the full time pupils in these schools. Immigrant pupils mean children born outside the British Isles who have come to this country with, or to join, parents or guardians whose countries of origin were abroad, and also children born in the United Kingdom to parents whose countries of origin were abroad and who came to the United Kingdom on or after January 1st. 1958. The three immigrant groups, West Indians, Pakistanis, (now Pakistan and Bangladesh), and Indians, comprised 74.4% of all immigrant pupils on January 1st. 1968, with Indians 21.1%, Pakistanis 8.5% and West Indians 44.8%. By January 1969, the number of immigrant pupils had risen to 3.2% of all full time pupils in state schools (Morrish 1971).

Immigration of coloured immigrants into Leicester began in the early 1950's, so by 1957 it had become apparent that the City was attracting significant coloured immigrants to live and work there. However, in the early stages of immigration in Leicester, it was decided not to make any administrative distinction between immigrant and indigenous children in the schools, so from 1957 to 1966 the numbers of immigrant children in Leicester schools were not counted. In 1966, when counting began, the Leicester school roll included 6.4% of immigrant children and this increased annually from then onwards until in 1972 it was higher than that in any other Local Education Authority outside the London area (and this was prior to the influx of Ugandan Asians in 1972). By 1974, immigrant pupils comprised 17.66% of the school roll in Leicester, i.e. 9941 immigrant children, with 272 originating in Pakistan, 617 in the West Indies and all the rest, except for 354 from other countries, of Indian origin (Mander 1980).

In the early stages of immigration, the numbers of immigrant pupils in schools in Great Britain were not evenly distributed across both the primary and secondary school sector, e.g. in Nottingham, in January 1967, there were 7% of coloured children, born in this country, at secondary school and 61% at primary school (Rose 1969). Today, the pattern is more even, e.g. in Leicester city, over one quarter of the Asian population were born in the United Kingdom and of the City's population, 9.6% are Asian children aged 5 - 9 years, and 11.4% are age 11 - 15 years, so the numbers of immigrant children in the primary and secondary sectors of education are more evenly distributed (Leicester Report 1983).

Age Distribution

In immigrant households there are few retired people, the majority are young, which produces a high dependency ratio, e.g. White households 1.17, Asians 1.52. In Birmingham, for example, only 16% or less were 45 years of age or older in the immigrant households and 70 - 80% were between 25 - 44 years of age, compared with the United Kingdom population where 60% are 45 years or more and 36% are between 25 - 44 years of age. (Rose 1969). Leicester city shows a similar pattern with the highest proportion of elderly in the White component and the highest proportion of younger children and adults aged under 44 years in the Asian component of the population (Leicester Report 1983). The births to Asian mothers in Leicestershire showed a progressive rise over the period 1976-1980 of 28% compared with a rise of 11% in the non-Asians, in the same period, due to differences in age and fertility patterns. 14% of all Leicestershire births and 33% of the births in the city of Leicester are to the Asian population (Dhariwal 1982).

Health.

There are a number of genetic diseases of immigrant families that obviously will occur in Great Britain to a similar extent as in the home country, especially as in this country, the Indian communities still tend to keep together, live in housing areas with others from the same village or area in India from which they emigrated, and intermarry within the same group cultures. These genetic diseases include those of thalassaemia, favism and sickle cell anaemia. Arthurton in 1972 commented that as a general practitioner, he frequently encountered cases associated with such diseases as sickle cell anaemia and thalassaemia in his Asian patients in Bradford.

Other diseases are brought to this country by the immigrants already infected, because such diseases are common in their own country, e.g. malaria, tuberculosis, hookworm disease, threadworms and roundworms, kwashiorkor (Studd, Tuck, Cardozo and Gibb 1982) and some of these, e.g. roundworms, threadworms, are then transmissible to others living in the communal environment. Archer, Bamfield and Lees (1965) in a survey of 1317 immigrant children from the New Commonwealth, resident in Bradford, found an overall incidence of helminth infestation of 18.6% with 1.1% of children having been infected in this country from others, (these children having been born in the United Kingdom and resided here from birth onwards). They also found that for some infestations, e.g. whipworm (Trichuris trichiura), the rate was as high after 5 years of residence in this country as it was for the new arrivals, although for some other infestations, e.g. dwarf tapeworm (Hymenolepsis nana), the rate of infestation appeared to diminish with length of residence in this country. In a study of the incidence of tuberculosis among Asians in West Ham, it was found that, of the Asians who developed tuberculosis over a 5 year period, about one fifth of the Asians did so as a result of a recent visit to Asia, one third appeared to acquire the infection before leaving Asia and nearly one half appeared to acquire their disease from known or unknown contacts in the United Kingdom (McCarthy 1984).

It has been observed that bacterial, viral and parasitic infections affect growth and physique (Jelliffe and Jelliffe 1966). The children who have emigrated from the Indian subcontinent carry more of these infections overall compared with the indigenous population of Great Britain. In addition, there is also the possibility that the parents' growth during their childhood, in India, was affected by such infections, thus producing a smaller adult phenotype, since Behar (1968) claims that one of the factors determining malnutrition and, therefore growth, is the high prevalence of infectious diseases in the underdeveloped regions of the world and the synergistic interaction of nutrition and infection. Smaller females have lighter babies (Tanner and Thompson 1970), i.e. phenotype as well as the genetic disposition affects the size of the children. Such diseases will become less prevalent in the immigrant community as it becomes established and the length of time of residence in this country increases, as these are diseases that are dictated by the environment rather than genetically transmissible. Since many diseases affect the growth of a child unfavourably, as these diseases become less common so growth will become less impaired in the immigrant population, and this is one factor amongst others, that could contribute to greater growth at a given age in future generations of Indian ethnic groups.

There are also other illnesses and medical conditions that show a more severe effect on the immigrant than on the local population such as rheumatic fever, which is prevalent in the developing countries of Africa, Asia, Central and South America, often with an earlier onset, more severe carditis and higher mortality than in the temperate zones. The incidence of rheumatic fever is directly related to overcrowding, particularly where more than 2 children share the same bed, encouraging person to person spread of the disease. There is also a tendency for it to occur in families, which could reflect socioeconomic conditions, although there may also be a genetic susceptibility. The social proximity of the Asian families and the larger family size combined with poorer living conditions will aggravate the spread and seriousness of this disease (Lancet editorial 1985).

There are also those diseases which show a higher incidence of occurrence in the immigrant population compared with the indigenous population, e.g. tuberculosis, minimal change nephrotic syndrome. Feehally, Kendell, Swift and Walls (1985) found a higher incidence of the latter in Asian children living within the city of Leicester, and a similar result was found among the Asian child population in Birmingham (Sharples, Poulton and White 1985). For the former disease, in Bradford, Arthurton (1972) found that the admissions for all forms of nonbony tuberculosis in 1965-1969, were 72% for Asian children and Froggatt (1985) reported that the incidence of tuberculosis was approximately 20 times higher among the New Commonwealth and Pakistan population than the rest of the population, in 1980-1982. More recently, a survey of all notifications of tuberculosis in England and Wales for the first 6 months of 1983, showed that 56% of the 3002 newly notified patients were white and 37% were from the Indian subcontinent, with the highest rate of notifications occurring in the Indian population. Overall, people of Indian, Pakistani and Bangladeshi ethnic origin had a notification rate approximately 25 times higher than the rate of notification for the white population (Medical Research Council 1985). Furthermore, an analysis of the causes of death in peoples from the Indian subcontinent, assessed by ethnic group, in England and Wales found that more Indians than expected died of parasitic and infective diseases, notably tuberculosis, among others (Balarajan, Bulusu, Adelstein and Shukla 1984). However, in Bradford, at least, but probably applicable to other towns with similar population mix in inner urban areas, Froggatt (1985) has suggested that the higher incidence of tuberculosis in the Asian population is not necessarily due to race, but more likely due to the socioeconomic position of that population.

Finally, other illnesses that have been eliminated in this country crop up again in the immigrant community, because of changes in their environmental circumstances e.g. rickets (Hodgkin, Hine, Kay, Lumb and Stanbury 1973) anaemia (Britt and Harper 1976). Over 20 years ago it was recognised that the Asian population living in Great Britain were at risk of developing rickets and osteomalacia (Dunnigan, Paton, Haase, McNicol, Gardner and Smith 1962) and a Department of Health and Social Security working party on the fortification of food with vitamin D (1980) concluded that Asian adolescents in Britain remained at risk of developing rickets and recommended vitamin D supplements where necessary. However, Pietrek, Windo, Preece, O'Riordan, Dunnigan, McIntosh and Ford (1976), found that vitamin D supplements were taken regularly by only a minority of Asians in Glasgow and they also concluded that attempts to persuade Asian immigrants to change their dietary habits to include more vitamin D containing foods were unsuccessful. A recent report by O'Hare, Uttley, Belton, Westwood, Levin and Anderson (1984) indicated that the problem was still endemic in Asian adolescents.

There appears to be a higher incidence of asthma in Great Britain among children of Asian and West Indian parents than in India and the West Indies. Typical eczema of the elbows and behind the knees is also seen a lot in infants. Later, wheezing, associated with colds and mild bronchitis develops. Then, in the pre-school years, nocturnal attacks of wheezing, the cough with exertion, and coughing and wheezing during the day occur. Possible factors for the more prevalent asthma among the Asian immigrant children are overcrowding, the increased ability of the house dust mite to survive in warm upholstered settees and blankets used in Great Britain, use of paraffin heaters and the irritant effect of paraffin on the lungs, damp cold weather and the greater tendency to live indoors, and the high incidence of home piecework done by the immigrant women for the clothing industry. The incidence of food related asthma is also higher in Asian children compared with non-Asian children (Wilson 1985). Asthma is one of the commonest causes for the Asian and West Indian child missing school but a large number grow out of the tendency to asthma by puberty (de H.Lobo 1978). There are also problems with the treatment of eczema for the immigrant child, in that the ointments containing cortisone which control it tend to de-pigment the skin where they have been used a lot.

Diet.

One of the biggest problems which the immigrant communities have to face is that of change in dietary intake, namely, the lack of vegetables in this country similar to those grown locally in their villages in India, or expense if they have been imported, coupled with the restricted intake of certain foods that are more freely available, because of religious taboos and practices. Basically, the Muslims eat no pork and their food must be halal, which might make it difficult to obtain or expensive. The Hindu parents are usually vegetarian and eat neither eggs, meat, fish or chicken, although the most liberal parents do eat beef or allow their children to do so (Bardhan pers.comm.). They rely for their protein upon dairy products and pulses, lentils and dahl with the Gujarati

Hindus from India as strict vegetarians whilst those from East Africa are less so (Hunt 1977). The Sikhs eat both meat and vegetables and are, on the whole, the best nourished and robust of the Asian immigrants.

With limitations on intake of certain foods and higher intake of others, some problems occur more often in Asians in this country than the White population, e.g. high incidence of florid rickets and an even higher incidence of subclinical rickets in Asian immigrants in Glasgow, (Goel, Logan, Arneil, Sweet, Warren and Shanks 1976) especially in school children aged 5-15 years, adolescents and young women, basically due to dietary deficiency in vitamin D, but also possibly due to the high intake of wheat fibre in chapattis (Robertson et al 1982). Delayed weaning of Asian children and the choice of foods, which tend to be iron deficient, e.g. home made preparations of rice, potatoes, milk puddings, when weaning eventually occurs, gives rise to higher incidences of anaemia in the Asian community, (Jivani 1978: de H.Lobo 1978: Harris, Armstrong, Ali and Loynes 1983) and poor growth due to inadequate nutrition in the weaning period (Jivani 1978).

But studies of calorie and protein intake in children aged 1 - 5 years in India, showed a diet basically deficient in calories and vitamin A and iron (Mitra 1978) so the immigrant child, who arrives in this country, may already be disadvantaged, of parents who have previously grown up with a similar background of malnutrition. However, the point must be made that in many of the Asian diets which are deficient in some way, the deficiency may not be due to religious proscription but rather to traditional dietary habits and the long term solution is one of education (Britt and Harper 1976).

In an attempt to counteract any deficiency in the Asian diet, in Leicestershire, the schools meal service is currently offering a choice of dishes for the lunch time meal, including a Western vegetarian dish, an Asian vegetarian dish and a Western dish with no beef, in an attempt to cater for the diverse dietary requirements of the

Leicestershire population, with its high numbers of immigrants from the Indian subcontinent, in some areas of the county. This recently introduced system (approximately eighteen months ago) is proving very popular, with uptake high in both the indigenous and immigrant population and 59.1% of primary school children now partaking of a school dinner (Leese pers.comm.). Dietary illness, such as rickets has now virtually disappeared in Leicestershire, with only three cases in 1984 (Spalding pers.comm.).

Finally, many attempts are now being made, at various levels, e.g. by health visitors to new mothers, by dieticians and domestic science teachers to school children, to give dietary advice, based upon the Asian community's own cultural background and religious restrictions i.e. the advice has to be linked with the dietary restrictions and intake of both the Muslims, the Hindus and the Sikhs. The intake of vitamin D in the diet can be increased with the use of fortified vegetable oil margarines for cooking or ghee which can be clarified from margarine in a similar way to its preparation from butter, (which produces ghee with a lower vitamin D content). Introduction to oily fish such as herrings, (although Bangladeshis already eat sea fish), and encouragement to use whole eggs and fortified milks, e.g. condensed or evaporated, for the preparation of sweetmeats, instead of khoya (a form of condensed milk made at home by boiling pasteurised milk) will all lead to an increased vitamin D intake. Most cereal grains are poor in minerals, e.g. rice is low in calcium and iron, so encouragement in an increased intake of food sources rich in these minerals will be of benefit to the Asian diet, e.g. ragi (finger millet) is rich in calcium and iron, bajra (spiked millet) is rich in iron (Gopalan, Rama Sastri and Balasubramian 1976).

Training in the preparation of the chosen food is also important, e.g. the Asian housewife is prone to washing rice several times before use, thus causing the B group vitamins which are water soluble to be lost.

FIGURE 2

AREAS OF SAMPLE POPULATION - LEICESTER

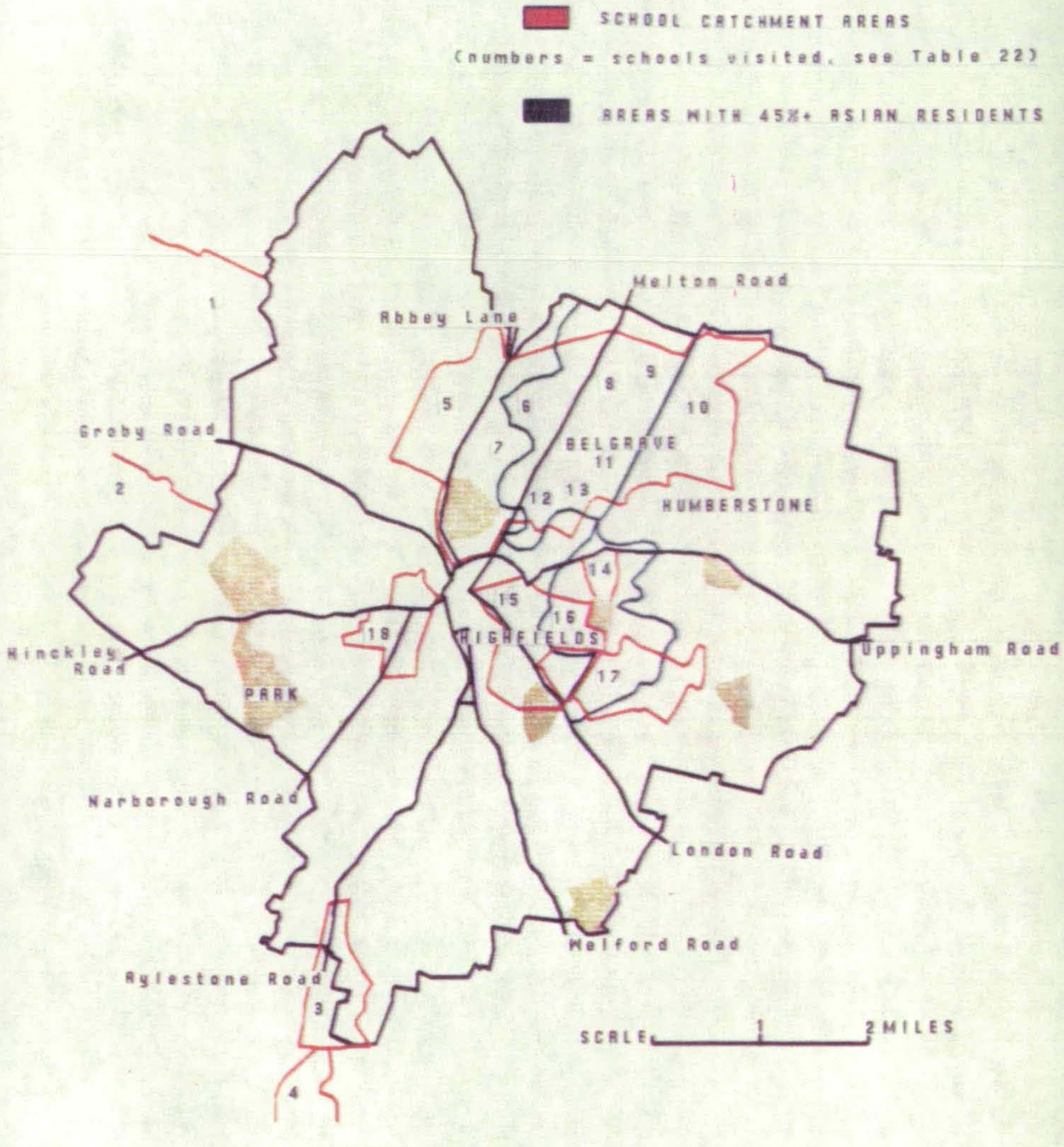
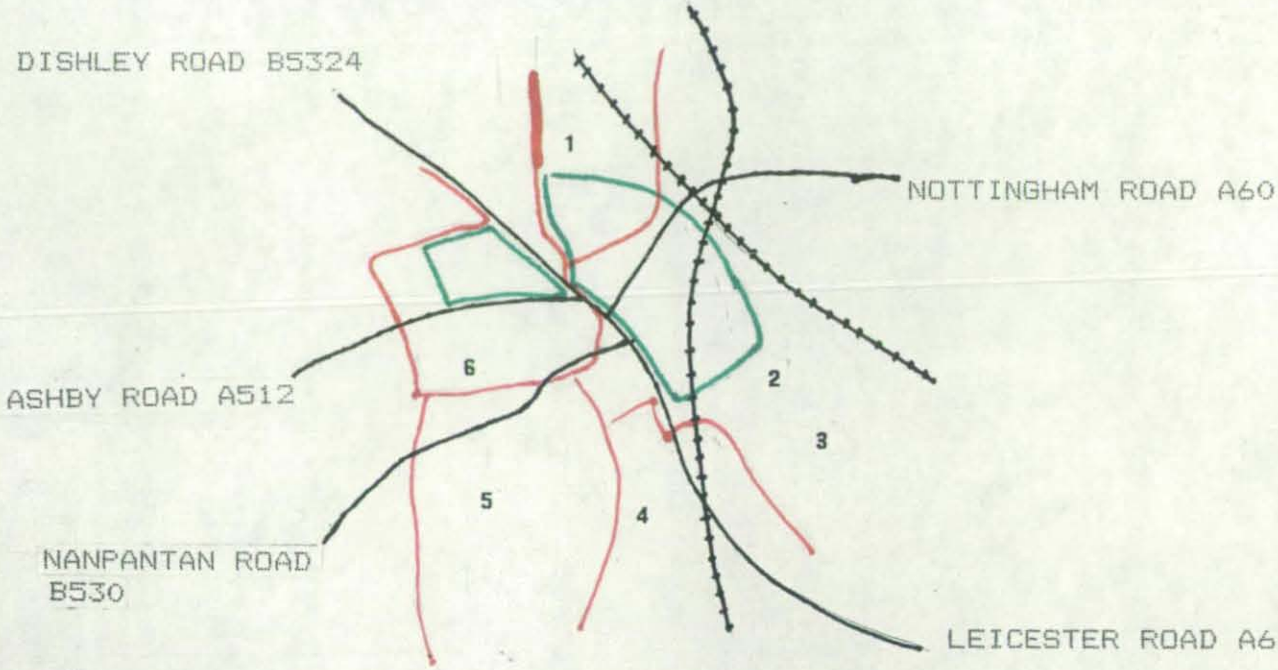


FIGURE 3

AREAS OF SAMPLE POPULATION - LOUGHBOROUGH



SCALE 2 KM

SCHOOL CATCHMENT AREAS

1 RENDELL PRIMARY
2 COBDEN INFANT
3 COBDEN JUNIOR
4 SHELTHORPE PRIMARY
5 MOUNTFIELDS JUNIOR
6 ROSEBERRY PRIMARY

AREAS OF PREDOMINANT ASIAN RESIDENCE

CHAPTER 3

REVIEW OF THE LITERATURE

LITERATURE REVIEW

3.1 CHOICE OF MEASUREMENTS

The concept of the use of anthropometric parameters for the assessment of healthy growth and development in children was established in the early part of the nineteenth century by humanitarians as a reaction to the appalling conditions of the poor and their children at this time (Tanner 1981), although the choice of which parameters give the most valid information is still being debated.

The first longitudinal growth recording of stature was by Buffon (1877) reporting Count Philibert Gueneau De Montbeillard's measurements on his son over an 18 year period. Stature is an anthropometric parameter that is fairly simple to measure and was initially used by the military to select the tallest recruits because of their associated advantages of strength, greater stride, longer reach, etc. (Tanner 1981). It is a measure of linear or skeletal growth, and as such is not influenced by an accumulation of water and/or fat (Davies 1981), so it is a stable indicator of growth (Falkner 1978) as differences in the individual's environment, whilst affecting bone, do so to a lesser extent than soft tissue. A child's stature is largely influenced by that of the parents, i.e. a genetic influence, since the correlation between midparent height and child's height by the age of two is high (Tanner 1976). Also, during a period of rapid growth such as in the first two years of life, length increases by approximately 25cm. in the first year and 12cm. in the second year of life, for males on the fiftieth centile, making it an eminently measurable parameter for assessing nutrition and health in a young child or baby (MacCarthy 1981). It is, anatomically, a complex parameter as it includes the dimensions of the leg, the vertebral column and skull and the contribution of each of these to the total varies in different individuals and in different populations (Barnicot 1977: Eveleth 1978). However, it is well known that in a healthy, adequately nourished child, the skeleton develops as a single unit and its various components tend to keep pace with one another in their maturation, so stature should reflect the growth of other parts of the skeleton (Bayer and Bayley 1959), including those of the components that contribute to the overall height. Since short stature occurs in several endocrine disorders and other diseases, stature serves as a useful diagnostic measurement (e.g. Bate, Price, Holme and McGucker 1984, Vanderschueren-Lodeweyckx 1984). Consequently, stature is the best measurement of overall size, but it gives no information on the trunk/lower limb relationship, for this, sitting height and subischial length are used.

The relationship between the trunk and the lower limbs of the body not only varies with increasing age during childhood but also varies between different races, and to a limited extent between the sexes, with females having, in early childhood, in many populations, longer legs to trunk than males (Eveleth 1978). Sitting height therefore, gives information on proportional growth in members of a population, by comparing total stature against sitting height or alternatively by subtracting sitting height from stature to provide an approximation for lower limb length, described as subischial length. Barnicot (1977) described the relative sitting height, (sitting height/stature) X 100 as the 'cormic index' and found that this varied in different populations. It has also been found that this relationship in children may change due to changes in rate of maturation, when a population makes changes in its environment by migration to another country, e.g. Shapiro (1939) and Kano and Chung (1975) found this in their studies of Japanese immigrants in Hawaii, and Kim (1982) examined this growth pattern in Korean children in Japan. But this change may not produce permanent differences as Greulich (1957, 1958) reported of a study of Japanese children in America, whom he remeasured as adults (1976).

Weight is an anthropometric parameter that is easily measured, but it is a non-specific measurement of growth as it is the sum of body fat and lean body mass and therefore any weight gain is due to incremental gain of the different body components (Davies 1981). Unlike height, weight can fluctuate in any one individual, both increasing and decreasing in value, and it is dependent upon many factors, not the least being a full or empty bladder and/or bowels, but the most significant correlation was found between change in body weight and food intake and energy expenditure by Edholm, Adam and Best (1974). Maximum daily variation in weight was found to rarely exceed 1.5% of body weight, regardless of body size or age in young men (Khosla and Billewicz 1964) and a similar variability was found in children (Rao and Sastry 1976) although Robinson and Watson (1965) found slightly higher variability in young female adults. The daily variation in weight is also a function of body weight itself (Khosla and Billewicz 1964). Nevertheless, weight is useful as an approximate guide to growth when growth is very rapid, e.g. in the newborn, weight is a good indicator of good health, but with older children it becomes of less value as the weight gain is only 17.6kg. in males and 18.9kg. in females, on the fiftieth centile, for children between the ages of two and ten years (Tanner et al 1966a,b). However, since a child's weight curve should follow similar centiles to that of height (Bayer and Bayley 1959) or head circumference (in the first 2 years of life only)(Valman 1980), with similar patterns of annual increments, the extent of any disparity between the two measures helps to separate out the changes due to maturation from those due to nutrition and if weight deviates alone, it is more apt to signify a change in nutritional status. So weight can supply information upon the growth and nutritional standing of a child or population, but ideally it should be considered in association with other anthropometric parameters such as height, arm circumference and/or skinfolds.

Skinfold measurements provide a practical field method of assessing fatness of an individual or of a population (Durnin and Rahaman 1967; Shephard, Jones, Ishii, Kaneko and Olbrecht 1969; Parizkova and Roth 1972) by measuring the amount of fat in the subcutaneous tissue. Equations are then available, to convert selected subcutaneous skinfold measurements into a value for body density, e.g. Durnin and Womersley (1973, 1974) and body density values, whether determined by under water displacement techniques or by skinfold measurements, can then be converted to percentage body fat (Siri 1956). Subcutaneous fat thickness correlates highly with total body fatness and with the percentage of body weight that is fat (Himes 1980), so helping to distinguish between those individuals whose weight is above the expected norm for height because of increased lean body mass, e.g. as in athletes, and those with excessive fat. Norgan and Ferro-Luzzi (1982) in a study of weight-height indices and body fatness as determined by body density and skinfold measurements, found that weight/height^2 and relative weight were the best weight-height indices of fatness although weight-height indices on their own could not distinguish between overweight due to muscle bone, water or fat and take no account of changes in body composition with age. Since some of the weight-height indices correlate with fat mass, Keet, Hansen and Truswell (1970) claimed that they could be used as an additional reliable measure of suboptimal nutrition and early protein-calorie malnutrition in group surveys, particularly where exact ages are not known, although their survey was limited to South African children only.

It is recognised that there are sexual and age differences in compressibility of the tissues, e.g. Edwards (1951), (but his British subjects were all patients at an endocrine clinic) and Marshall (1966). Clegg and Kent (1967) found greater skin thickness and compressibility of the skinfold in young female adults, although above a certain value, the increase in skinfold thickness was not accompanied by increased compressibility. However, in males, they found that compressibility increased with increased thickness of fold, irrespective of value. There are also sexual and age differences in overall amounts of subcutaneous tissue, e.g. Frisancho (1974) found that sexual dimorphism in the triceps skinfold was defined as early as three years of age and, by adulthood, females exceeded males by 83%. Chen Damon and Elliott (1963) and Lee and Ng (1965) also reported higher average fat fold values in females compared with males, although the quoted ratio between the two differs, with the different researchers. Malina (1966) measuring Negro and White Philadelphia children, found that the White females had higher skinfold values at all 3 sites measured (triceps, subscapular and midaxillary) than the White males and the Negro males and females. Ulijaszek, Evans and Mumford (1979) found distinct differences in the triceps/subscapular ratio between European and West Indian boys, aged 11-17 years, living in London, which they attributed to genetic differences in the distribution of subcutaneous fat. However, some researchers have found ethnic differences in some sites although not in others. Johnston, Hamill and Lemeshow (1974) suggested that racial differences exist in the triceps site, but that variation in the subscapular skinfold was attributable to environmental causes.

Many sites have been studied by many researchers, on both adults and children, to determine those that reflect best the total body fat, e.g. Parizkova (1961) who recommended 10 sites, Durnin and Rahaman (1967) who selected 4, Shepherd et al (1969), who studied 8 sites and recommended 6, Parizkova and Roth (1972) who studied 11 sites. The most comprehensive study is probably that of Edwards (1950) who started with 93 sites, although this was later reduced to 53. A combination of triceps and subscapular were shown to represent total body fat best by Parizkova and Roth (1972), and to show least inter-observer error (Edwards, Hammond, Healy, Tanner and Whitehouse 1955). Other authors have recommended the triceps (Brozak 1956; Tanner 1959), suprailiac and triceps (Sloane, Burt and Blythe 1962; Chen et al 1963; Lee and Ng 1965) or triceps, subscapular and suprailiac (Shepherd et al 1969). After reviewing the relevant literature, Roche (1979b) concluded that, based upon validity and practicality, the preferred skinfolds for measurement on children were the triceps, anterior chest and subscapular. Alternatively, it has been suggested that subcutaneous fat measured at one site provides a good estimate of fat thickness at other sites (Himes 1980). Whichever site is chosen, accurate location is essential as Ruiz, Colley and Hamilton (1971) demonstrated. They found significant differences in triceps skinfold values due to horizontal or vertical displacement from the identified site.

Fat patterning also makes it important to measure fat thickness on the trunk as well as on the extremities as there is considerable variation among individuals in the distribution of subcutaneous fat (Garn 1954; 1955). Malina (1966) found that the trunk sites, subscapular and midaxillary, demonstrated a different pattern of growth and development compared with the triceps skinfold. But, in terms of limb fat, whilst the triceps site appears to be that preferred by many researchers, Mueller and Stallones (1981) using data from the literature and pricipal component analysis, claimed that the leg fat is an important site in terms of indicating individual differences in the anatomical distribution of fat, when used in conjunction with a trunk site. Finally, there appear to be changes in fat patterning with age and environment. Ramirez and Mueller (1980) found that older children had relatively less fat on the extremities and more on the trunk, compared with their younger children. They also found that the migrant children in their study were fatter than a group of similar ethnic background in the country of origin. The children measured in their study ranged from 5-17 years of age. Similarly, Ulijaszek et al (1979) reported that the Indo-Pakistani children living in London had larger subscapular skinfolds than the European children.

Arm circumference is another anthropometric parameter that relates very well with the state of nutrition in the subject. Numerous techniques have been developed to screen children for early detection of malnutrition, as quickly and as cheaply as possible, but also reliably. The use of the arm circumference, either with other anthropometric parameters, e.g. Kanawate and McClaren (1970) related it to head circumference and found the resulting ratio age dependent between 3 and 48 months, or without, e.g. Shakir and Morley (1974) who developed a colour coded cord and Laugeson (1975) using a similar approach with a bangle, has been considered. Perhaps the most common approach has been to use arm circumference linked with the triceps and biceps skinfolds to determine the approximate proportion of muscle mass and therefore the body's protein reserves and for such, some researchers have developed standards (Frisancho 1974; 1981). These can then be related to the nutritional status of the child, as many researchers have indicated, e.g. Frisancho and Garn (1971) who found a correlation between muscle diameter and stature in Guatamalan rural children, among others (Gurney and Jelliffe 1973; Waterlow 1973b). Alternatively they can be used to compare the nutritional status of 2 child populations such as shown by Martorell, Yarborough, Lechtig, Delgado and Klein (1976), or in a clinical application on adults (Burgett and Anderson 1979). Upper arm circumference in childhood is not age dependent but it shows only a small change compared with that for weight and height, e.g. Frisancho (1974) found in a study of White North Americans, aged 0 - 44 years, that between one and five years arm circumference increased 15% in males and 11% in females, (compared with a 81% (89% - females) increase in weight and 44% (46% - females) increase in height - Tanner et al 1966). Between six and thirteen years it increased 32% in males and 34% in females, (weight: 108% - males, 125% - females; height: 34% - males, 37% - females so it can be used to evaluate the nutritional status in children without necessarily knowing the exact age (Frisancho 1974). Burgett and Anderson (1979) also found no difference between right and left arm measurements for triceps, arm circumference or arm muscle circumference, for both sexes except for the arm circumference in a sample participating in predominantly right handed activities.

Head circumference has been studied because it is related to intracranial volume and brain weight (Davies 1981). It is also well recognised that it has a relatively narrow range of measurement for each age group and a standard deviation that remains small and nearly constant for the entire growing period (Tanner 1978). Nelhaus (1968) found almost no variation based on racial, national or geographic factors and only slight differences between the sexes, with the circumference of the male greater, but with differences that did not exceed one centimeter for the mean at any age, but Kantero and Tiisala (1971) found variation between different ethnic groups. Coon (1955) suggested that the size and shape of the head has some adaptive significance for heat regulation and Beals (1972) found an inverse relationship between mean cephalic index and temperature. Head circumference as a measurement of growth is of most use below the age of two years as 88% of growth takes place by that age (Tanner 1978). Vaughan (1969) quoted an increase in head circumference of 30% (10-11cm.) in the first six months of life, followed by an increase of 7% (3cm.) from six months to one year, and Cheek (1968) quoted a growth rate of half a centimeter per year from the end of the first year of life to adulthood.

Some researchers have tried to combine some of the growth parameters or relate them together in a number of different ways in an attempt to provide more information; H.Q - height quotient and W.Q. - weight quotient (Graham, McLean, Kallman, Rabold and Mellits 1979); log weight-log height (Cole 1979); expected weight for height (Waterlow 1973a, Waterlow, Buzina, Keller, Lane, Nickaman and Tanner 1977; Chinn and Morris 1980) weight and height for age and weight for height, (Dahers, Barac-Nieto and Spurr 1981), or to counteract problems where some information such as age is not known (Shakir, Demarchi and El-Milli 1972; Janes, McFarlane and Moody 1979).

All of these measurements help to describe healthy growth and are therefore helpful in monitoring both the nutritional status and health of the person, although there is still great debate as to which parameters best identify dietary and other growth problems, e.g. Dugdale et al (1970) suggested that height and midarm muscle circumference were guides to the state of protein nutrition and skinfold thickness gave a guide to overall calorie nutrition, Marshall(1966) stated that the most useful anthropometric measures are height, skinfolds and limb circumference for growth assessment. Several authors suggest that height for age and weight for height are essential, e.g. Waterlow et al 1977; Richardson 1980).

Use has been made of measurements of growth parameters to produce growth standards for different racial groups, e.g. Hammill, Drizd, Johnson, Reed, Roche and Moore (1979) National Centre for Health Statistics percentiles in the United States, Tanner et al (1966a,b), Standards from birth to maturity for British children, and to examine the differences that may exist, in terms of growth patterns, between different races, by comparing other ethnic groups with the European or North American standards e.g. such studies by Malina (1966); Davies (1971); Katzarski and Ofosu-Amaar (1973); Amirhakimi (1974); Davies, Belwar and Dove (1974); Lowenstein and O'Connell (1974); Eveleth and Tanner (1976); Martorell et al (1976); Graham et al (1979); Gallo and Mestrina (1980); Sukkar, Kerms, Makeen and Khalid (1980) to name some. Alternatively or additionally, they are used to attempt to determine differences in growth produced by the environment upon different individuals and populations e.g. studies by Hiernaux (1964); Low (1971); Habicht, Yarborough, Martorell, Malina and Klein (1974); Ashcroft and Desai (1976); Johnston, Dechow and MacVean (1975); Johnson, Wainer, Thissen and MacVean (1976); Martorell, Yarborough, Lechtig, Delgado and Klein (1977); Mueller and Titcomb (1977); Mueller and Malina (1980).

3.2. ENVIRONMENTAL FACTORS AFFECTING GROWTH

Environmental factors which affect growth manifest themselves in many ways, e.g. climatic conditions. A number of studies have suggested that the physical environment affects growth, as it has been shown that in warmer conditions, the length of the limbs is greater relative to the trunk, the distal segments are larger relative to the proximal segments of the limbs and the body tends to have smaller girths and transverse diameters, thus producing a lower weight per unit stature (Roberts 1960). Crognier (1981) found a similar trend when considering 3 areas of the world, i.e. the tallest and heaviest people were found chiefly in the regions of cold and/or wet climate, and the smaller and leaner ones in the hot and/or dry areas, although Froment and Hiernaux (1984) could only partially explain the differences between their populations in the Niger bend in terms of climatic influence on phenotype.

A number of studies have suggested that the rural/urban environment affects growth although the final conclusions are not decisively in favour of one habitat or the other. Douglas and Blomfield (1958) found that children living in the English county areas were generally taller than those living in the towns, although this was contraindicated by Backstrom and Kantero (1971) who found children living in the rural areas of Finland were shorter in stature throughout their growth period compared with urban children in Helsinki. Davies et al (1974) found no differences between their rural and urban African children and Malina, Himes, Stepick, Lopez and Buschang (1981) found some differences in favour of rural communities, but the differences were more attributable to other factors, e.g. nutrition rather than habitat. Meredith (1978) in a survey of standing heights of young children in different parts of the world found that children residing in cities were neither consistently taller or shorter on average than their counterparts residing in rural areas.

It is probable that the rural/urban influence is just one aspect of the overall effect on growth produced by varying socio-economic conditions. A wealth of studies have examined this subject. In general, the higher the social class, the taller the child (Goldstein 1971), but the correlation is not as straight forward as this, because the more deprived groups, who tend to be social class V, (Registrar General's classification) tend to have larger families, and higher levels of unemployment and these factors also correlate with stature (Rona, Swan and Altman 1978; Cole, Donnett and Stanfield 1983; Rona and Chinn 1984), although the latter workers found less effect of unemployment on height in 1981 compared with 1972. Weight is also affected by socioeconomic conditions e.g. Bogin and MacVean (1978) found that their low socioeconomic children were significantly shorter and lighter than the high socioeconomic children, although Whitelaw (1971) found a significant trend towards increased obesity in children of families of social classes IV and V, compared with social classes I and II, and a similar pattern, when assessed by triceps skinfold thickness, was found in white urban children (Stunkard, D'Aquili, Fox and Filion 1972). Smith, Chinn and Rona (1980) suggested that the association between height and socioeconomic factors probably occurs before the age of 5 because they found no evidence of an absolute decrease in height differences, over 1 year, in their 5-10 year olds of differing socioeconomic background, and a similar result was reported for females aged 7-13 (Bogin and MacVean 1978) and for children 11-12 years old (Hackett, Rugg-Gunn, Appleton, Parkin and Eastcoe 1984), whilst Billewicz, Thomson and Fellowes (1983) confirmed the establishment of differences by 5 years of age. Further inter-related with socioeconomic conditions are other factors which have been shown to have an effect on growth, such as birth order and family size. Jacoby, Altman, Cook, Holland and Elliott (1975) found that only children had a greater tendency to obesity, as did fatherless children, and a similar result was found in single parent family children, by Garman, Chinn and Rona (1982). Douglas and Blomfield (1958) found that the first born were taller than the second and third, although there were no differences in non-manual workers male children and Goldstein(1971) found differences between the first born and younger sibs, with the first born the tallest. Reasons for this are not entirely obvious as Cook, Altman, Moore, Topp, Holland and Elliott (1973) found no influence of social class, family size or mother's work status on total nutrient intake. This leads to another factor that affects growth, that of diet, e.g. nutritional growth retardation due to a diet poor in quantity or quality of essential nutrients (Hansen, Freesemann, Moodie and Evans 1971) and conversely, overnutrition and accelerated growth (Forbes 1977).

There are other environmental factors which affect growth, such as medical welfare or lack of such facilities (Collis and Janes 1968), psychological factors (MacCarthy 1981), smoking (Goldstein 1971; Butler and Goldstein 1973), season (Marshall and Swan 1971; Marshall 1975) to name 4, but these will not be considered further with respect to this study.

Habicht et al (1974) claimed that differences in growth of preschool children associated with social class and therefore environment, were far greater than those which could be attributed to ethnic factors alone, although their conclusions were based upon comparisons of well-off and poor children, but of different ethnic groups. However, Ashcroft and Desai (1976), came to the conclusion that growth is not influenced by environmental factors alone. They compared the influence of ethnic origin and environment, which included nutrition, on anthropometric measurements in a study of infants and children of African, Indian, Chinese and European origin in Guyana and Jamaica, and found differences between the races which could not be explained by nutrition or other environmental causes thus showing that ethnic origin cannot be disregarded when assessing nutritional status by anthropometric measurement. The debate on the relative importance or influence of genetic factors as opposed to environmental pressures has led some researchers to conclude that national standards suitable for all populations are adequate, (Richardson 1973; Waterlow 1973a, 1980; Habicht et al 1974; McLaren and Read 1975; Buzina, Keller, Nickaman, Tanner and Waterlow 1977; Graitcer and Gentry 1981) and conversely, for others either to claim that local standards are best (Jelliffe and Jelliffe 1968; Dellaportas 1969; Santos-David 1972; Gallo and Mestrina 1980; Goldstein and Tanner 1980; Manshande 1980; Van Loon, Saverys, Vulsteke, Vlietinck and Eekels 1986) or that different ethnic group norms cannot be used by others because of the differences in race and environment (Greulich 1957; Chang, Lee, Low and Kvan 1963; Low 1971; Sukkar et al 1979).

The reference standards available for use on children, in the United Kingdom were initially those of Tanner and Whitehouse (1958) although some aspects of children's growth had been studied in the National Study of Health and Development started in 1946 (Douglas and Blomfield 1958), in Newcastle-upon-Tyne starting in 1947 (Miller, Courth, Walton and Knox 1960) and the National Child Development Study 1958 (Goldstein 1971). Since then, other workers have studied the growth of children in different geographical areas, e.g. England and Scotland, the National Study of Health and Growth 1972 (Rona and Altman 1977; Rona and Chinn 1986), or more specifically, Newcastle upon Tyne children born in 1962, (Billewicz et al 1983). But the reference standards for height and weight in current use for children in Great Britain are those of Tanner et al (1966) and Tanner and Whitehouse (1976).

Any standards produced need reviewing and possibly revising every few years because of the phenomenon of secular trend (Low 1971; Meredith 1976; Eveleth, Bowers and Schell 1979; Roche 1979a; Chinn and Rona 1984). It has been suggested that secular trend in stature, in the well fed populations of the world, has now ceased for the time being (Rona and Altman 1977; Cameron 1979), although Chinn and Rona (1984) showed a continuous positive trend for height among primary school children in England and Scotland and Ounsted, Moar and Scott (1985) have shown a similar positive increase recently in head circumference.

3.3 GROWTH OF CHILDREN IN INDIA

Until the 1950's, anthropometric surveys were often conducted in conjunction with the Indian census, (Guha 1935) and were basically to determine the racial composition of the people of India (Lukacs 1984). However, over the last twenty five years, with the greater realisation that physical growth and development of children is a sensitive index of the health and nutrition of a community and that anthropometry provides the operational measure for assessing long term nutritional status, growth in children has been studied in depth by many researchers. The All India Study, (I.C.M.R. 1972) is probably the largest study that has been carried out to date, on children in India, and even then it was not totally representative of the whole country. The states of Assam, Bihar, Gujarat, West Bengal and some parts of the states of Maharashtra and the Union Territories, except Delhi, were not represented in the study and the state of Mysore and several parts of the State of Andhra Pradesh could not be covered even though they were included in the original plan. The study therefore, covered eleven states in India, measured a number of anthropometric parameters on children from all socioeconomic strata and monitored pubertal signs, in 127,866 children aged between birth and twenty one years. The data were analysed in terms of urban/rural habitat and region of India, religion, using the five major religions of India, i.e. Hindu, Muslim, Sikh, Jain and Christian, and socioeconomic status and per capita income. An attempt was made to construct reference standards for Indian children for the various ethnic, regional and socioeconomic groups. Although apparently healthy children only were measured, those with marginal nutrition and occult infection may not have been totally excluded.

In the United Kingdom, the system of classifying families into socioeconomic groups is based broadly upon occupation. In India, however, because of lack of employment opportunities and little fixation of wages for the different categories of occupation, classification based solely upon occupation does not reflect the true economic status of the individual or their family in the different groups. Prosad (1969) therefore proposed a classification scheme which incorporated both occupation and economic status when describing the social class of any person and some of the studies have used this method to determine social class category.

In terms of growth, although Guha (1944) distinguished fifty one different ethnic groups in India itself, the principal dissimilarities are brought about by socioeconomic differences rather than by ethnic variations (Eveleth and Tanner 1976). Since India's population shows such a diversity, in terms of economic, social, cultural and nutritional factors, many studies carried out over the last twenty years by researchers in India have attempted to analyse how the effects of some or all of these factors are implicated in growth. In most cases, an attempt has been made to classify subjects into socioeconomic classes, broadly upper, middle and lower, and comparison made of growth achievement in the different classes. Generally, studies on both preschool and school age children have revealed differences in growth between the different classes, with those in the higher social classes being taller and heavier (Banik, Krishna and Mane 1970a; Raghavan, Singh and Swaminathan 1971), growing faster than those of the lower income bracket (Mukerji and Kaul 1970) and in advance pubertally (Prabhakar, Sundaram, Ramanujacharyulu and Taskar 1972). In addition, it has also been shown that adverse socioeconomic status has more effect on weight than on height (Banik et al 1970a). Manwani and Agarwal (1973) studying the growth pattern of Indian children receiving optimum nutrition, in the first year of life, found that growth curves for height and head circumference fitted Western norms but for 40% of their sample, the weight data did not, because those subjects suffered frequently recurring infections which interfered with weight gain. Prasad, Kumar and Dayal (1971) found no difference in the mean head circumference in their two economic groups but height, weight and chest circumference were definitely influenced by economic factors with weight again being more affected than height.

Alternatively, comparisons have been made between the Indian data, of varying social class, and that from other areas of the world, usually the United States - Harvard data (Nelson 1969) or that of Tanner et al (1966a,b) from the United Kingdom. In these cases, it has usually been found that the Indian data falls short of the American or British reference data. Naik, Zopf, Kakar, Singh and Sood (1976) measuring a mixed socioeconomic group from the Punjab, of both urban and rural dwelling children found that their subjects fell short of the Harvard standards, especially for weight, but less so for height. However, some other workers have shown that the Harvard standards are valid for some Indian children, e.g. well-to-do Hyderabad boys were as tall as their American counterparts, although the girls were shorter, but both the girls and the boys were as tall as British data (Rao et al 1976). In a study of well-to-do Indian boys, Rao and Sastry (1977) found that the growth of their subjects, as measured by height and weight, matched that of American and British boys up to the age of 10 years, but tended to be lower after that, with smaller peak height velocity and peak weight velocity than the British boys, and differences in weight being greater than those for height. For other anthropometric dimensions, i.e. weight, arm circumference, and triceps skinfold, the values were lower up to the age of about 3 years but began to approach the British and American comparable values after that. Raghavan et al (1971) found that their well-to-do Indian children were as tall and as heavy as American children of corresponding ages, 5-14 years in boys and 5-12 years in girls, although a low socioeconomic group, in the same study, fell far short of the American data, for height and weight. The low socioeconomic group of Mather, Gupta and Rao (1972) also showed marked retardation, when height and weight data were compared with the Harvard reference data, as did the low socioeconomic group of preschool children, aged one to five years in Jaipur (Rajasthan) reported by

Gupta, Dutta and Dutta (1978). The heights and weights for this group were even lower than the I.C.M.R. data (1972). Banik, Nayer, Krishna and Raj (1972) in their study of a well privileged population and an under privileged population, both living in urban Delhi, found that the children with good nutrition in the well privileged community were almost as tall and as heavy as their American counterparts (however they used Stuart and Stevenson's American standard 1959, which means that the comparison has been made on data collected at least 13 years apart), whilst those children forming the under privileged community corresponded to the 25th. centile of the American standards for height and the 10th. centile for weight. They suggested that the well fed children of different countries grew in a similar pattern in spite of ethnic (genetic) origin and concluded that nutritional factors play a greater role in influencing the growth rate of children than gene pool. Bhargava, Kumari, Choudhury and Lall (1980) found similar weight gains in their Indian boys in Delhi compared with British boys in the first 2 years of life, but then growth velocity in the Indian subjects declined. Similarly for height, the increases up to one year matched that of the British data, but this was followed by a gradual decrease with the boys' heights and weights remaining between the 10th and 25th centiles from 2-6 years of age and the girls between the 3rd and 25th centiles from 1-6 years. They suggested that the subsequent decline in their children, who weighed 2500g or more at birth but were born to families of low socioeconomic status, was due to the influence of the environment. In support of this, a study by Madhavan, Susheela and Swaminathan (1967) on children aged from one to five years, classified into four categories of growth, on the basis of individual values of each of the following, height and weight measurements and weight/height ratio, compared with the mean and standard deviation of the total sample, found that protein-calorie malnutrition was highest in the lowest grade of growth, in all age groups. It was also suggested by Banik et al (1970a) that the inadequacy of food, infection, poor environmental sanitation and the poor socioeconomic status of the parents are jointly responsible for producing lighter and smaller children in the lower social classes. Udani (1963) postulated that the effect of adverse socioeconomic conditions acting through generations can result in genetic differences that are inferior in terms of physical growth. Further to this, work by Athavale, Kandoth and Sonnad (1971) found developmental retardation alongside reduced physical dimensions in their subjects, who were of the lowermost socioeconomic group.

Finally, some of the Indian studies have been carried out with the intention of establishing reference standards for Indian children of various ethnic, regional and socioeconomic groups, e.g. The All India Study (I.C.M.R. 1972) which is still the most comprehensive attempt to date. But the standards derived from this study fell short of the Harvard reference standards, and the results reflected the current growth status in India rather than a standard closer to the optimum that could be realistically achieved with improved environmental conditions. Seth, Sundaram and Gupta (1979) suggested that standards could be based upon data from the upper 25% of the low and middle socioeconomic groups for weight and from the upper 50% for height. In this way such standards would not be unrealistically high, which they would be, if based upon the high socioeconomic population only. Or, conversely, they would be too low, if based upon a national sample, which in a country like India, contains a preponderance of low and middle socioeconomic groups. Such reference standards, if established, would be extremely useful as they would be derived from, and used for, the same ethnic group, rather than using data of another country and another ethnic population.

Unfortunately, in their attempts to provide reference data, a number of researchers have presented their data in the form of centiles, and the validity of these centiles, in some cases must be doubted, as the subject numbers are small, e.g. Prasad et al (1971) quote their outer centiles, the 10th and 90th, calculated mathematically on a six month age range, but the number of subjects in one age band was only 23. Agarwal, Manwani, Khanduja, Agarwal and Gupta (1970) quote values for the 5th and 95th centiles based upon subject numbers ranging from 4-134, but in 25 of the 29 age groups the subject numbers are below 100, and Ghani, Verma, Ghai and Seth (1971), quoting the same outer centiles had only 21-29 subjects in each age and sex band. However, the study by Phadke and Limaye (1973) although not quoting the subject numbers at each age increment, had over 4000 infants aged between birth and one year from which to develop their outer centiles, in this case, the 25th and 75th.

Returning to the extreme diversity of India's population, comparison of growth data from the various studies is limited because they have been compiled in various parts of the country, i.e. people in some areas of Punjab, although poor, may be regarded as relatively affluent compared with some families in other areas of India and far better nourished than the poor areas of India, where people are on the verge of starvation. So any growth data may only be representative of the state in which the study was carried out, e.g. Agarwal et al (1970) found differences in weight between their study and studies of children from Poona, Bombay and Vellore although they do not actually state in their report the origin of their schoolchildren.

A number of studies have been carried out in Punjab including those of Sharma and Kaul (1970), Singh (1970), Sidhu and Phull (1974), Naik et al (1976), Garg (1978) Prakash and Cameron (1981) and Bhalla, Kaul and Kumar (1986), but with the exception of Naik et al (1976)(n = 1670), the other studies involved from small to very small numbers of subjects (n = 154-463). However, between them they covered the whole socioeconomic spectrum, the age range 0-17 years, (Bhalla et al covering 0-1 year, Naik et al the 0-6 year olds and the other 5 studying the 5-18 year olds), both sexes (Naik et al, Prakash and Cameron and Bhalla et al reporting on both sexes, the other 4 reporting on boys only), as well as the rural/urban habitat. Generally, the studies of growth of certain anthropometric parameters in children in Punjab show that the Indian Punjabi childrens' heights and weights were lower than the Harvard standards (1969) or for those of Tanner et al (1966a,b) the data matched the 25th centile in the high and mid-to-low socioeconomic groups, and lay between the 3rd and the 10th centiles in the low socioeconomic groups. But one of the more recent studies (Prakash and Cameron 1981) found that the boys heights matched that of Tanner et al's 50th centile, as did the girls, until the age of 9, and then they dropped to the 25th centile. A secular trend is reported of increased adult height, in India (Madhavan et al 1964) and since such a trend usually is initiated in childhood, the differences between the earlier and later data may be evidence of this. It is also well documented that Punjab is a comparatively affluent state and the occurance of secular trend has been linked with improved socioeconomic conditions and nutrition (Eveleth and Tanner 1976, Jelliffe and Jelliffe 1979).

Just south of Punjab State lies Delhi, the capital city of India and the children of this region (including Agra) are well reported in studies of growth and development. There were 5 studies carried out between 1968 and 1979 on 0 - 5 year old children and 2 on 5 - 15 year olds, all involving urban males and females and, across the 7 studies, all socioeconomic classes were represented. Of the 7 studies, 4 were longitudinal in design and 3 cross-sectional. However there are a number of factors that contribute to a reduction in value of the information reported in some cases, e.g. Banik et al (1970a); Banik, Krishna, Mane, Raj and Tasker (1970b; 1972) reporting on the effects of socioeconomic factors and nutrition in a longitudinal study of 0 - 5 year olds started with a sample size of 1725 but by the fifth year of measurement, had only 124 children. A similar problem was encountered by Ghosh, Hooja, Ahmad, Acharyulu and Bhargava (1974) who measured 233 children at birth, but only 26 of the same children at the age of 2 years. It is possible that the final sample is not representative of the initial population sampled, and is biased in some way, because the losses are higher in some subgroups of the sample population than in others. Secondly, in another longitudinal study, that of Ghai and Sandhu (1968) the data are reported cross-sectionally, thus losing some of the information that is obtained by using the longitudinal technique, but also limiting the value of the data reported on the later age bands, $1^1/_2$-$4^1/_2$years. A similar loss of information occurs in one of only two studies covering the adolescent age group. Seth, Ghai and Sugathan (1972) studied 395 7 - 14 year old boys and girls in a longitudinal study and computed the velocity of growth at yearly intervals for weight and height but do not appear to have fitted individual growth curves or analysed the data from a specific point such as peak growth rate, in order to cater for the varied timing of the adolescent growth spurt in their sample. Conversely, one cross-sectional study quotes velocity of growth values in its 5 - 15 year old population (Ghani et al 1971).

Studies on the growth of children in Maharashtra, the state which abuts the southern borders of Gujarat, appear to be limited in number and age range, although the sample number studied is impressive, n=1110-4721 (Athavale et al 1971; Phadke and Limaye 1973; Limaye, Chouhan, Lakhani and Phadke 1974). Athavale et al (1971) studying 0-5 year old children, from Bombay, showed that those belonging to the lowermost socioeconomic groups had retarded growth compared even with the I.C.M.R. (1972) data, i.e. their heights and weights were below the I.C.M.R. 25th centile and Phadke and Limaye (1973) found that infant growth, i.e. growth in the first year of life, as measured by anthropometry, improved with improved socioeconomic status and with urbanisation. They found that the 75th centile for their data (of mixed socioeconomic status) was comparable with the Harvard 25th centile. Finally, the heights of a group of children of high socioeconomic status from Poona, (Limaye et al 1974) compared favourably with the Harvard standards, although the weights did not match so well but in both cases, the values were higher than the I.C.M.R. (1972) values.

Data from Hyderabad, south India, shows similar results to that on children from the north, i.e. well-to-do children match the Western standards of Tanner et al (Rao et al 1976) or the Harvard standards (Singh and Swaminathan 1971) for height in both cases, and weight in the latter study, whilst those of low socioeconomic status are retarded compared with the Harvard standards (Mathur et al 1972) and often have signs of nutritional deficiency (Madhavan et al 1967; Singh and Swaminathan 1971). The Hyderabad studies represented a fairly comprehensive sample of the child population in that state, as they covered both sexes, socioeconomic groups ranging from high to low and age groups ranging from 1-5 years (Madhavan et al 1967; Mathur et al 1972; Rao et al 1976), 5-16 years (Raghavan et al 1971) and 12-17 years (Satyanarayana, Naidu, Swaminathan and Rao 1981). The five studies altogether, measured 12,340 subjects.

Other areas of north India from which growth data have been reported include those of Jabalpur in the state of Madya Pradesh (Mukerji and Kaul 1970); Gupta et al (1978) in Jaipur, Rajasthan; Kashmir (Kaul 1975); and in east India, Calcutta, West Bengal (Hauspie et al 1980).

In a review of studies of stature of young children in different parts of the world, including India, Meredith (1982) concluded that, in general, in the period 1950-1980, urban girls and boys in the age band of late childhood exceeded their rural peers by nearly 2.5cm. in height and 1.1kg. in body weight. This conclusion, supported by a number of studies in India (Mukerji and Kaul 1970; Phadke and Limaye 1973; Sidhu and Phull 1974), confirming that urban children are better built in each case compared with rural dwelling children, has serious implications for the growth of Indian children overall, because the majority of India's population live in a rural habitat.

Finally, India has not only extreme socioeconomic variation between its inhabitants and great diversity of habitat, but the population also follow a number of different religious cults and these various religions each have their specific laws, customs or practices, a number of which relate to the restriction or intake of certain foods, thus resulting in a control of the diet. Since dietary intake is directly linked with growth, religion may be an additional factor that has an effect upon growth. Unfortunately little attempt appears to have been made to quantify or even analyse the effect of this factor. The All India study (I.C.M.R. 1972) in an analysis of their sample by religious group, (Hindu, Sikh, Muslim, Jain and Christian) reported that the mean values of height and weight of Sikh children were found to be the highest in both sexes, with the Hindus and Muslims slightly lower (higher than the Jains and Christians) and Muslim anthropometric values being marginally higher than the Hindu, in both sexes, and at most ages. Very few other studies describe the religious affiliation of the subjects in their samples so it is possible that they contain representatives of some or all of the major religions and even some members from the minor ones of India, e.g. Buddhism, thus producing growth data from a non-homogenous sample in which the heterogenous factor, the religion, appears to have its own effect upon growth. Some studies have identified the religion followed by their sample and limited their studies to one specific religious group only, Hindus, in each case (Sharma and Kaul 1970; Singh 1970; Mathur et al 1972; Kaul 1975; Hauspie et al 1980) but no attempt appears to have been made to extend the All India Study (I.C.M.R. 1972) technique of comparing different religious groups, either in one area of the country or of comparing one specific religious group across a number of different geographical locations or socioeconomic conditions.

3.4 GROWTH OF INDIAN CHILDREN IN THE UNITED KINGDOM

Since there are large numbers of children from the Indian subcontinent now living in Great Britain, the pattern of growth of the Indian child living in this country, now becomes relevant for medical, sociological, educational and industrial reasons. However, studies on the growth of the Asian population living in this country are even more limited than those on the population living in their country of origin, although the sudden rise in immigrant population in the early 1960's with the imminence of the Commonwealth Immigrants Acts (1962 and 1968), has led to some recent studies on Asian immigrants.

Considerable attention has been given to fetal growth and birth size in the different racial groups in Great Britain because of perinatal mortality implications. This applies especially to those from the Indian subcontinent, because with their higher fertility rate compared with that of the indigenous population, e.g. there was a rise of 28% in the number of births born to Asian mothers, in Leicestershire, between 1976 and 1980, compared with a rise of 11% in non Asians over the same period (Dhariwal 1982), the Asian newborn represent a sizable contingent of the total number of births in the United Kingdom, especially in certain specific areas of the country, e.g. over half of the births in England and Wales to mothers born in India, Pakistan or Bangladesh, take place in greater London, West Midlands or West Yorkshire (Ashley 1982).

Generally, it has been found that the Asian newborn are lighter, shorter and have smaller head circumferences than the European population (Brooke and Wood 1980, Davies, Senior, Cole, Blass and Simpson 1982) although Alvear and Brooke (1978) found that their Asian sample had similar linear measurements to a European sample whilst agreeing with the above researchers for weight and head circumference. An analysis of birthweights of babies born to Indian and Pakistani mothers in Birmingham between 1968 and 1978, (Clarson, Barker, Marshall and Wharton 1982) showed that the Pakistani babies were significantly heavier in

1978, even after allowing for changes in gestational age, sex, parity and maternal height. There was no significant difference in the Indian birthweights. The authors concluded that this was a secular change with environmental factors playing an important role, although the Pakistani birthweights were still more than 140g. below the British overall mean.

Information obtained in the longitudinal study of Brooke and Wood (1980) also showed that whilst the Asian children had smaller anthropometric dimensions initially, catch-up growth occurred during the first 3 months of life, in linearity, weight and head circumference, although the latter 2 measurements then declined in value relative to standard European data. Goel et al (1981) studying immigrant children, aged 2 months to 16 years, in Glasgow, found that their indigenous Scottish sample were significantly smaller ($p<0.01$) than their Asian group, but there was no significant difference in weight. Since it is known that Scottish adults are smaller than those living in England (Rosenbaum et al 1985) this might explain the slight discrepancy in the weights and heights between the Asian immigrant population living in Scotland and those living in England in each case compared with the indigenous population.

But studies of pregnant Asian mothers also showed that, in general, they were shorter and lighter than their European counterparts, (Alvear and Brooke 1978; Grundy, Hood and newman 1978; McFadyen, Campbell-Brown, Abraham, North and Haines 1984) although their skinfold thicknesses were similar (Alvear and Brooke 1978). Similar results were found by Chetcuti, Sinha and Levene (1985) with the exception of a difference in skinfold thickness in one subgroup of their Indian Asian population, - the Muslim mothers triceps skinfold values were smaller ($p<0.02$). However, when McFadyen et al (1984) adjusted their data to take account of the effects of maternal size, parity, gestational age and fetal sex, they found no significant difference in birthweight between their Indian Muslim and their European newborn although the Hindu babies were still about 190g. lighter than the European, and Hindus from East Africa had lighter babies than those from India. An earlier study, that of Grundy et al (1978) having corrected for maternal height and weight, also found that their Asian (included India, Pakistan, Bangladesh, Sri lanka and African Asian) babies were still 190g. lighter ($p<0.001$) than their European babies, after allowing for all other factors, e.g. parity of mother, sex of child.

It is now being acknowledged that the Asian population in Great Britain are not a homogenous group and therefore some studies on this population have distinguished between peoples from India, Pakistan, Bangladesh or those Indians who have come from East Africa. Furthermore, there is now greater awareness that within a group of Asians originating from one country in the Indian subcontinent there are a number of differences in lifestyle, religion and dietary habits. Thus a number of the more recent studies have distinguished between the Hindu, Muslim and Sikh pregnant mother and her baby. Sinha and Levene (1984) in a study of pregnant women in Leicester, reported that they had found no differences in size between mothers from the 3 Asian subgroups, divided by religious practice into Hindu, Muslim and Sikh, although the Asian mothers were lighter and shorter than the Caucasian. However, they found differences in the babies born to these 3 religious subgroups with the Sikh newborn heavier, longer, and with greater occipital-frontal circumference and triceps skinfold thickness compared with the 2 other groups. They did not find differences between the Muslim and Hindu babies for various body indices. A later paper, possibly referring to the same study (Chetcuti et al 1985) reported similar results. However another study in Harrow (McFadyen et al 1984) found no difference between Muslim and European birthweights but the Hindus were lighter. The Asian subjects in this study originated from Pakistan, India and East Africa whereas in the former study all the subjects originated from India only.

A study by Wharton, Eaton and Wharton (1984) of the dietary intake of pregnant Indian Hindus and Sikhs, Pakistani Muslims and Bangladeshi Muslims showed that the Sikhs had the highest intake of nutrients and the greatest variety of food, with the Hindus following a similar diet. The Pakistani Muslims energy content was below that of the Sikhs and the Hindus, whilst the Bangladeshi Muslims had the lowest intake of both energy and most nutrients. However the researchers stated that it was not clear whether the differences had any effect on the life and health of the individuals or whether dietary intake was related to fetal growth. But a study by Brooke, Butlers and Wood (1981) in which some pregnant Asian women received a vitamin D supplement in the last trimester of pregnancy, showed that there was no significant difference at birth in weight, length and head circumference between those newborn whose mothers had received the supplement and those who had not. But over the first year of life, the infants, of mothers who had received the supplement, showed improved postnatal growth and they were heavier and longer, although there was no significant difference in head growth.

But diet and the state of nutrition continues to affect growth throughout childhood and a number of researchers have considered the dietary intake in the Asian infant and child population living in Great Britain. Aykroyd and Hossain (1967) in a sample of Pakistani infants in Bradford, found that artificial feeding practices had been adopted by the majority although breast feeding would have been the norm if the mothers had remained in Pakistan. They also found great variation in dilution in preparation of the milk powder, but weaning practices seemed to be adequate. Jivani (1978) reported on the nutritional problems associated with inadequate weaning of Asian infants and Evans, Walpole, Qureshi, Memon and Everley Jones (1976) found that Asian immigrants in Wolverhampton predominantly bottle fed their infants, in 23% of households with over concentrated feeds, and in 43% with inadequate or non-existent sterilisation techniques. In addition, no additional vitamin supplements were given in many cases. Harris et al (1983) in a study of Bangladeshi children of Tower Hamlets also found deficiencies in the infants' diets, with respect to vitamin D, iron and calcium, and carbohydrate intake was high. They also found delayed weaning in a number of the children thus giving a diet predominantly of breast milk even in the second year of life. Not only are there problems at the infant stage in terms of breast versus bottle and subsequent weaning, but Wenlock and Buss (1977) found that the nutritional quality of the food purchased by a number of Asian families, was lower than the national average for riboflavin, vitamin A and Vitamin D. Also, a study of the dietary intake in immigrant schoolgirls in Leicester revealed that 99% of the sample had a lower intake of vitamin D than that recommended (D.H.S.S. 1969), and the percentage of girls with an intake of other nutrients lower than that recommended was, 81% for vitamin B_{12}, 77% for iron, 64% for protein, 53% for calcium and 48% for energy (Pearson, Burns and Cunningham 1977).

The immigrants from the Indian subcontinent are not evenly distributed throughout the United Kingdom. They live, in certain towns and cities only, predominantly, in communities distinguishable often by religion, or original area of emigration, and so any information on the growth of Asian children that exists, tends to be specific to an area, or to a community, e.g. Aykroyd and Hossain (1967) reported on Pakistani children living in Bradford; Britt and Harper (1976) commented on Punjabis living in Southall; Goel et al (1981) reported on immigrant children from Glasgow and Ulijaszek and Nicoll (1983) on Pakistani and Indian Punjabi children in Nottingham. The Asian Indian and Pakistani communities in Birmingham have been studied by Clarson et al (1982) and Wharton et al (1984); Harris et al (1983) reported on Bangladeshi children in Tower Hamlets, London and Davies et al (1982) and Chetcuti et al (1985) have studied the birth size of Indian ethnic subgroups in Leicester, whilst Peters, Hashim and Marshall (1982) in a preliminary report on this study, considered the application of British standards for use on Asian children living in Leicestershire. Since it has already been shown that there are differences in growth in children originating from the different countries comprising the Asian subcontinent, and since, further, there are differences even within one country, due to varying environmental factors, such as geographical location, urban versus rural habitat, socioeconomic factors and religion as practised by each family, a comparison of much of the data available for Asian children in the United Kingdom is not practicable or valid.

In addition, whilst anthropometric data on the newborn from the Asian subcontinent are available, growth of Asian children now resident in Great Britain has not been fully researched or reported. Brooke and Wood (1980) measured weight, crown heel length and head circumference of 80 British Asians at birth and repeated the measurements at 3, 6, 9 and 12 months of age. 73% of their subjects were from families originating in India, mainly Gujaratis and Punjabis, 17% from Pakistan, and 10% from Bangladesh, Sri Lanka or East Africa of Indian or Pakistani origin. They found that linear growth remained comparable with British standards after an early period of catch-up growth but that weight-gain velocity declined so that mean weight at one year of age for the Asians was 1kg. less than the standards. Hashim (pers. comm.), in a cross-sectional study measured height, weight, head and upper arm circumference, triceps and subscapular skinfolds and sitting height in 191 preschool Asian and British children in Leicestershire and found differences in weight, head circumference and skinfold thickness between her 2 populations but no differences in height. She stated that the differences that occurred were probably more attributable to socioeconomic class than to ethnic background. Goel et al (1981), measured the height, weight and bone age of 479 children aged from 2 months to 16 years, of Asian, African, Chinese and Scottish origin. He found that his Asian population were significantly taller than his Scottish group although there was no difference for mean weight between the same two groups. Ulijaszek and

Nicoll (1982) found no difference in height between their 549 Asian children aged 3 to 11 years inclusive, (who were predominantly Pakistani Muslims or Indian Punjabi Sikhs), and Tanner et al's (1966a,b) standards. But weight for age and triceps skinfold values were lower. Rona (1985) and Rona and Chinn (1986), reported on the heights, weights and triceps skinfolds of 6862 children of primary school age measured as part of a Nutritional Surveillance System of primary schoolchildren. They found large differences in height, weight for height and triceps skinfold in their different ethnic groups which included a group of Indo-Pakistani origin. Thus the results are not in total agreement although generally heights of the Asian immigrant children seem to match those of the indigenous population whilst weights, head circumferences and skinfolds are all smaller.

The number of studies carried out on children originating from the Indian subcontinent and now resident in Leicestershire has been limited to those on the newborn (Davies et al 1982; Chetcuti et al 1985), preschool children (Hashim pers.comm.) and a subgroup of school children from the National Study of Health and Growth (Rona and Chinn 1986). Leicestershire has a predominantly Indian Gujarati and East African Indian (Gujarati) population, who are mainly adherents of Hinduism yet no study seems to have been carried out specifically on Hindu Indian children in the United Kingdom or comparison made between Hindu children and those who follow Sikhism or Islam, although the Hindu newborn have been studied as one of separate religious subgroups (McFadyen et al 1984; Chetcuti et al 1985). Furthermore, there appears to be no study on the growth of children originating from Gujarat, India and now resident in Great Britain.

3.5 SUMMARY OF AIMS

Thus, the aims of this thesis are to examine and describe the growth pattern of immigrant children from the subcontinent of India, who are currently residing in Leicestershire, using selected anthropometric parameters and standard measuring techniques. It is proposed that these children may show a growth pattern that differs from that of the indigenous population because of differences in genetic and environmental background. Secondly, an attempt will be made to evaluate the homogeneity of the Indian immigrant child population in Leicestershire, with respect to country of origin in the Indian subcontinent and religious adherence.

However, the supposition that the growth characteristics of the immigrant Indian child are still similar to those of Indian children, living in that area of India, from which the immigrant child's ancestors originate and from where the families emigrated, is also doubtful. Environmental conditions have an important role to play in influencing growth, and emigration from India to Great Britain has resulted in considerable environmental change. This thesis attempts to analyse the role of certain environmental factors on growth, such as the length of stay in Great Britain and therefore duration of exposure to conditions that appertain for the immigrant child in this country and impact of a transitional period of residence in another area of the world, i.e. East Africa.

Finally, growth of the indigenous child population in Leicestershire will also be considered with respect to the reference standards currently in use, some of which are based upon a child population measured in the 1950's. It is hypothesised that there will be some discrepancy between the current population and the reference data, because of the occurance of a positive secular trend in at least some of the growth parameters, over the last 20 years.

CHAPTER 4

METHOD

METHOD

4.1 TECHNIQUE

The initial arrangements for the Leicestershire Growth Study were already in hand when I joined the study. Permission had already been obtained from the Leicestershire Ethical Committee under a joint application from Dr. B.S.Marshall and Professor W.A.Marshall to measure Leicestershire children and a number of small pilot studies had been run in a local medical centre and in some of the Leicester schools. The results from these studies suggested that a full-scale study should be carried out (Marshall pers.comm.).

For the pilot studies, a letter and consent form, which included a number of questions, was prepared and sent to parents and guardians of children attending the schools involved. The letter outlined the reason for the survey and listed the measurements that would be taken, requested parental consent to measure the child and emphasised the confidentiality of the information obtained. For the main growth study, following discussion with Wendy Blair, Charnwood Community Relations Officer (pers. comm.), a modified letter and consent form were prepared, and following its acceptance by Dr. Barbara Marshall (Specialist in Community Medicine, Leicestershire Area Health Authority), this was the copy used for the Leicestershire Growth Study, (for copies of the original letter and consent form and the modified version see Appendix B).

The questions included with the consent form concerned:-

a) the birth place of the child, the parents and grandparents, in order to derive some information about the ethnic background of the child and whether he/she was a first or subsequent generation child born in the United Kingdom within that family,

b) diet, to obtain information on breast and bottle feeding and numbers of vegetarian eaters.

It was stressed in the letter that the information on the consent form was confidential and no names appeared on the measuring protocols. The total confidentiality of the study and of the information that would be given by the parents was also stressed to each headteacher, when visited, so that they could reiterate this to their pupils and/or parents where necessary. The heads were also informed that if there were problems about doubts on confidentiality or language problems leading to lack of comprehension concerning the questions, then, the answers to the questions could be omitted, but the consent form should be signed whereever possible. In most cases an attempt was made by parents to answer some if not all of the questions.

Information from the questions on the consent form was coded onto the protocol form - see appendix C. Additional information about the religious background of the Asian children was obtained from a study of the names of the Asian children and this information was also coded onto the protocol - appendix D. For information about the naming systems of Asians from the Indian subcontinent, Henley (1979) was consulted. A specimen copy of the protocol form used is included as Appendix F.

In order to receive the co-operation of the parents in obtaining measurements on their children, especially the Asian parents, who with their limited comprehension of the English language in many cases, tend to be suspicious of official forms, Wendy Blair of the Charnwood Community Relations Council was contacted. Apart from general discussion about the ethnic mix in Loughborough and the state of the immigrant community overall, a list of names of the religious leaders or representatives of the different immigrant ethnic communities in Loughborough, was obtained from her. On her advice, certain of the leaders of the Asian immigrant groups were contacted :- the representative for the Sikhs, the representative for the Loughborough Islamic Cultural Association, president of the Geeta Bhawan group and Chairman of the Shree Ram Krishna Centre. In each case a personal visit was made to explain the purpose of the Growth Study, to emphasise that it was for the well-being of the children, to outline which measurements would be made and to give them a copy of the letter, consent form and protocol form, so that when or if they received any queries from members of their community, once the Study was under way in the schools, they could reassure and help with the filling in of the forms if asked. The initial meeting with the Sikh representative was followed by an invitation from him to attend the Sunday service at the Sikh Temple in Loughborough, (the Sikh community was actually using St Peters Church Hall, Storer Road, for their meetings as the Temple was in process of construction) where, on being introduced to all the people present, details of the Growth Study were given, any questions were answered and general discussions held on the topic with those who were interested. The Islamic representative came to the Orchard (the Charnwood Community Relations Centre) to discuss the Growth Study and the possibility of personal visits to individual homes to measure the Muslim mothers with their young children at home - as in the strict Muslim family the female is unable to leave the home, and consequently her young children are unlikely to attend any of the playgroups or nursery schools, and are not therefore available for measurement until the age of five (Loughborough has no nursery units attached to their infant or junior schools, unlike Leicester). Unfortunately this idea did not come to fruition as the Islamic representative was unable to find any families prepared to participate in such a scheme.

Whilst these preparations were being made with the ethnic minority community leaders of people from the Indian subcontinent, in Loughborough, contact was also being made by Dr.B.S.Marshall with the Leicestershire Education Authority and Social Services for permission to carry out the Study in the schools and day nurseries and to make arrangements for which schools and day nurseries to contact about taking part in the Growth Study. The initial contact with the school was made to the head by the medical officer. This contact was then followed up and a personal meeting arranged with each head to explain the purpose of the Growth Study, the practical requirements, i.e. space to set up the equipment, time required to measure the children, and how it would affect their school in terms of the day to day running operations. In one school, a complete staff meeting was called, at which the case for measuring the children had to be presented and a vote was taken by all the members of staff present for acceptance or otherwise of the children being measured in their school. Fortunately the vote was in favour!

With acceptance in principle by each head, a date was then arranged for the measuring and sufficient letters and consent forms left for distribution to the parents. It was left to the head's discretion as to when to send the letters out, so that this could be fitted in with other information that had to be sent out from the school to the parents at certain times, on condition that the replies were back by the date of commencement of the study in that school. The week before the visit, most schools were contacted again, by telephone, to remind them of the impending visit and to cover any problems that might have arisen in the meantime. Some schools were visited repeatedly and their new intake measured each year, others were visited once only (see appendix E for list of schools and details of visits).

Two day nurseries, Regent Street, in Loughborough, and High Street, in Coalville, were also visited at approximately 6 monthly intervals over a period of approximately 3 years.

All the schools contacted were very helpful, but due to problems with space, the space allocated for measurement of the children, in the different schools, ranged from the sublime to the ridiculous, and included large/small medical rooms often filled with much other non-medical equipment, cloakrooms, entrance halls, classrooms, staffrooms and even on one occasion, the headmaster's office. Sometimes, because of availability of space or lack of it, the equipment had to be disassembled after the morning session and reassembled on another site for the afternoon session.

All children who returned the consent form, signed, were measured including those with known growth problems, as indicated by the parents on the consent forms, (such problems included achondroplasia, spina bifida, muscular dystrophy, twisted spine - details not known, identified growth failure, chromosome abnormality). The information from these children was then excluded before analysis of the data.

Seven measurements were taken on each child, stature, weight, sitting height, head circumference, upper arm circumference, triceps and subscapular skinfolds, using the techniques recommended by Cameron, Hiernaux, Jarman, Marshall, Tanner and Whitehouse (1981) and as described below and illustrated in figures 4, 5 and 6. All the measurements (with the exception of 198 subjects) were taken by one trained observer, the author (J.P.). The measurements took from three to five minutes per child, depending partly upon the age of the child - older children were more co-operative in helping to position themselves for the measurements and they did not need help getting undressed or dressed afterwards, or their shoelaces tying. Children were only available for measurement between approximately 9.30-10.30a.m., 11.0a.m.-12 noon, and 1.30-3.15p.m. during the school day, so on average, 70 children were measured each day. An attempt was also made to fit the measuring of the children in each class around their television programmes, play rehearsals etc. so that too much disruption was not caused to the work and life of the school. For nearly all of the visits to the schools and day nurseries, two people were in attendance, one to measure (J.P.) and a second person in a clerical role, recording the measurements.

All measurements were taken on the left hand side of the body, with a few exceptions, i.e. where children had had injections in their left arm on the same day, a deformed left arm, a left arm with a plaster cast on it. All the children were measured barefoot, and minus jumpers, but trousers and/or skirts, and underpants were retained, because in many cases the temperature of the measuring room was not suitable for a state of further undress.

Standing height was measured using a portable Harpenden stadiometer, (manufacturer - Holtain Ltd., Crosswell, Crymnych, Dyfed, Wales). The subject was measured barefoot, with his heels, scapulae and buttocks touching the vertical part of the stadiometer. With the Frankfort plane horizontal, gentle traction was applied under the mastoid processes. The result was recorded to the last completed 1mm.. Care was taken that the child did not raise his heels from the ground during the taking of the measurement. Supine length was measured using an infantometer for those children too small or immature to co-operate on the stadiometer. The small child/baby was placed in a supine position on the infantometer with one person holding his head, so that he looked straight upwards,(the Frankfort plane was then vertical), and the head was held in contact with the top of the infantometer. A second person pressed the child's knees down making contact with the board and applied gentle traction to stretch him/her. The infant's feet were held with the toes pointing directly upwards and the movable footboard was adjusted to rest against the infant's heels. The measurement was recorded to the last completed 1mm.. A blanket or sheet was placed across the horizontal surface of the infantometer before placing the child, supine on it as the cold surface was unpleasant for the children. Supine heights usually record 5mm. higher than standing heights in the same child.

Weight was measured using a beam balance, with the subject wearing minimal clothing, sometimes pants only, but usually trousers/skirt as well. Weight was recorded to the nearest 0.01kg..

Sitting height was measured using an anthropometer held vertically in the mid-line of the subject's back but not touching it. The child sat upright, hands on knees and feet supported so that the popiteal fossa were clear of the table by about 3mm.. The head was positioned in the Frankfort plane and gentle upward pressure was applied under the chin and at the occiput, by the observer's fingers. The subject was asked to sit up as tall as possible. Readings were recorded to the nearest 0.1cm..

Head circumference was measured using a flexible steel tape held parallel to the Frankfort plane, just above the eyebrows, and pulled tight to compress the hair. Readings were recorded to the nearest 1mm..

The upper arm circumference was also measured using a flexible steel tape held horizontally around the arm, midway between the acromial process and the olecranon, with the arm hanging relaxed. The tape was held so that it was in contact with the skin but without compressing it. Arm circumference readings were recorded to 1mm..

Skinfolds were measured using an improved version of Tanner-Whitehouse Harpenden skinfold calipers, namely Holtain skinfold calipers, (manufactured by Holtain Ltd., Wales) which exert a constant pressure of 10gcm.$^{-2}$, over a jaw opening of 0-20mm. The triceps skinfold was measured at the same level as the upper arm circumference, over the posterior surface of the triceps muscle, at the mid point of a vertical line from the acromial process to the olecranon, with the arm hanging relaxed. The subscapular skinfold was measured just below the angle of the left scapula with the fold slightly inclined in the natural cleavage of the skin. The skinfold was measured in each case, by picking up a double fold of skin and subcutaneous tissue between the forefinger and thumb of the left hand, and pinching it clean of the underlying muscle. The finger and thumb were initially placed approximately two centimeters apart and then brought together. The jaws of the calipers were applied to the skinfold about two centimeters below the fingers, so that the pressure on the fold at the point measured was exerted by the caliper faces and not by the fingers. When the caliper had been applied, the jaws were permitted to exert their full pressure on the skin by removal of the measurer's fingers from the trigger lever of the calipers, but the fold continued to be held by the measurer's forefinger and thumb until the measurement was read. The measurement value was recorded as the needle on the dial stopped creeping downwards and became stationery, about 3 seconds after applying the caliper jaws. Readings were recorded to 0.1mm..

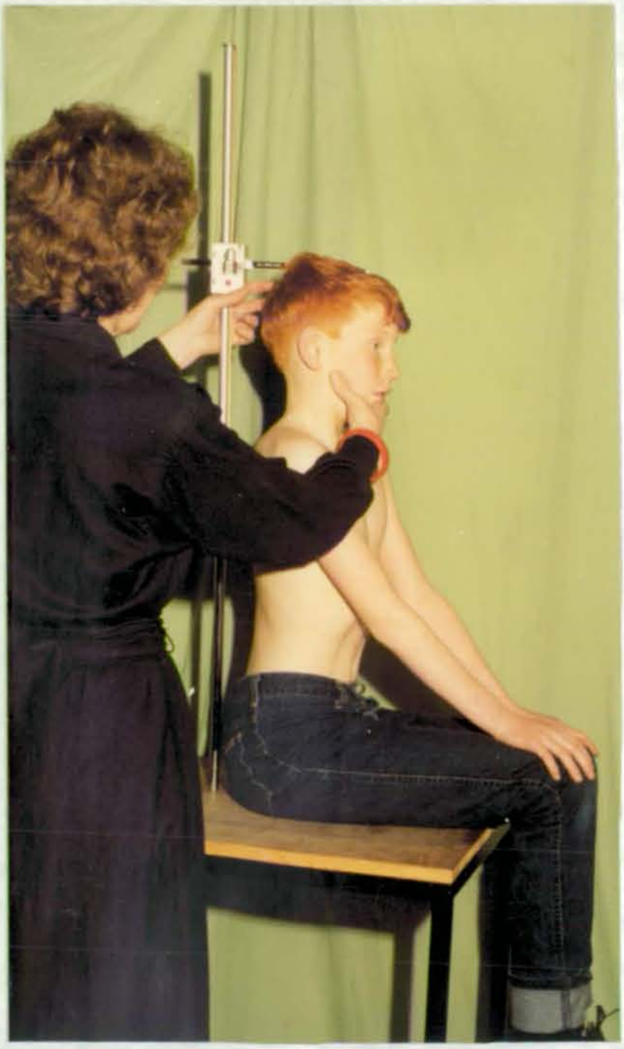
In order to find out whether the schools who took part in the growth study were a representative group from the whole of Leicestershire, copies of the catchment area for each school visited were obtained from County Hall, Leicester, and studied in conjunction with Ordnance Survey maps containing details of the electoral wards and enumeration districts. A list of all enumeration districts covered in the Growth Study was compiled and using the 1981 census data for Great Britain, information on those districts was obtained. This information covered the age distribution of the residents, their place of birth and socioeconomic status. Comparison was made with the census data 1981 for all of Leicestershire, to determine whether the population studied was a representative sample of Leicestershire children or more specifically represented the children found in inner urban areas, only in terms of socioeconomic status.

The anthropometric data were stored on the Loughborough University Honeywell mainframe computer and analysed, partly using a Minitab statistics package (Ryan, Joiner and Ryan 1981).

FIGURE 4

PHOTOGRAPHS ILLUSTRATING TYPICAL ANTHROPOMETRIC TECHNIQUES

Stature measured using a Harpenden Stadiometer.



Sitting height measured using an anthropometer

FIGURE 5

PHOTOGRAPHS ILLUSTRATING TYPICAL ANTHROPOMETRIC TECHNIQUES

Upper arm circumference measured with a flexible steel tape

Head circumference measured using a flexible steel tape.

FIGURE 6

PHOTOGRAPHS ILLUSTRATING TYPICAL ANTHROPOMETRIC TECHNIQUES

Triceps skinfold measured using Holtain skinfold calipers.

Subscapular skinfold measured using Holtain skinfold calipers.

4.2 **RELIABILITY**

Reliability of measurement was checked by the calculation of the standard error of measurement (S meas.) for each growth parameter measured on a separate group of students, before the onset of the actual study. The repeatability was then monitored during the study by repeat measuring of some of the children in the study.

To calculate the reliability of the measuring technique for each anthropometric parameter measured, the standard error of measurement or 'S meas' was calculated. Each measurement consists of the true value of the measurement, which is unknown and an error component - the error being both that due to observer and that due to the instrument. However, the instruments were checked for calibration before every measuring session, so it is assumed that the main error will be that due to the observer. A number of subjects were measured twice and the difference between the 2 results obtained. Since the true measurement will be the same each time the subject is measured, the difference between measurements is equal to the difference between errors. Therefore the variance of the difference between the errors

$$\text{Var}\ (X_{e1} - X_{e2}) = S^2{}_{e1} + S^2{}_{e2} - 2rS_{e1}S_{e2}$$

where X_{e1} = observer error in the first reading,
and X_{e2} = observer error in the second reading,
and $S_{e1}{}^2$ = variance of error in the first reading,
and $S_{e2}{}^2$ = variance of error in the second reading.

The variances for the 2 readings are assumed to be uncorrelated and equal in the 2 samples, so the variance of the differences

$$S^2{}_d = 2S^2{}_e$$

Each error variance or S meas is an independent estimate of the observers error, so

$$S^2{}_d = 2S^2{}_e = 2\ S^2\text{meas}$$

Therefore the standard deviation of the differences is

$$S_d = \sqrt{2}\ .\ S\ \text{meas}, \quad \text{i.e. } S\ \text{meas} = S_d/\sqrt{2}$$

and because S meas is a measure of distribution, any measurement taken is likely to be within $^+/_-$ 1.96 (S meas) of the 'true' value, 95% of the time.

The following values of S meas were obtained (using n = 7-23 subjects) for each parameter in this study:-

parameter	n	S meas	xd	1.96 (Smeas)	NCHS* survey(a)
height(cm)	23	0.16	-0.12	0.3	0.494
sitting height(cm)	13	0.32	-0.53	0.6	0.535
head circumference(cm)	17	0.16	0.29	0.3	-
arm circumference(cm)	13	0.16	0.05	0.3	0.347
triceps skinfold(mm)	16	0.36	0.32	0.7	0.80
subscap. skinfold(mm)	17	0.30	-0.03	0.5	1.83
weight(g)	7	4.94	0.001	9.6	11.73

* NCHS = National Centre for Health Statistics
(a) values are technical errors of measurement which are only equivalent to values of S meas if it can be assumed that there is no observer bias, i.e. the sum of the differences between repeated measurements is equal to zero. The values are taken from studies on children (Johnston, Hamill and Lemeshow 1972: Malina, Hamill and Lemeshow 1973). Cameron (1984) states that an observer's S meas falling within the figures of the NCHS survey quoted above would be viewed as comparable with accepted reliabilities from experienced observers measuring in a cross-sectional situation.

The mean of the difference in value between the first and second reading and its sign indicates any bias in the measuring - remeasuring technique. To test for significant bias in these differences obtained in the test-retest measurements, a Students paired T test was used, the null hypothesis being that the true mean value of the differences is zero. The results were not significant, at the $p<0.05$ level, for any parameter, i.e. the null hypothesis was accepted.

Tanner and Weiner (1949) quoting the coefficient of correlation between a series of measurements which for a single observer equals the coefficient of reliability found:-

stature	0.997	in this study	0.995
sitting height	0.986		1.000
upper arm circumference	0.977		0.999
triceps skinfold	0.982		0.983
subscapular skinfold	0.968		0.996
head circumference			0.994
weight			1.000

(the upper arm circumference and triceps skinfold sites were slightly different in the 2 studies and the skinfold values were obtained with Franzen calipers in the Tanner and Weiner (1949) study and with Holtain calipers in the Leicestershire Growth Study).

4.3 STATISTICAL METHODOLOGY

The following statistics have been used in this thesis:-

(a) mean
(b) median
(c) standard deviation
(d) standard error of the mean
(e) confidence limits (i) of the mean
(ii) of the standard deviation

(f) skewness
(g) kurtosis
(h) variance ratio
(i) two tailed T test
(j) one way analysis of variance
(k) standard deviation scores (Z scores)
(l) chi square analysis
(m) simple regression
(n) analysis of covariance

MEAN ($\bar{x}$)

This is the average value, the standard measure of location and it has been calculated as

$$\bar{x} = \Sigma X/N$$

where X = the raw data
N = the number of subjects

MEDIAN

This is the central value of a distribution, such that greater and smaller values occur with equal frequency. It has been used where distributions of data are skewed, such as weight. The median is calculated as follows:-

N values of X are arranged in order from least to greatest and the median is the value X_K if N is odd, K = (N + 1)/2. If N is even, the median lies halfway between the two central values of the distribution.

STANDARD DEVIATION - S

This is the most important measure of dispersion of a distribution and it is used to describe any distribution that is Guassian. It is defined in this study as:-

$$S = \sqrt{\frac{\Sigma (X - x)^2}{N - 1}}$$

STANDARD ERROR OF THE MEAN - $S_{\overline{x}}$

This gives an estimation of the precision of the sample mean for estimating the population mean, i.e. it measures the degree of uncertainty in a sample. It is defined as:-

$$S_{\overline{x}} = S/\sqrt{N}$$

where S = the standard deviation for the population sample
and N = the sample size.

CONFIDENCE LIMITS OF THE MEAN

This defines the limits within which the sample mean would be expected to fall, 95% of the time (95% confidence limits) if sampling were continued indefinitely. The 95% confidence limits of the mean are defined as:-

$$\text{lower limit} = \overline{x} + (t_{0.025})(S_{\overline{x}})$$
$$\text{upper limit} = \overline{x} + (t_{0.975})(S_{\overline{x}})$$

where t is obtained from standard statistical tables, using the appropiate degrees of freedom, (N-1). If N is large (i.e. $\geqslant$ 120), $t_{0.025}$ and $t_{0.975}$ are approximately equal to -1.96 and +1.96 respectively.

CONFIDENCE LIMITS OF THE STANDARD DEVIATION

95% CL of S - these define the limits within which the standard deviation would be expected to fall, 95% of the time, if sampling continued indefinitely. The 95% C.L. of the standard deviation are defined as:-

$$\sqrt{\frac{(N - 1)(S^2)}{\chi^2_{0.025}}} \quad \text{lower limit,}$$

$$\sqrt{\frac{(N - 1)(S^2)}{\chi^2_{0.975}}} \quad \text{upper limit}$$

χ^2 is obtained from standard statistical tables, using the appropiate degrees of freedom, (N - 1). Where N is very large, e.g. over 100, χ^2 cannot be obtained from tables. In this case,

$$\sqrt{2\chi^2} - \sqrt{2N-1} = R$$

may be used as a normal deviate with unit variance. Thus -1.96 is set equal to R to obtain the χ^2 associated with the 95% lower confidence limit, and +1.96 is set equal to the same expression to obtain the χ^2 associated with the upper limit of the 95% confidence interval of the SD.

SKEWNESS

A measure of the amount of skewness in a sample is given by the average value of $(x - \bar{x})^3$. This quantity is called the third moment about the mean. If, for a given body dimension, low values of X are bunched close to the mean $\bar{x}$, but high values extend far above the mean, this measure will be positive, since the large positive contributions $(X - \bar{x})^3$, when X exceeds x will predominate over the smaller negative contributions when X is less than $\bar{x}$. By a similar argument, negative skewness arises where the extended tail is below the mean. To render the measure independent of the scale on which the data are recorded it is divided by S^3. The coefficient of skewness used is defined as:

$$g_1 = m_3/(m_2\sqrt{m_2})$$

where $m_3 = \Sigma(X-\bar{x})^3/N$

and $m_2 = \Sigma(X-\bar{x})^2/N$

If the data for a given anthropometric parameter came from a population that is normally distributed, then, for large samples where $N > 150$, g_1 is approximately normally distributed with a mean of zero and a standard deviation of $\sqrt{6/N}$. Thus if the observed value of skewness lies outside the range:

$$\pm (1.96)(\sqrt{6/N})$$

then there is evidence to suppose, at least at the 0.05 level of significance, that the data come from a non-normal population. Where $N \leqslant 150$, tables are available to evaluate g_1.

KURTOSIS

A measure of the amount of kurtosis in a sample is given by the average value of $(X - \bar{x})^4$ divided by S^4. For the normal distribution this has the value 3. In calculating the coefficient of kurtosis it is standard practice to subtract 3 so that 0 is the expected value. In this case, if the ratio minus 3, exceeds 0 then there is usually, in comparison with the normal distribution, an excess of values near the mean and far from it, with some depletion of the mid-way flanks of the sample distribution. Values of less than 0 arise from curves that have a flatter top than the normal. The coefficient of kurtosis used here is:

$$g_2 = m_4/m_2^2)-3$$

where $$m_4 = \Sigma(X-\bar{x})^4/N$$

and m_2 is as previously defined under the discussion of skewness. In very large samples ($N > 1000$) g_2 is normally distributed with mean 0 and standard deviation $\sqrt{24/N}$. Thus, in large samples, if the observed value of g_2, the coefficient of kurtosis exceeds:

$$\pm (1.96)(\sqrt{24/N})$$

then, it is assumed, at least at the 0.05 level of significance, that the data do not come from a normally distributed population. Where N is less than 1000, tables are available to evaluate g_2 or (g_2+3).

VARIANCE RATIO (or F test)

This test investigates whether sample variances are sufficiently alike to assume that they are independent estimates of the same population variance, i.e. the null hypothesis H_o: $\sigma_1^2 = \sigma_2^2$.

$$F = S_1^2/S_2^2$$

with N_1-1 and N_2-1 = degrees of freedom.

where S_1^2 and S_2^2 = two sample variances, based on random samples of size:

N_1 and N_2,

respectively from two populations. The F value obtained is checked against tables which have been prepared showing the value of F which will be exceeded with a given degree of probability for given degrees of freedom.

TWO TAILED T TEST (with unequal variances)

This test was used to determine whether the difference between the mean values of two samples drawn from different sources is significant of a real difference between the parent sources. In the process of measuring the difference between two means, the test does not assume that the standard deviations of the two populations are equal. For markedly unequal sample sizes, and when the assumption that the sample variances are from a common population cannot be justified, the two tailed T test (with unequal variances) is better (Brownlee1965). In addition, the two tailed T test was used in all cases in this study because the direction of deviation from the expected, if it occured, would not necessarily occur in one direction only.

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{S_1^2/N_1 + S_2^2/N_2}}$$

where

$\bar{x}_1$ = mean of the first sample,

$\bar{x}_2$ = mean of the second sample,

S_1 = S.D. of the first sample,

S_2 = S.D. of the second sample,

N_1 = no. of subjects, sample 1,

N_2 = no. of subjects, sample 2,

t, the value obtained, can be compared with values from 't' tables prepared to show the values t may reach for given probability levels, and degrees of freedom,

$df = N_1 + N_2 - 2$

The null hypothesis is that the average differences in the values of the anthropometric parameter being considered, between the 2 sample populations is zero.

ANALYSIS OF VARIANCE

The procedure determines whether the variation that occurs among groups is significantly greater than the variation expected given the amount of variation within the groups. In this study an analysis of variance was carried out, for each anthropometric parameter and age group, between the different ethnic groups and between the different religions within a single ethnic group, i.e. the children originating from India.

The null hypothesis is that the populations all have the same mean u,

i.e. $H_0 : \mu_1 = \mu_2 = \ldots\ldots \mu_n$

The sums of squares are broken down into the two sources, - variation due to a factor (e.g. variation between ethnic groups) and variation due to random differences and error (e.g. variation within any one ethnic group):

ssq.(total) = msq.(between groups-factor)
+ ss(within groups-error)

F ratio = msq.(factor)/msq.(error)

The F ratio is large if the factor msq. is much larger than the error msq., i.e. when the variation is greater between ethnic groups than the variation due to random error within the ethnic group.

Acceptance of the F ratio is based upon an F table:
with df. (a-1) for the factor
and (N-a) for the error,
where a = the number of factors.

If the F value is greater than the table value for the given degrees of freedom and level of probability, the null hypothesis is rejected.

STANDARD DEVIATION SCORES

Standard deviation scores or Z scores are created by dividing the deviation of a measurement from the mean by the standard deviation.

$$Z = \frac{X_i - \bar{x}}{S}$$

where $\bar{x}$ = the mean,

S = the standard deviation in a given age-sex population,

X_i is the individual anthropometric measurement.

Every value in a distribution may be transformed into a

Z score in which case each Z will represent the deviation of a specific score from the mean expressed in standard deviation units. The advantage of transforming values to Z scores is that the Z scores represent abstract numbers as opposed to the concrete values of the original scores and the Z scores are therefore independent of such factors as age.

Further statistical analysis can then carried out upon the mean and standard deviation of the Z scores, using analysis of variance or t tests.

CHI SQUARE ANALYSIS

The chi square test can be used to test the 'goodness of fit' between an observed number of responses compared with an expected number. The null hypothesis states the proportion of responses from the sample expected to fall in each of certain chosen categories and the chi square technique tests whether the observed frequencies are sufficiently close to the expected ones to be likely to have occurred under the null hypothesis H_o.

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$$

where O_i = observed number of cases categorised in the ith category,

E_i = expected number of cases in the ith category under H_o,

k = number of categories.

If the agreement between the observed and the expected frequency is close, the difference between the 2 values will be small in each case, and chi square will be small. Conversely if the differences are large, chi square will be large. The value obtained for chi square with its associated degrees of freedom (df = k - 1), is referred to a table of the critical values for the chi square distribution with its associated probability of occurance under the null hypothesis.

Alternatively the chi square test can be used to determine the significance of differences between 2 or more independent groups. The hypothesis, H_1, is that the 2 groups differ with respect to some characteristic and therefore with respect to the relative frequency with which the group members fall in a number of different categories. The null hypothesis, H_0, that there is no difference between the groups may be tested by:-

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{k}\frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where O_{ij} = observed number of cases categorised in the ith row of the jth column,

E_{ij} = number of cases expected under H_0 to be categorised in the ith row of the jth column,

r = number of rows,

k = number of columns.

The values of chi square are distributed with $df = (r - 1)(k - 1)$, and the probabilities associated with various values of chi square are given in a table, as for the one sample case described above.

The advantage of the chi square distribution is that it may be used to test whether several independent samples have come from the same population, without having to make the assumption that the observations are from normally distributed populations, all of which have the same variance.

SIMPLE REGRESSION

This produces an equation that uses one variable to explain the variation in another variable, using the method of least squares. The equation for a straight line is

$$y = a + bx$$

and for the least squares line, a and b are found using

$$b = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\Sigma(x_i - \bar{x})^2} \qquad a = \bar{y} - b\bar{x}$$

The variance of a and b can also be obtained:-

$$V(a) = V\ \Sigma y_i/K = \sigma^2/K$$

$$V(b) = V\ \frac{\Sigma(x_i - x)y_i}{\Sigma(x_i - \bar{x})^2} = \frac{\sigma^2}{\Sigma(x_i - \bar{x})^2}$$

and the estimated variance of b is obtained by replacing σ^2

by s^2.
Therefore

$$V(b) = s^2/\Sigma(x_i - \bar{x})^2$$

and the estimated standard deviation of b = V(b).
To test statistically for significant evidence of an association between x and y, i.e. the hypothesis that b = 0,

$$t = \frac{b - \text{(hypothesised value)}}{\text{(estimated SD of b)}}$$

$$t = \frac{b - 0}{\text{SD of b}}$$

information given in t ratio, with df = n-1.
If the t ratio is significant, this gives evidence that b is probably not 0, this in turn implies that the value on x is at least slightly useful as a predictor of the value on y. A similar test can be made for a. Values of t are treated as in the two tailed t test, i.e. tables are available, for values of t for selected probability levels and various degrees of freedom.

SIMPLE ANALYSIS OF COVARIANCE

This is basically an analysis of variance, i.e. a test of whether a group of population means are identical, but with adjustment for variation in x, the variable x being the covariate.
Analysis of covariance was used to compare several regression lines, in the following steps:-
(a) testing to see that the variance around the separate lines could be regarded as homogenous,
(b) testing whether parallel lines through the respective means could be regarded as an acceptable fit,
(c) testing whether the group means can be regarded as lying on a least squares line
(d) testing whether an overall regression line is an adequate fit for all groups.

CHAPTER 5

RESULTS

RESULTS

Twenty four schools and 2 day nurseries were visited over a period of 3.25 years and 4,652 children were measured using the cross-sectional study technique. This represented an uptake in each school of 40-98%. 18 of the schools were in Leicester city and its surrounding areas, e.g. Anstey, and 6 were in Loughborough (see Figures 2 and 3 for catchment areas of each school). After removing from the data any children with identified growth problems and a few who had been measured twice due to a change of school during the period of measurement, 4,639 children remained. This represented approximately 3% of the Leicestershire population, aged 0-12 years.

Because this study is concerned with the growth of children from the Indian subcontinent and the European population resident in Leicestershire, these two groups were identified from the ethnic background coded from the questionnaire, and all the analysis was carried out on these subjects only. Secondly, because of the small numbers of subjects in the age band 0-2.999 years (n = 89 boys, 95 girls) and 11-11.999 years (n = 91 boys, 95 girls, with the majority being of European origin), these two bands were ignored for the purpose of this analysis, and the age groups 3.000-10.999 years only were analysed. Additionally, with such small numbers of Bangladeshi children (n = 49 boys, 64 girls) and Pakistani (n = 15 boys, 11 girls) aged 3-10 years, these subjects were also omitted from the analysis. This produced a population sample of 3775 children, (1870 boys and 1905 girls) including children from India, Indian children from East Africa and European children. The distribution of the subjects by age and country of origin, for each sex, is shown in Table 1. The distribution of the Indian children, categorised by religious adherence is given in Table 2. There are more Indian subjects included in the analysis when described by religious adherence than described by country of origin because of the source of the information, i.e. the religious category was identified from the name of each subject, which was always available, the country of origin from the questionnaire, which was not always fully completed.

The median age for each year band for both sexes together and each sex separately is given in Table 3. Table 4 shows the medians for the three religious groups - Hindus, Muslims and Sikhs of the children originating from India and the European children. As can be seen from Table 3 and 4, the three year old sample is biased towards the older children in that age band because of the source of subjects, i.e. children are admitted to the nursery units from three years of age and unless a visit to a school coincided with a new intake of younger children, the children measured were all three years plus. Similarly, the seven year old sample is affected by the higher number of infant schools visited compared with junior schools coupled with the fact that the children move from the infant to the junior school, where necessary, at the end of the school year in which they have their seventh birthday. Although the analysis in this study groups the subjects into single year age bands for comparison between different subsets, Table 4 indicates that, for some year bands, the comparison may be biased by the fact that some groups are represented by a a younger sample than others.

The anthropometric data collected in this study for each age group, each sex, country of origin and separate religious groups (for the children originating from the Indian subcontinent) are presented in Tables 5 - 20 and plotted in Figures 7 - 20. Each anthropometric parameter except weight, has been described in terms of the mean, its standard error and 95% confidence limits, standard deviation, and its 95% confidence limits. For weight, the median and its standard error is quoted only. Where the subject numbers are low, i.e. $N < 3$, means and medians only are given.

The data for each anthropometric parameter were initially checked for normality of distribution, using measures of skewness and kurtosis. Table 21 gives the results for the coefficient of skewness for each anthropometric parameter and each age band. The letters 'NS' (not significant) indicate where there is no evidence that the data are skewed, positively or negatively and therefore they may be regarded as gaussian. Where the Indian and

European populations differed in their anthropometric values, data was skewed, but when the 2 ethnic groups were considered separately, the distributions were found to be guassian, e.g. head circumference.

Table 21 also records the significance or not of the coefficient of kurtosis, for each anthropometric parameter. The letters 'NS' indicate that there is no evidence that the data are significantly 'peaky' (leptokurtic) or 'flattened' (platykurtic).

If either or both of the coefficients of skewness and kurtosis are labelled as being significant in Table 21, then the data for that anthropometric parameter cannot be reliably regarded as coming from a normally distributed population. Because the skinfold values show a non-Gaussian distribution, they were transformed into a logarithmic scale, using the transformation of Edwards et al (1955) which they claimed served reasonably well for all sites and ages, in both sexes;

skinfold transform = 100 $\log_{10}$(reading in 0.1mm. - 18)

This transform appeared to fit the Leicestershire population sampled for the triceps skinfold values, but the subscapular skinfold values remained significantly non-gaussian, even after applying the above transformation. An attempt was made to find an alternative transform which would produce a guassian distribution for the subscapular skinfold in the Leicestershire population. The best result was obtained with

Skinfold transform = 100 $\log_{10}$(reading in 0.1mm. - 30)

A specific decision was made not to obtain details of occupation of the parents involved in the Leicestershire Growth Study. This was partly because of the sensitivity of the immigrant population to personal questions but mainly because classification of the Asian population according to occupation does not always accurately reflect their social or economic status, using the Registrar General's scheme. It is known that immigrant workers have taken jobs which demand fewer qualifications than they have achieved, in order to obtain work, e.g. a very high proportion of Indians were involved in manual work - 76% compared with a total population in Great Britain so employed of 51% (Morrish 1971). Consequently, information on socioeconomic status is not available and differences that occur because of these socioeconomic differences cannot be evaluated.

From the comparison of the census data for the areas in which measurements were collected (U.M.R.C.C. 1982) compared with the data for the whole of Leicestershire(O.P.C.S. 1982), as shown in Table 22, it can be seen that our Leicestershire sample does not entirely match the current Leicestershire population. There were more children measured in schools in the inner urban areas of Leicester and Loughborough, than in the suburbs. Consequently, our sample contains higher numbers of households with heads from the New Commonwealth or Pakistan and more households with the head of the house born abroad. However, for such factors as number of people per room, shared bathroom facilities and percentage of households without a car, the figures are in closer agreement.

Information about the relationship between the distribution of our groups of children in each school and the overall distribution in the school is shown in Table 23. The number allocated to each school corresponds with the catchment area for the school as shown in figures 2 and 3. Because our right to measure a child depended upon a signed consent form from the parent, obviously our sample in each school was not and could not be random, but it can be seen from Table 23, that it represented the overall distribution of each group identified, in each school, fairly well. In some cases, there is a discrepancy between the figures, attributable to the fact that the actual figures represent the current ethnic mix in some schools (1987) rather than the mix that appertained when measurements were taken. The ethnic mix in a few school catchment areas has changed over the past 5 years, e.g. Uplands Infants, Cobden Infants and Junior and Rendell Primary.

TABLE 1

SUBJECT NUMBERS BY COUNTRY OF ORIGIN

MALES

Age(yrs.)	EUROP'N	INDIAN	E/A	B.DESH	PAK'N
3+	41	21	22	5	3
4+	80	47	92	2	3
5+	160	67	85	9	3
6+	133	77	96	8	4
7+	158	38	72	3	1
8+	171	36	47	7	0
9+	150	36	36	8	0
10+	141	27	37	7	1

FEMALES

Age(yrs.)	EUROP'N	INDIAN	E/A	B.DESH	PAK'N
3+	33	20	16	2	0
4+	76	48	84	7	1
5+	126	81	102	17	5
6+	152	69	121	10	2
7+	150	60	68	4	2
8+	167	30	48	11	0
9+	152	36	51	7	0
10+	164	27	24	6	1

TABLE 2

SUBJECT NUMBERS OF INDIANS, CATEGORISED BY RELIGION

	MALES			FEMALES		
Age (yrs.)	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh
3+	24	16	7	22	12	18
4+	101	30	17	98	29	16
5+	112	31	22	146	30	23
6+	106	37	36	150	21	28
7+	87	13	13	104	19	15
8+	73	8	9	67	6	9
9+	56	2	19	76	6	7
10+	55	3	11	46	2	10

TABLE 3

MEDIAN AGE OF POPULATION SAMPLE

Age (yrs.)	BOTH SEXES	MALES	FEMALES
3+	3.692	3.654	3.751
4+	4.553	4.568	4.540
5+	5.482	5.482	5.482
6+	6.463	6.450	6.487
7+	7.423	7.437	7.392
8+	8.490	8.467	8.518
9+	9.511	9.515	9.493
10+	10.490	10.526	10.470

TABLE 4

MEDIAN AGES OF INDIAN RELIGIOUS GROUPS AND EUROPEANS

MALES

Age (yrs.)	Hindu	Muslim	Sikh	European
3+	3.786	3.663	3.510	3.598
4+	4.537	4.565	4.740	4.568
5+	5.438	5.586	5.528	5.526
6+	6.439	6.572	6.599	6.427
7+	7.326	7.400	7.376	7.503
8+	8.441	8.694	8.274	8.466
9+	9.458	9.109	9.323	9.544
10+	10.433	10.274	10.608	10.566

FEMALES

Age (yrs.)	Hindu	Muslim	Sikh	European
3+	3.786	3.663	3.510	3.652
4+	4.537	4.565	4.740	4.526
5+	5.438	5.586	5.528	5.526
6+	6.439	6.572	6.599	6.427
7+	7.326	7.400	7.376	7.503
8+	8.441	8.694	8.272	8.466
9+	9.458	9.109	9.323	9.544
10+	10.433	10.274	10.608	10.567

TABLE 5 ANTHROPOMETRIC DATA - MALES AGE 3.000-3.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	24	16	7	41	21	22
HEIGHT (CM.)						
MEAN	100.4	97.9	98.0	99.5	97.7	100.5
STD. ERROR(x̄)	0.9	0.9	1.1	0.8	0.7	1.0
95%CL(x̄) +/-	1.89	1.98	2.73	1.57	1.50	2.00
STD. DEV.	4.48	3.72	2.95	4.98	3.30	4.51
95%CL(SD) up	6.28	5.75	6.49	6.37	4.79	6.45
low	3.48	2.75	1.90	4.09	2.52	3.47
HEAD CIRCUMFERENCE (CM.)						
MEAN	49.0	49.1	49.6	50.3	49.0	48.9
STD. ERROR(x̄)	0.2	0.4	0.7	0.2	0.3	0.2
95%CL(x̄) +/-	.41	.81	1.79	.42	.56	.48
STD. DEV.	.98	1.52	1.94	1.32	1.24	1.08
95%CL(SD) up	1.37	2.35	4.27	1.69	1.80	1.54
low	.76	1.12	1.25	1.08	.95	.83
ARM CIRCUMFERENCE (CM.)						
MEAN	16.1	16.3	16.7	16.8	16.4	16.2
STD. ERROR(x̄)	0.2	0.3	0.3	0.2	0.2	0.2
95%CL(x̄) +/-	.46	.57	.62	.35	.36	.43
STD. DEV.	1.09	1.07	.67	1.10	.79	.96
95%CL(SD) up	1.53	1.65	1.47	1.41	1.14	1.38
low	.85	.79	.43	.91	.60	.74
SITTING HEIGHT (CM.)						
MEAN	57.3	56.0	56.8	58.1	56.2	57.4
STD. ERROR(x̄)	0.5	0.5	0.8	0.5	0.4	0.5
95%CL(x̄) +/-	.95	1.11	2.04	.93	.88	1.06
STD. DEV.	2.25	2.09	2.21	2.69	1.94	2.40
95%CL(SD) up	3.16	3.23	4.86	3.83	2.81	3.43
low	1.75	1.54	1.42	2.29	1.48	1.85
TRICEPS SKINFOLD (log transformed units)						
MEAN	185.4	183.0	198.1	187.4	187.4	187.1
STD. ERROR(x̄)	2.2	3.5	3.1	1.7	2.7	2.0
95%CL(x̄) +/-	4.56	7.46	7.49	3.41	5.60	4.12
STD. DEV.	10.80	14.00	8.10	10.80	12.30	9.30
95%CL(SD) up	15.15	21.65	17.82	13.82	17.84	13.29
low	8.39	10.34	5.22	8.87	9.41	7.15
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	163.5	159.7	175.8	170.7	163.2	164.7
STD. ERROR(x̄)	3.3	3.6	8.3	2.8	3.9	2.5
95%CL(x̄) +/-	6.76	7.62	20.35	5.65	8.19	5.23
STD. DEV.	16.00	14.30	22.00	17.90	18.00	11.80
95%CL(SD) up	22.44	22.12	48.39	22.90	26.10	16.87
low	12.43	10.56	14.18	14.70	13.77	9.08
WEIGHT (KG.)						
MEDIAN	15.06	14.65	16.00	15.63	14.46	15.52
STD.ERR.(med)	0.5	0.6	0.8	0.4	0.5	0.3

TABLE 6 ANTHROPOMETRIC DATA - FEMALES AGE 3.000-3.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	22	12	8	33	20	16
HEIGHT (CM.)						
MEAN	99.2	98.8	99.7	98.5	97.9	99.2
STD. ERROR(x̄)	0.7	1.3	2.6	0.7	0.9	1.1
95%CL(x̄) +/-	1.45	2.92	6.13	1.49	1.78	2.40
STD. DEV.	3.26	4.60	7.33	4.19	3.80	4.51
95%CL(SD) up	4.66	7.81	14.92	5.78	5.55	6.98
low	2.51	3.26	4.85	3.46	2.89	3.33
HEAD CIRCUMFERENCE (CM.)						
MEAN	48.2	47.8	48.4	49.2	48.0	48.2
STD. ERROR(x̄)	0.3	0.3	0.7	0.3	0.3	0.3
95%CL(x̄) +/-	.54	.72	1.66	.56	.54	.70
STD. DEV.	1.22	1.14	1.99	1.57	1.15	1.32
95%CL(SD) up	2.93	1.93	4.05	2.17	1.68	2.04
low	.94	.81	1.32	1.30	.87	.98
ARM CIRCUMFERENCE (CM.)						
MEAN	16.1	16.9	16.5	17.2	16.0	16.5
STD. ERROR(x̄)	0.3	0.3	1.0	0.2	0.3	0.4
95%CL(x̄) +/-	.57	.72	2.25	.45	.65	.83
STD. DEV.	1.28	1.14	2.69	1.27	1.38	1.55
95%CL(SD) up	1.83	1.93	5.47	1.75	2.02	2.40
low	.98	.81	1.78	1.05	1.05	1.14
SITTING HEIGHT (CM.)						
MEAN	55.8	57.0	57.1	56.9	55.1	56.8
STD. ERROR(x̄)	0.6	1.1	1.4	0.4	0.7	0.6
95%CL(x̄) +/-	1.31	2.35	3.24	.90	1.48	1.27
STD. DEV.	2.95	3.70	3.88	2.51	3.17	2.38
95%CL(SD) up	4.22	6.28	7.90	3.36	4.63	3.68
low	2.27	2.62	2.57	2.01	2.41	1.76
TRICEPS SKINFOLD (log transformed units)						
MEAN	188.3	197.1	195.6	194.9	190.8	192.2
STD. ERROR(x̄)	2.1	4.0	4.5	1.8	2.8	2.8
95%CL(x̄) +/-	4.26	8.83	10.54	3.73	5.94	5.91
STD. DEV.	9.60	13.90	12.60	10.50	12.70	11.10
95%CL(SD) up	13.72	23.59	25.64	14.50	18.55	17.17
low	7.39	9.85	8.33	8.67	9.66	8.20
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	168.6	174.2	179.6	175.4	168.8	176.1
STD. ERROR(x̄)	2.6	7.3	5.4	2.9	3.7	5.0
95%CL(x̄) +/-	5.32	16.14	12.71	5.87	7.82	10.55
STD. DEV.	12.00	25.40	15.20	16.50	16.70	19.80
95%CL(SD) up	17.15	43.10	30.93	22.78	24.39	30.63
low	9.23	17.99	10.05	13.62	12.70	14.63
WEIGHT (KG.)						
MEDIAN	14.00	14.29	13.98	15.97	13.54	15.97
STD.ERR.(med)	0.5	0.8	2.9	0.4	0.7	0.7

TABLE 7 ANTHROPOMETRIC DATA - MALES AGE 4.000-4.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	101	30	17	80	47	92
HEIGHT (CM.)						
MEAN	104.9	104.9	109.0	105.3	105.1	105.7
STD. ERROR($\bar{x}$)	0.5	0.8	1.0	0.6	0.8	0.5
95%CL($\bar{x}$) +/-	1.03	1.53	2.03	1.22	1.55	1.02
STD. DEV.	5.20	4.09	3.95	5.48	5.29	4.94
95%CL(SD) up	6.03	5.50	6.01	6.98	7.26	5.82
low	4.57	3.26	2.94	5.00	4.66	4.34
HEAD CIRCUMFERENCE (CM.)						
MEAN	49.5	49.4	50.7	50.7	49.7	49.7
STD. ERROR($\bar{x}$)	0.2	0.3	0.3	0.2	0.2	0.2
95%CL($\bar{x}$) +/-	.32	.51	.62	.33	.41	.35
STD. DEV.	1.63	1.36	1.21	1.49	1.38	1.70
95%CL(SD) up	1.89	1.83	1.84	1.90	1.89	2.00
low	1.43	1.08	.90	1.36	1.22	1.49
ARM CIRCUMFERENCE (CM.)						
MEAN	16.2	16.5	17.3	16.9	16.3	19.5
STD. ERROR($\bar{x}$)	0.2	0.3	0.5	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.30	.51	.97	.29	.44	.35
STD. DEV.	1.54	1.37	1.88	1.29	1.50	1.67
95%CL(SD) up	1.78	1.84	2.86	1.64	2.06	1.97
low	1.35	1.09	1.40	1.18	1.32	1.47
SITTING HEIGHT (CM.)						
MEAN	59.1	59.7	60.6	60.4	58.9	59.8
STD. ERROR($\bar{x}$)	0.2	0.7	0.6	0.4	0.5	0.3
95%CL($\bar{x}$) +/-	.45	1.41	1.29	.69	1.06	.57
STD. DEV.	2.27	3.78	2.42	3.04	3.57	2.77
95%CL(SD) up	2.63	5.08	3.74	3.80	4.85	3.26
low	1.99	3.01	1.79	2.72	3.11	2.43
TRICEPS SKINFOLD (log transformed units)						
MEAN	182.4	185.5	189.7	182.8	185.2	183.2
STD. ERROR($\bar{x}$)	1.1	2.6	3.8	1.5	2.2	1.6
95%CL($\bar{x}$) +/-	2.14	5.23	8.02	3.01	4.41	3.19
STD. DEV.	10.80	14.00	15.60	13.50	15.00	15.30
95%CL(SD) up	13.26	18.82	23.74	17.18	20.58	17.91
low	9.89	11.15	11.62	12.31	13.21	13.35
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	161.7	163.4	167.4	162.9	160.7	164.3
STD. ERROR($\bar{x}$)	1.7	3.2	7.6	1.8	3.2	1.9
95%CL($\bar{x}$) +/-	3.46	6.57	16.20	3.50	6.35	3.85
STD. DEV.	17.40	17.60	31.50	15.70	21.60	18.50
95%CL(SD) up	21.37	23.66	47.93	19.98	29.64	21.66
low	15.93	14.02	23.46	14.32	19.02	16.15
WEIGHT (KG.)						
MEDIAN	16.20	16.43	18.00	17.34	16.14	16.50
STD.ERR.(med)	0.3	0.5	1.0	0.3	0.6	0.4

TABLE 8 ANTHROPOMETRIC DATA - FEMALES AGE 4.000-4.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	98	29	16	76	48	84
HEIGHT (CM.)						
MEAN	102.9	103.7	104.8	105.1	103.6	102.8
STD. ERROR(x̄)	0.5	0.8	0.9	0.6	0.5	0.5
95%CL(x̄) +/-	.94	1.56	1.88	1.14	1.08	.99
STD. DEV.	4.67	4.09	3.53	4.99	3.70	4.55
95%CL(SD) up	5.68	5.53	5.46	6.19	5.13	5.48
low	4.23	3.25	2.61	4.43	3.29	4.01
HEAD CIRCUMFERENCE (CM.)						
MEAN	48.8	48.8	49.2	49.9	48.7	48.9
STD. ERROR(x̄)	0.4	0.3	0.3	0.2	0.2	0.4
95%CL(x̄) +/-	.71	.50	.62	.39	.39	.82
STD. DEV.	3.52	1.32	1.17	1.71	1.34	3.76
95%CL(SD) up	4.28	1.79	1.81	2.12	1.86	4.53
low	3.19	1.05	.86	1.52	1.19	3.32
ARM CIRCUMFERENCE (CM.)						
MEAN	16.3	16.4	16.9	16.9	16.6	16.2
STD. ERROR(x̄)	0.2	0.2	0.4	0.2	0.1	0.2
95%CL(x̄) +/-	.29	.46	.84	.35	.39	.32
STD. DEV.	1.46	1.21	1.57	1.53	1.35	1.45
95%CL(SD) up	1.77	1.64	2.43	1.90	1.87	1.74
low	1.32	.96	1.16	1.36	1.20	1.27
SITTING HEIGHT (CM.)						
MEAN	58.0	58.3	59.2	60.0	58.5	58.0
STD. ERROR(x̄)	0.3	0.6	0.5	0.3	0.4	0.3
95%CL(x̄) +/-	.52	1.13	1.15	.68	.77	.52
STD. DEV.	2.59	2.96	2.15	2.91	2.66	2.38
95%CL(SD) up	3.15	4.00	3.33	3.54	3.69	2.87
low	2.35	2.35	1.59	2.53	2.37	2.10
TRICEPS SKINFOLD (log transformed)						
MEAN	188.3	187.1	190.4	187.0	190.5	186.4
STD. ERROR(x̄)	1.4	2.4	3.8	1.4	1.9	1.5
95%CL(x̄) +/-	2.69	4.87	7.99	2.74	3.90	2.91
STD. DEV.	13.40	12.80	15.00	12.00	13.40	13.40
95%CL(SD) up	16.29	17.31	23.20	14.88	18.59	16.15
low	12.14	10.16	11.08	10.66	11.93	11.82
SUBSCAPULAR SKINFOLD (log transformed)						
MEAN	175.5	167.8	173.0	169.0	173.9	171.8
STD. ERROR(x̄)	1.9	2.1	5.6	1.9	2.8	1.8
95%CL(x̄) +/-	3.75	4.34	11.88	3.80	5.55	3.67
STD. DEV.	18.70	11.40	22.30	16.60	19.10	16.90
95%CL(SD) up	22.73	15.42	34.49	20.59	26.49	20.37
low	16.94	9.05	16.47	14.75	17.00	14.91
WEIGHT (KG.)						
MEDIAN	15.48	15.89	16.75	17.23	16.18	15.15
STD.ERR.(med)	0.3	0.4	0.8	0.3	0.4	0.3

TABLE 9 ANTHROPOMETRIC DATA - MALES AGE 5.000-5.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	112	31	22	160	67	85
HEIGHT (CM.)						
MEAN	110.7	110.3	113.6	112.9	111.2	111.0
STD. ERROR($\bar{x}$)	0.4	0.9	1.0	0.4	0.4	0.5
95%CL($\bar{x}$) +/-	.87	1.74	2.08	.73	.88	1.08
STD. DEV.	4.65	4.74	4.70	4.65	3.60	5.00
95%CL(SD) up	5.34	6.34	6.72	5.21	4.60	6.06
low	4.10	3.79	3.62	4.18	3.20	4.44
HEAD CIRCUMFERENCE (CM.)						
MEAN	49.6	49.9	50.5	51.4	49.9	51.4
STD. ERROR($\bar{x}$)	0.1	0.2	0.2	0.1	0.2	0.1
95%CL($\bar{x}$) +/-	.24	.40	.47	.20	.30	.27
STD. DEV.	1.28	1.08	1.07	1.26	1.22	1.26
95%CL(SD) up	1.47	1.44	1.53	1.41	1.56	1.52
low	1.13	.86	.82	1.13	1.09	1.11
ARM CIRCUMFERENCE (CM.)						
MEAN	16.7	16.4	17.4	17.2	16.9	16.7
STD. ERROR($\bar{x}$)	0.2	0.3	0.5	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.33	.64	1.05	.20	.48	.38
STD. DEV.	1.73	1.75	2.37	1.30	1.98	1.77
95%CL(SD) up	1.98	2.34	3.39	1.46	2.53	2.15
low	1.52	1.40	1.82	1.17	1.76	1.57
SITTING HEIGHT (CM.)						
MEAN	61.5	61.0	62.7	63.9	61.8	61.6
STD. ERROR($\bar{x}$)	0.3	0.5	0.5	0.2	0.3	0.3
95%CL($\bar{x}$) +/-	.51	.96	1.07	.39	.55	.63
STD. DEV.	2.74	2.63	2.41	2.37	2.26	2.94
95%CL(SD) up	3.15	3.52	3.44	2.64	2.89	3.56
low	2.42	2.10	1.85	2.11	2.01	2.61
TRICEPS SKINFOLD (log transformed units)						
MEAN	181.3	179,6	184.6	179.4	180.3	182.8
STD. ERROR($\bar{x}$)	1.5	2.6	4.1	1.1	2.2	1.5
95%CL($\bar{x}$) +/-	2.93	5.21	8.56	2.16	4.37	3.06
STD. DEV.	15.50	14.20	19.30	14.40	17.90	14.10
95%CL(SD) up	17.73	18.98	27.58	16.15	22.86	16.99
low	13.60	11.35	14.85	12.96	15.93	12.44
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	163.3	160.2	167.9	160.1	161.9	164.7
STD. ERROR($\bar{x}$)	1.6	3.3	5.0	1.2	2.6	1.7
95%CL($\bar{x}$) +/-	3.25	6.71	10.29	2.35	5.23	3.45
STD. DEV.	17.30	18.30	23.20	15.00	21.40	16.00
95%CL(SD) up	19.83	24.46	33.16	16.82	27.33	19.40
low	15.22	14.62	17.85	13.50	19.05	14.20
WEIGHT (KG.)						
MEDIAN	18.28	16.92	19.52	19.75	18.96	18.65
STD.ERR.(med)	0.3	0.9	1.0	0.2	0.5	0.4

TABLE 10 ANTHROPOMETRIC DATA - FEMALES AGE 5.000-5.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	146	30	23	126	81	102
HEIGHT (CM.)						
MEAN	109.3	108.1	111.5	112.3	109.4	109.6
STD. ERROR($\bar{x}$)	0.4	0.9	1.2	0.5	0.6	0.5
95%CL($\bar{x}$) +/-	.77	1.90	2.50	1.05	1.16	.96
STD. DEV.	4.73	5.09	5.78	6.04	5.24	4.90
95%CL(SD) up	5.33	6.84	8.18	6.88	6.20	5.67
low	4.24	4.05	4.47	5.36	4.54	4.30
HEAD CIRCUMFERENCE (CM.)						
MEAN	48.9	48.5	49.5	50.2	48.9	48.9
STD. ERROR($\bar{x}$)	0.1	0.2	).3	0.1	0.2	0.1
95%CL($\bar{x}$) +/-	.23	.44	.56	.27	.33	.24
STD. DEV.	1.40	1.19	1.30	1.52	1.48	1.24
95%CL(SD) up	1.58	1.60	1.84	1.73	1.75	1.43
low	1.25	.95	1.01	1.35	1.28	1.09
ARM CIRCUMFERENCE (CM.)						
MEAN	16.6	16.1	17.0	17.7	16.6	16.5
STD. ERROR($\bar{x}$)	0.1	0.3	0.2	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.25	.52	.50	.27	.32	.30
STD. DEV.	1.53	1.39	1.16	1.57	1.44	1.53
95%CL(SD) up	1.73	1.87	1.64	1.79	1.70	1.77
low	1.37	1.11	.90	1.39	1.25	1.34
SITTING HEIGHT (CM.)						
MEAN	60.4	59.5	61.6	63.0	60.4	60.6
STD. ERROR($\bar{x}$)	0.2	0.5	0.5	0.3	0.3	0.3
95%CL($\bar{x}$) +/-	.44	1.08	1.12	.54	.65	.52
STD. DEV.	2.74	2.88	2.59	3.07	2.92	2.66
95%CL(SD) up	3.09	3.87	3.67	3.50	3.45	3.08
low	2.45	2.29	2.00	2.73	2.53	2.33
TRICEPS SKINFOLD (log transformed units)						
MEAN	188.0	182.1	189.1	191.8	187.7	186.9
STD. ERROR($\bar{x}$)	1.2	2.7	2.8	1.1	1.6	1.5
95%CL($\bar{x}$) +/-	2.29	5.41	5.75	2.13	3.09	2.88
STD. DEV.	14.10	14.50	13.30	12.20	14.00	14.70
95%CL(SD) up	15.90	19.49	18.83	13.89	16.56	17.00
low	12.63	11.55	10.29	10.84	12.13	12.89
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	173.1	168.1	171.7	172.0	171.8	172.1
STD. ERROR($\bar{x}$)	1.6	3.7	3.7	1.5	2.2	2.0
95%CL($\bar{x}$) +/-	3.21	7.58	7.70	2.97	4.33	3.87
STD. DEV.	19.80	20.30	17.80	17.00	19.60	19.70
95%CL(SD) up	22.33	27.29	25.20	19.36	23.19	22.79
low	17.73	16.17	13.77	15.10	16.98	17.27
WEIGHT (KG.)						
MEDIAN	17.13	17.13	18.08	19.775	17.22	17.21
STD.ERR.(med)	0.3	0.6	0.7	0.3	0.4	0.4

TABLE 11 ANTHROPOMETRIC DATA - MALES AGE 6.000-6.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	106	37	36	133	77	96
HEIGHT (CM.)						
MEAN	116.6	115.0	119.2	118.0	116.8	116.9
STD. ERROR(x̄)	0.6	0.8	0.9	0.4	0.7	1.1
95%CL(x̄) +/-	1.09	1.69	1.77	.86	1.31	1.10
STD. DEV.	5.64	5.05	5.24	5.06	5.78	5.43
95%CL(SD) up	6.50	6.68	6.83	5.74	6.93	6.53
low	4.96	4.15	4.25	4.51	5.02	4.87
HEAD CIRCUMFERENCE (CM.)						
MEAN	50.0	50.2	50.9	51.5	50.4	50.2
STD. ERROR(x̄)	0.1	0.2	0.2	0.1	0.2	0.1
95%CL(x̄) +/-	.26	.44	.46	.27	.36	.25
STD. DEV.	1.33	1.31	1.37	1.57	1.57	1.25
95%CL(SD) up	1.53	1.73	1.79	1.78	1.88	1.50
low	1.17	1.08	1.11	1.40	1.36	1.12
ARM CIRCUMFERENCE (CM.)						
MEAN	17.1	16.6	17.9	17.6	17.2	17.20
STD. ERROR(x̄)	0.2	0.3	0.3	0.1	0.2	0.2
95%CL(x̄) +/-	.34	.59	.63	.25	.42	.37
STD. DEV.	1.77	1.78	1.86	1.50	1.85	1.85
95%CL(SD) up	2.04	2.35	2.42	1.70	2.22	2.23
low	1.56	1.46	1.51	1.34	1.61	1.66
SITTING HEIGHT (CM.)						
MEAN	63.7	63.0	65.2	65.6	63.7	63.9
STD. ERROR(x̄)	0.3	0.4	0.4	0.2	0.3	0.3
95%CL(x̄) +/-	.64	.72	.79	.47	.66	.63
STD. DEV.	3.31	2.17	2.33	2.70	2.90	3.13
95%CL(SD) up	3.82	2.87	3.04	3.03	3.48	3.77
low	2.91	1.79	1.89	2.37	2.52	2.81
TRICEPS SKINFOLD (log transformed units)						
MEAN	182.2	173.2	188.2	175.9	182.4	180.9
STD. ERROR(x̄)	1.4	2.9	3.3	1.3	2.0	1.8
95%CL(x̄) +/-	2.85	5.87	6.73	2.50	3.95	3.51
STD. DEV.	14.80	17.60	19.90	14.70	17.40	17.30
95%CL(SD) up	17.07	23.27	25.94	16.68	20.86	20.81
low	13.01	14.48	16.14	13.10	15.11	15.51
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	166.6	153.7	169.3	156.2	163.0	165.9
STD. ERROR(x̄)	2.1	3.0	4.0	1.3	2.4	2.3
95%CL(x̄) +/-	4.14	6.11	8.02	2.46	4.79	4.62
STD. DEV.	21.50	18.30	23.70	14.50	21.10	22.80
95%CL(SD) up	24.79	24.19	30.89	16.45	25.29	27.43
low	18.90	15.05	19.22	12.92	18.32	20.45
WEIGHT (KG.)						
MEDIAN	20.17	19.24	22.33	21.39	19.96	20.31
STD.ERR.(med)	0.4	0.6	0.8	0.3	0.5	0.5

TABLE 12 ANTHROPOMETRIC DATA - FEMALES AGE 6.000-6.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	150	21	28	152	69	121
HEIGHT (CM.)						
MEAN	115.0	112.7	117.9	117.5	115.8	114.8
STD. ERROR($\bar{x}$)	0.4	1.0	1.1	0.5	0.6	0.5
95%CL($\bar{x}$) +/-	.80	2.13	2.31	.94	1.24	.96
STD. DEV.	5.02	4.68	5.95	5.94	5.17	5.32
95%CL(SD) up	5.65	6.79	8.10	6.68	6.70	6.08
low	4.50	3.58	4.70	5.33	4.67	4.71
HEAD CIRCUMFERENCE (CM.)						
MEAN	49.1	49.2	50.1	50.1	49.5	49.0
STD. ERROR($\bar{x}$)	0.1	0.3	0.3	0.3	0.2	0.1
95%CL($\bar{x}$) +/-	.24	.65	.59	.21	.35	.27
STD. DEV.	1.47	1.43	1.51	1.34	1.47	1.51
95%CL(SD) up	1.66	2.07	2.06	1.51	1.91	1.72
low	1.32	1.09	1.19	1.20	1.33	1.34
ARM CIRCUMFERENCE (CM.)						
MEAN	17.0	16.4	17.9	17.9	17.2	16.9
STD. ERROR($\bar{x}$)	0.1	0.3	0.4	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.27	.65	.80	.26	.38	.33
STD. DEV.	1.69	1.43	2.06	1.66	1.58	1.85
95%CL(SD) up	1.90	2.07	2.80	1.87	2.05	2.11
low	1.52	1.09	1.63	1.49	1.43	1.64
SITTING HEIGHT (CM.)						
MEAN	62.9	61.8	64.4	65.1	63.3	62.9
STD. ERROR($\bar{x}$)	0.2	0.6	0.5	0.3	0.3	0.2
95%CL($\bar{x}$) +/-	.39	1.31	1.03	.49	.59	.47
STD. DEV.	2.42	2.80	2.66	3.01	2.45	2.61
95%CL(SD) up	2.72	4.09	3.62	3.36	3.18	2.98
low	2.17	2.13	2.10	2.67	2.21	2.31
TRICEPS SKINFOLD (log transformed units)						
MEAN	186.7	182.9	193.3	188.7	188.0	187.3
STD. ERROR($\bar{x}$)	1.4	3.0	3.5	1.3	2.0	1.6
95%CL($\bar{x}$) +/-	2.70	6.28	7.17	2.46	4.07	3.11
STD. DEV.	16.80	13.80	18.50	15.40	16.90	17.20
95%CL(SD) up	18.89	20.01	25.18	17.30	21.90	19.61
low	15.04	10.56	14.63	13.79	15.27	15.20
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	171.6	165.1	175.1	169.3	171.9	171.8
STD. ERROR($\bar{x}$)	1.5	3.5	3.8	1.5	3.1	1.8
95%CL($\bar{x}$) +/-	3.00	7.24	7.83	2.88	4.26	3.58
STD. DEV.	18.70	15.90	20.20	18.10	17.70	19.80
95%CL(SD) up	21.02	23.06	27.50	20.36	22.94	22.57
low	16.74	12.16	15.97	16.24	15.99	17.50
WEIGHT (KG.)						
MEDIAN	19.24	17.92	20.71	20.89	19.55	19.20
STD.ERR.(med)	0.3	0.7	1.0	0.3	0.5	0.4

TABLE 13 ANTHROPOMETRIC DATA - MALES AGE 7.000-7.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	87	13	13	158	38	72
HEIGHT (CM.)						
MEAN	121.9	120.5	124.1	124.7	121.2	122.4
STD. ERROR(x̄)	0.6	1.6	2.0	0.4	0.9	0.7
95%CL(x̄) +/-	1.19	3.47	4.32	.85	1.91	1.37
STD. DEV.	5.59	5.75	7.15	5.45	5.81	5.83
95%CL(SD) up	6.86	9.50	11.81	6.11	7.79	7.04
low	5.02	4.12	5.13	4.89	4.85	5.04
HEAD CIRCUMFERENCE (CM.)						
MEAN	50.4	50.9	50.8	50.2	50.6	50.5
STD. ERROR(x̄)	0.5	1.2	1.7	0.3	0.7	0.5
95%CL(x̄) +/-	.90	2.57	3.75	.62	1.43	1.06
STD. DEV.	4.21	4.05	6.21	4.00	4.33	4.49
95%CL(SD) up	5.16	6.87	10.26	4.49	5.80	5.38
low	3.78	2.87	4.45	3.60	3.61	3.85
ARM CIRCUMFERENCE (CM.)						
MEAN	17.4	16.9	18.3	18.3	17.4	17.6
STD. ERROR(x̄)	0.2	0.5	0.7	0.1	0.3	0.2
95%CL(x̄) +/-	.39	1.02	1.55	.28	.63	.49
STD. DEV.	1.83	1.68	2.57	1.81	1.92	2.07
95%CL(SD) up	2.24	2.77	4.24	2.03	2.57	2.50
low	1.64	1.20	1.84	1.63	1.60	1.79
SITTING HEIGHT (CM.)						
MEAN	65.8	64.6	66.0	68.6	65.3	65.9
STD. ERROR(x̄)	0.3	0.8	1.1	0.2	0.5	0.4
95%CL(x̄) +/-	.62	1.65	2.34	.43	1.00	.71
STD. DEV.	2.91	2.60	3.87	2.67	2.99	3.00
95%CL(SD) up	3.55	4.41	6.39	4.48	3.95	3.59
low	2.60	1.84	2.77	3.26	2.46	2.58
TRICEPS SKINFOLD (log transformed units)						
MEAN	180.1	181.9	183.7	176.6	181.2	181.7
STD. ERROR(x̄)	2.0	4.9	6.3	1.3	2.6	2.4
95%CL(x̄) +/-	3.97	10.64	13.78	2.64	5.30	4.82
STD. DEV.	18.60	17.60	22.80	16.90	16.10	20.50
95%CL(SD) up	22.82	29.07	37.65	18.97	21.58	24.74
low	16.70	12.62	16.35	15.20	13.43	17.72
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	163.2	160.2	172.3	157.7	165.1	164.5
STD. ERROR(x̄)	2.3	4.7	8.9	1.4	3.9	2.7
95%CL(x̄) +/-	4.61	10.15	19.40	2.81	7.97	5.43
STD. DEV.	21.60	16.80	32.10	18.00	24.20	23.10
95%CL(SD) up	26.50	27.74	53.01	20.20	32.43	27.87
low	19.40	12.05	23.02	16.18	20.18	19.97
WEIGHT (KG.)						
MEDIAN	22.09	21.19	22.87	24.19	21.905	22.00
STD.ERR.(med)	0.6	1.4	2.2	0.4	0.9	0.7

TABLE 14 ANTHROPOMETRIC DATA - FEMALES AGE 7.000-7.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	104	19	15	150	60	68
HEIGHT (CM.)						
MEAN	120.3	115.9	123.8	122.4	120.3	119.9
STD. ERROR($\bar{x}$)	0.6	1.0	1.4	0.5	0.7	0.8
95%CL($\bar{x}$) +/-	1.12	2.12	3.04	.96	1.34	1.58
STD. DEV.	5.77	4.39	5.49	6.00	5.17	6.51
95%CL(SD) up	6.66	6.49	8.66	6.76	6.98	8.38
low	5.07	3.32	4.02	5.38	4.70	5.84
HEAD CIRCUMFERENCE (CM.)						
MEAN	49.5	49.3	50.6	50.9	49.6	49.5
STD. ERROR($\bar{x}$)	0.1	0.4	0.4	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.26	.77	.92	.21	.36	.34
STD. DEV.	1.34	1.54	1.67	1.29	1.38	1.41
95%CL(SD) up	1.54	2.31	2.63	1.45	1.83	1.80
low	1.17	1.16	1.22	1.16	1.23	1.26
ARM CIRCUMFERENCE (CM.)						
MEAN	17.3	17.1	18.4	18.2	17.4	17.40
STD. ERROR($\bar{x}$)	0.2	0.3	0.6	0.1	0.3	0.3
95%CL($\bar{x}$) +/-	.41	.59	1.29	.27	.53	.52
STD. DEV.	2.10	1.23	2.33	1.68	2.05	2.16
95%CL(SD) up	2.43	1.82	3.67	2.33	2.77	2.78
low	1.84	.93	1.71	1.51	1.86	1.94
SITTING HEIGHT (CM.)						
MEAN	65.1	63.0	66.3	67.3	64.8	65.1
STD. ERROR($\bar{x}$)	0.3	0.4	0.6	0.3	0.3	0.4
95%CL($\bar{x}$) +/-	.53	.77	1.24	.48	.66	.71
STD. DEV.	2.74	1.59	2.24	3.02	2.54	2.91
95%CL(SD) up	3.16	2.35	3.53	3.40	3.43	3.74
low	2.41	1.20	1.64	2.71	2.31	2.61
TRICEPS SKINFOLD (log transformed units)						
MEAN	189.8	185.2	190.5	188.1	187.6	190.8
STD. ERROR($\bar{x}$)	1.9	3.4	5.3	1.2	2.5	2.1
95%CL($\bar{x}$) +/-	3.67	7.13	11.41	2.43	4.93	4.28
STD. DEV.	18.70	14.80	20.60	15.20	18.90	17.50
95%CL(SD) up	21.51	21.89	32.48	17.11	25.30	22.35
low	16.33	11.18	15.08	13.63	17.03	15.58
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	174.5	165.9	180.6	165.3	173.2	175.2
STD. ERROR($\bar{x}$)	2.4	4.1	7.3	1.5	3.4	2.8
95%CL($\bar{x}$) +/-	4.84	8.58	15.56	2.91	6.73	5.68
STD. DEV.	24.90	17.80	28.10	18.20	26.00	23.40
95%CL(SD) up	28.76	26.32	44.31	20.49	35.11	30.10
low	21.86	13.45	20.57	16.32	23.63	20.99
WEIGHT (KG.)						
MEDIAN	20.44	20.49	23.48	23.01	20.735	20.50
STD.ERR.(med)	0.5	0.6	1.4	0.4	0.6	0.6

TABLE 15 ANTHROPOMETRIC DATA - MALES AGE 8.000-8.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	73	8	9	171	36	47
HEIGHT (CM.)						
MEAN	127.4	127.4	129.7	130.4	126.5	128.6
STD. ERROR($\bar{x}$)	0.7	1.6	1.9	0.5	1.0	0.8
95%CL($\bar{x}$) +/-	1.39	3.73	4.47	.92	2.12	1.57
STD. DEV.	5.97	4.46	5.81	6.11	6.26	5.35
95%CL(SD) up	7.25	9.08	11.13	6.83	8.16	6.81
low	5.20	2.95	3.92	5.52	5.08	4.49
HEAD CIRCUMFERENCE (CM.)						
MEAN	50.8	50.9	51.2	52.5	50.6	51.0
STD. ERROR($\bar{x}$)	0.2	0.4	0.3	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.35	.96	.73	.19	.48	.42
STD. DEV.	1.48	1.15	.95	1.25	1.43	1.42
95%CL(SD) up	1.80	2.34	1.82	1.40	1.86	1.81
low	1.29	.76	.64	1.13	1.16	1.19
ARM CIRCUMFERENCE (CM.)						
MEAN	18.3	18.8	18.7	18.8	18.2	18.5
STD. ERROR($\bar{x}$)	0.2	0.7	0.6	0.1	0.4	0.3
95%CL($\bar{x}$) +/-	.46	1.56	1.40	.25	.74	.53
STD. DEV.	1.95	1.86	1.82	1.69	2.18	1.80
95%CL(SD) up	2.37	3.79	3.49	1.89	2.84	2.29
low	1.70	1.23	1.23	1.53	1.77	1.51
SITTING HEIGHT (CM.)						
MEAN	68.1	68.9	70.4	70.6	67.8	68.9
STD. ERROR($\bar{x}$)	0.4	0.8	1.0	0.2	0.6	0.4
95%CL($\bar{x}$) +/-	.74	1.76	2.27	.42	1.15	.83
STD. DEV.	3.19	2.11	2.95	2.80	3.40	2.82
95%CL(SD) up	3.88	4.29	5.65	4.66	4.43	3.59
low	2.78	1.40	1.99	3.44	2.76	2.37
TRICEPS SKINFOLD (log transformed units)						
MEAN	184.8	178.1	183.8	176.8	181.0	188.2
STD. ERROR($\bar{x}$)	2.2	10.5	6.6	1.3	3.6	2.5
95%CL($\bar{x}$) +/-	4.32	24.83	15.14	2.56	7.31	5.08
STD. DEV.	18.50	29.70	19.70	17.10	21.60	17.30
95%CL(SD) up	22.48	60.45	37.74	19.10	28.15	22.02
low	16.11	19.64	13.31	15.44	17.52	14.51
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	166.8	166.9	175.1	158.1	168.2	168.6
STD. ERROR($\bar{x}$)	2.9	9.4	8.0	1.3	4.6	3.4
95%CL($\bar{x}$) +/-	5.69	22.33	18.37	2.59	9.27	6.79
STD. DEV.	24.40	26.70	23.90	17.30	27.40	23.10
95%CL(SD) up	29.65	54.34	45.78	19.33	35.72	29.40
low	21.24	17.65	16.15	15.62	22.22	19.37
WEIGHT (KG.)						
MEDIAN	24.28	25.68	27.14	26.26	24.58	25.55
STD.ERR.(med)	0.7	1.5	1.6	0.4	1.1	0.7

TABLE 16 ANTHROPOMETRIC DATA - FEMALES AGE 8.000-8.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	67	6	9	167	30	48
HEIGHT (CM.)						
MEAN	126.2	128.1	130.3	129.2	126.1	127.1
STD. ERROR($\bar{x}$)	0.9	2.3	1.2	0.6	1.2	0.7
95%CL($\bar{x}$) +/-	1.88	6.01	2.77	1.26	2.36	1.42
STD. DEV.	7.68	5.73	3.61	8.33	6.32	4.89
95%CL(SD) up	9.81	14.06	6.92	9.32	8.50	6.29
low	6.84	3.58	2.44	7.51	5.03	4.15
HEAD CIRCUMFERENCE (CM.)						
MEAN	49.8	49.8	50.6	51.3	49.8	50.0
STD. ERROR($\bar{x}$)	0.2	0.8	0.4	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.30	1.96	.99	.19	.44	.40
STD. DEV.	1.23	1.87	1.29	1.23	1.18	1.39
95%CL(SD) up	1.57	4.59	2.47	1.38	1.59	1.79
low	1.09	1.17	.87	1.11	.94	1.18
ARM CIRCUMFERENCE (CM.)						
MEAN	18.1	18.4	18.8	19.3	18.1	18.4
STD. ERROR($\bar{x}$)	0.3	0.9	0.6	0.2	0.3	0.3
95%CL($\bar{x}$) +/-	.50	2.32	1.48	.31	.60	.66
STD. DEV.	2.05	2.21	1.93	2.02	1.61	2.27
95%CL(SD) up	2.62	5.42	3.70	2.26	2.16	2.92
low	1.82	1.38	1.30	1.82	1.28	1.92
SITTING HEIGHT (CM.)						
MEAN	67.1	68.4	70.1	70.0	67.6	67.5
STD. ERROR($\bar{x}$)	0.4	0.9	0.8	0.2	0.5	0.5
95%CL($\bar{x}$) +/-	.74	2.33	1.78	.46	1.01	.91
STD. DEV.	3.02	2.22	2.32	3.00	2.71	3.12
95%CL(SD) up	3.86	5.45	4.44	3.36	3.64	4.01
low	2.69	1.39	1.57	2.70	2.16	2.64
TRICEPS SKINFOLD (log transformed units)						
MEAN	195.4	196.9	187.5	192.7	192.4	196.9
STD. ERROR($\bar{x}$)	2.3	7.3	8.3	1.4	3.3	2.9
95%CL($\bar{x}$) +/-	4.57	18.79	19.22	2.64	6.83	5.78
STD. DEV.	18.70	17.90	25.00	17.40	18.30	19.90
95%CL(SD) up	23.88	43.93	47.89	19.46	24.60	25.60
low	16.65	11.17	16.89	15.69	14.57	16.87
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	182.3	176.4	175.0	172.1	177.4	184.1
STD. ERROR($\bar{x}$)	3.3	7.8	8.7	1.7	3.6	4.2
95%CL($\bar{x}$) +/-	6.50	20.05	20.14	3.25	7.39	8.43
STD. DEV.	26.60	19.10	26.20	21.40	19.80	29.00
95%CL(SD) up	33.97	46.88	50.19	23.94	26.62	37.31
low	23.68	11.92	17.70	19.30	15.77	24.58
WEIGHT (KG.)						
MEDIAN	23.65	23.27	26.47	26.09	23.87	24.03
STD.ERR.(med)	0.8	2.6	1.7	0.4	0.8	1.1

TABLE 17 ANTHROPOMETRIC DATA - MALES AGE 9.000-9.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	56	2	19	150	36	36
HEIGHT (CM.)						
MEAN	132.5	129.8	136.9	134.3	133.5	133.4
STD. ERROR($\bar{x}$)	0.7		1.3	0.5	1.0	0.9
95%CL($\bar{x}$) +/-	1.45		2.80	1.06	2.00	1.90
STD. DEV.	5.41		5.80	6.62	5.92	5.62
95%CL(SD) up	7.05		8.58	7.45	7.72	7.33
low	4.75		4.38	5.94	4.80	4.56
HEAD CIRCUMFERENCE (CM.)						
MEAN	51.4	50.9	51.8	52.9	51.4	51.6
STD. ERROR($\bar{x}$)	0.2		0.3	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.38		.56	.21	.47	.48
STD. DEV.	1.43		1.16	1.30	1.38	1.41
95%CL(SD) up	1.86		1.72	1.46	1.80	1.84
low	1.26		.88	1.17	1.12	1.14
ARM CIRCUMFERENCE (CM.)						
MEAN	19.1	17.3	20.0	19.6	19.2	19.4
STD. ERROR($\bar{x}$)	0.3		0.8	0.2	0.5	0.4
95%CL($\bar{x}$) +/-	.64		1.76	.36	1.07	.73
STD. DEV.	2.38		3.66	2.25	3.15	2.15
95%CL(SD) up	3.10		5.41	2.53	4.11	2.80
low	2.09		2.77	2.02	2.55	1.74
SITTING HEIGHT (CM.)						
MEAN	70.0	68.7	72.6	72.4	70.4	70.8
STD. ERROR($\bar{x}$)	0.4		0.7	0.2	0.5	0.5
95%CL($\bar{x}$) +/-	.76		1.39	.46	1.06	.98
STD. DEV.	2.85		2.89	2.89	3.13	2.89
95%CL(SD) up	3.72		4.27	3.25	4.08	3.77
low	2.50		2.18	2.59	2.54	2.34
TRICEPS SKINFOLD (log transformed units)						
MEAN	189.5	177.6	190.3	181.5	186.4	193.3
STD. ERROR($\bar{x}$)	3.0		5.2	1.6	3.9	3.3
95%CL($\bar{x}$) +/-	6.08		10.99	3.18	7.95	6.77
STD. DEV.	22.70		22.80	19.90	23.50	20.00
95%CL(SD) up	29.59		33.72	22.41	30.63	26.07
low	19.92		17.23	17.84	19.06	16.22
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	176.2	156.8	174.7	160.5	170.4	179.8
STD. ERROR($\bar{x}$)	3.9		5.6	1.7	4.2	4.7
95%CL($\bar{x}$) +/-	7.77		11.89	3.31	8.66	9.44
STD. DEV.	29.00		23.90	20.60	25.10	27.90
95%CL(SD) up	37.81		35.84	23.16	35.72	36.37
low	25.45		17.93	18.44	21.35	22.63
WEIGHT (KG.)						
MEDIAN	26.21	24.66	30.04	28.81	26.24	28.45
STD.ERR.(med)	0.9		1.7	0.6	1.1	1.1

TABLE 18 ANTHROPOMETRIC DATA - FEMALES AGE 9.000-9.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	76	6	7	152	36	51
HEIGHT (CM.)						
MEAN	131.3	131.3	135.4	134.3	132.7	130.6
STD. ERROR($\bar{x}$)	0.7	2.3	3.2	0.5	1.0	0.8
95%CL($\bar{x}$) +/-	1.30	5.80	7.73	.97	2.07	1.57
STD. DEV.	5.65	5.53	8.36	6.12	6.01	5.58
95%CL(SD) up	6.96	13.57	18.39	6.89	8.55	6.94
low	4.99	3.45	5.39	5.49	5.11	4.67
HEAD CIRCUMFERENCE (CM.)						
MEAN	50.1	50.9	50.4	51.8	50.4	49.9
STD. ERROR($\bar{x}$)	0.2	0.6	0.3	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.31	1.44	.71	.26	.40	.40
STD. DEV.	1.35	1.37	.77	1.60	1.17	1.41
95%CL(SD) up	1.61	3.36	1.70	1.80	1.53	1.75
low	1.16	.86	.50	1.43	.95	1.18
ARM CIRCUMFERENCE (CM.)						
MEAN	18.9	18.6	19.9	20.0	18.9	18.9
STD. ERROR($\bar{x}$)	0.2	0.5	1.3	0.2	0.4	0.3
95%CL($\bar{x}$) +/-	.48	1.32	3.18	.33	.75	.61
STD. DEV.	2.09	1.26	3.44	2.10	2.23	2.18
95%CL(SD) up	2.49	3.09	7.57	2.36	2.91	2.71
low	1.80	.79	2.22	1.88	1.81	1.82
SITTING HEIGHT (CM.)						
MEAN	69.2	69.3	70.80	72.2	69.5	69.2
STD. ERROR($\bar{x}$)	0.3	1.5	1.6	0.3	0.5	0.4
95%CL($\bar{x}$) +/-	.66	3.78	3.93	.51	1.09	.82
STD. DEV.	2.88	3.60	4.25	3.20	3.22	2.92
95%CL(SD) up	3.43	8.84	9.35	3.60	4.20	3.63
low	2.48	2.25	2.74	2.87	2.61	2.44
TRICEPS SKINFOLD (log transformed units)						
MEAN	193.6	190.3	196.6	195.3	194.0	193.1
STD. ERROR($\bar{x}$)	2.3	6.7	7.2	1.6	3.1	2.8
95%CL($\bar{x}$) +/-	4.53	17.32	17.57	3.05	6.33	5.68
STD. DEV.	19.80	16.50	19.00	19.20	18.70	20.20
95%CL(SD) up	23.58	40.50	41.79	21.60	24.37	25.11
low	17.08	10.30	12.24	17.23	15.17	16.90
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	183.7	180.0	196.3	174.7	185.4	183.9
STD. ERROR($\bar{x}$)	3.2	10.3	11.9	1.9	5.0	3.9
95%CL($\bar{x}$) +/-	6.45	26.35	29.23	3.66	10.15	7.76
STD. DEV.	28.20	25.10	31.60	23.00	30.00	27.60
95%CL(SD) up	33.58	61.61	69.51	38.70	39.10	34.31
low	24.32	15.67	20.36	28.05	24.33	23.10
WEIGHT (KG.)						
MEDIAN	25.99	27.75	29.18	28.91	26.41	26.04
STD.ERR.(med)	0.8	2.0	4.2	0.6	1.2	1.0

TABLE 19 ANTHROPOMETRIC DATA - MALES AGE 10.000-10.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	55	3	11	141	27	37
HEIGHT (CM.)						
MEAN	137.7	137.2	142.2	140.3	138.6	137.5
STD. ERROR($\bar{x}$)	0.8		1.7	0.5	1.1	0.9
95%CL($\bar{x}$) +/-	1.60		3.71	1.05	2.34	1.90
STD. DEV.	5.91		5.53	6.35	5.92	5.68
95%CL(SD) up	7.63		9.70	7.18	8.11	7.51
low	5.14		3.86	5.68	4.66	4.67
HEAD CIRCUMFERENCE (CM.)						
MEAN	51.5	52.2	52.1	53.0	51.9	51.4
STD. ERROR($\bar{x}$)	0.2		0.3	0.1	0.2	0.2
95%CL($\bar{x}$) +/-	.38		.76	.23	.49	.49
STD. DEV.	1.42		1.13	1.42	1.24	1.46
95%CL(SD) up	1.83		1.98	1.61	1.70	1.93
low	1.23		.79	1.27	.98	1.20
ARM CIRCUMFERENCE (CM.)						
MEAN	20.0	20.6	21.1	20.3	20.3	19.7
STD. ERROR($\bar{x}$)	0.4		1.0	0.2	0.6	0.4
95%CL($\bar{x}$) +/-	.81		2.15	.33	1.19	.90
STD. DEV.	2.98		3.20	2.02	3.01	2.69
95%CL(SD) up	3.85		5.61	2.28	4.13	3.56
low	2.59		2.24	1.81	2.37	2.21
SITTING HEIGHT (CM.)						
MEAN	71.7	72.8	74.6	74.5	72.0	71.8
STD. ERROR($\bar{x}$)	0.4		0.9	0.3	0.6	0.5
95%CL($\bar{x}$) +/-	.88		2.00	.50	1.33	1.01
STD. DEV.	3.26		2.97	3.01	3.35	3.02
95%CL(SD) up	4.21		5.21	3.40	4.59	3.99
low	2.84		2.08	2.69	2.64	2.48
TRICEPS SKINFOLD (log transformed units)						
MEAN	192.4	200.7	202.2	183.5	195.6	190.9
STD. ERROR($\bar{x}$)	3.1		5.7	1.7	4.2	3.8
95%CL($\bar{x}$) +/-	6.25		12.63	3.40	8.55	7.64
STD. DEV.	23.10		18.80	20.60	21.60	22.90
95%CL(SD) up	29.84		32.98	23.29	29.61	30.27
low	20.09		13.14	18.41	17.01	18.84
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	177.6	184.8	183.7	163.6	175.1	182.2
STD. ERROR($\bar{x}$)	3.8		9.6	1.9	5.3	4.7
95%CL($\bar{x}$) +/-	7.58		21.43	3.75	10.96	9.44
STD. DEV.	28.00		31.90	22.70	27.70	28.30
95%CL(SD) up	36.17		55.96	38.48	37.97	37.41
low	24.35		22.29	27.54	21.82	23.28
WEIGHT (KG.)						
MEDIAN	29.98	34.22	34.19	32.59	31.41	29.37
STD.ERR.(med)	1.2		1.6	0.6	1.5	1.7

TABLE 20 ANTHROPOMETRIC DATA - FEMALES AGE 10.000-10.999 YEARS

	HINDU	MUSLIM	SIKH	EUROP'N	INDIAN	E.A.
NUMBER	46	2	10	164	27	24
HEIGHT (CM.)						
MEAN	135.6	134.8	139.2	140.1	135.4	137.0
STD. ERROR(x̄)	1.2		1.8	0.5	1.6	1.5
95%CL(x̄) +/-	2.34		4.03	.97	3.31	3.12
STD. DEV.	7.88		5.64	6.37	8.37	7.39
95%CL(SD) up	9.92		10.30	7.13	11.47	10.37
low	6.54		3.88	5.74	6.59	5.74
HEAD CIRCUMFERENCE (CM.)						
MEAN	50.4	50.9	51.2	52.1	50.2	50.6
STD. ERROR(x̄)	0.3		0.5	0.1	0.4	0.3
95%CL(x̄) +/-	.60		1.09	.21	.89	.62
STD. DEV.	2.03		1.52	1.37	2.25	1.47
95%CL(SD) up	2.56		2.78	1.53	3.08	2.06
low	1.68		1.05	1.23	1.77	1.14
ARM CIRCUMFERENCE (CM.)						
MEAN	19.6	18.8	18.7	20.6	18.9	20.2
STD. ERROR(x̄)	0.3		0.5	0.2	0.3	0.5
95%CL(x̄) +/-	.67		1.04	.34	.65	1.09
STD. DEV.	2.25		1.45	2.24	1.65	2.58
95%CL(SD) up	2.83		2.65	2.51	2.26	3.62
low	1.87		1.00	2.02	1.30	2.01
SITTING HEIGHT (CM.)						
MEAN	71.4	70.4	73.4	74.2	71.7	71.6
STD. ERROR(x̄)	0.6		1.0	0.3	0.7	0.9
95%CL(x̄) +/-	1.12		2.16	.48	1.39	1.79
STD. DEV.	3.77		3.02	3.14	3.51	4.23
95%CL(SD) up	4.75		5.51	5.25	4.81	5.93
low	3.13		2.08	3.85	2.76	3.29
TRICEPS SKINFOLD (log transformed units)						
MEAN	195.2	199.0	186.7	195.5	191.0	197.3
STD. ERROR(x̄)	2.8		5.3	1.4	3.5	4.2
95%CL(x̄) +/-	5.64		11.95	2.83	7.16	8.62
STD. DEV.	19.00		16.70	18.50	18.10	20.40
95%CL(SD) up	23.92		30.49	20.72	24.81	28.61
low	15.76		11.49	16.67	14.25	15.85
SUBSCAPULAR SKINFOLD (log transformed units)						
MEAN	185.8	179.6	180.2	175.7	182.0	190.6
STD. ERROR(x̄)	3.4		5.4	1.8	3.1	5.8
95%CL(x̄) +/-	6.92		12.30	3.47	6.45	11.99
STD. DEV.	23.30		17.20	22.70	16.30	28.40
95%CL(SD) up	29.33		31.40	25.42	22.34	39.84
low	19.33		11.83	20.45	12.84	22.07
WEIGHT (KG.)						
MEDIAN	28.84	28.60	31.13	32.27	30.29	31.00
STD.ERR.(med)	1.1		1.4	0.6	1.0	1.8

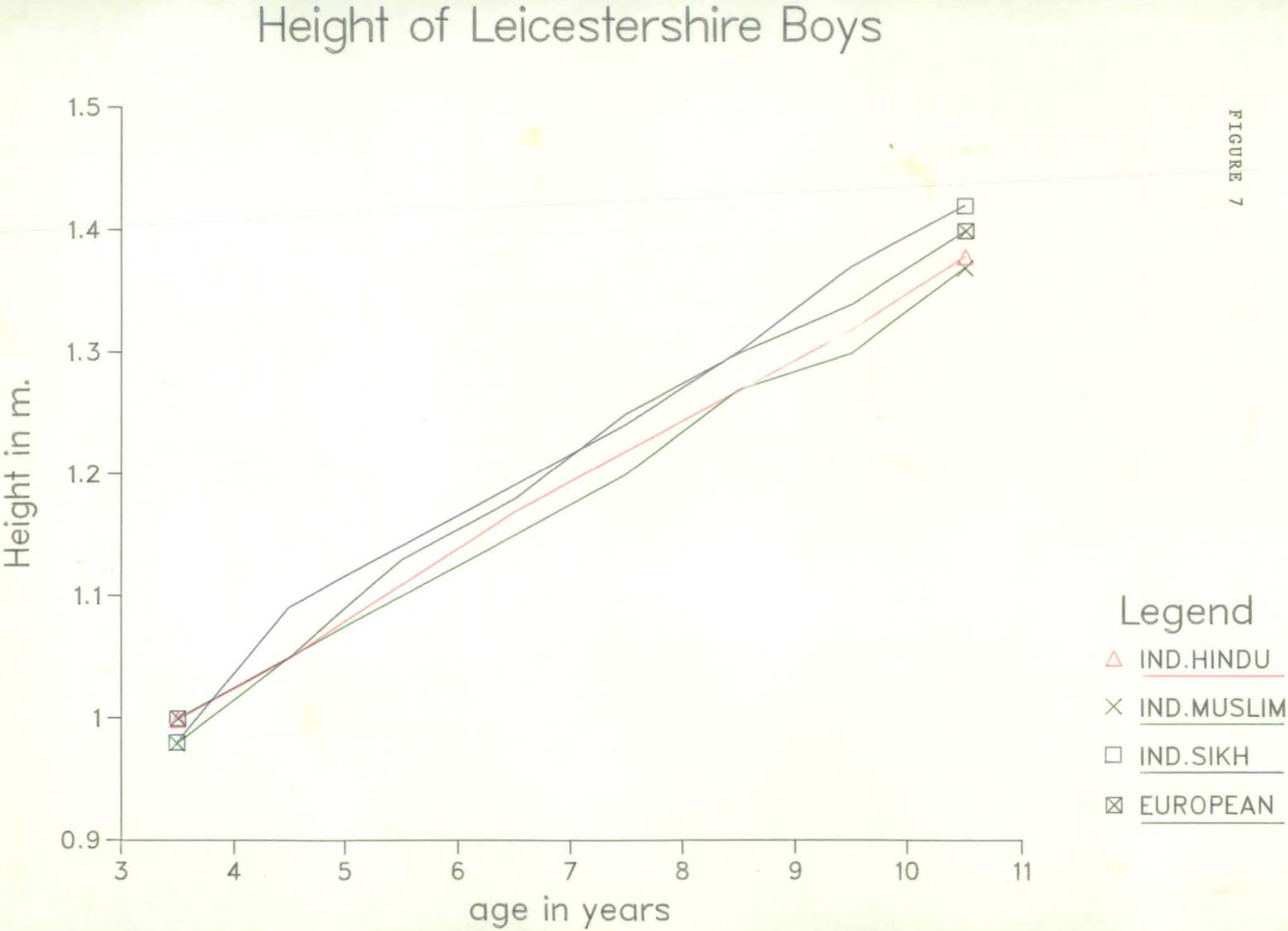
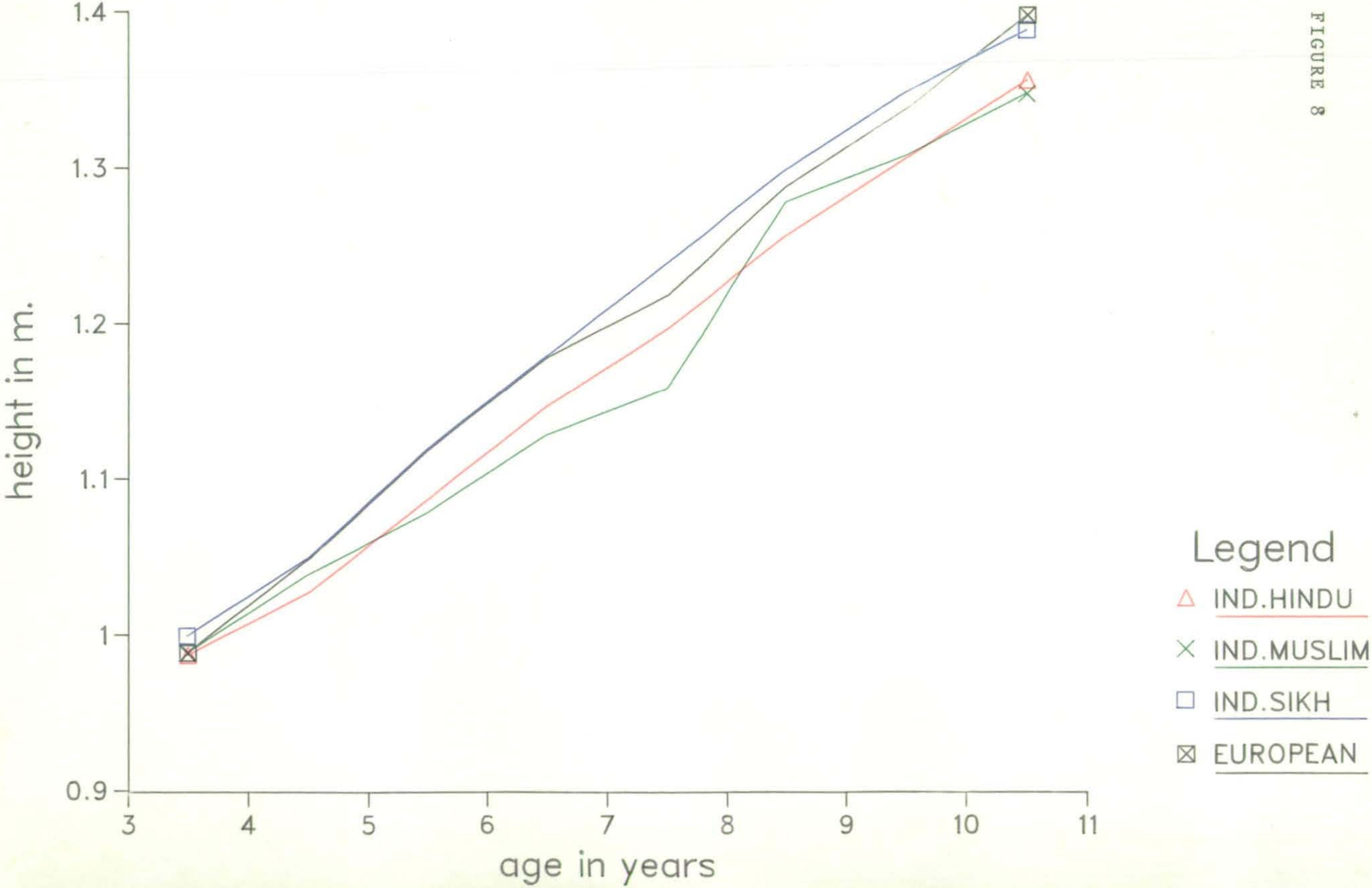

Height of Leicestershire Boys
Height in m.
1.5
1.4
1.3
1.2
1.1
1
0.9
3
4
5
6
7
8
9
10
11
age in years
Legend
IND.HINDU
IND.MUSLIM
IND.SIKH
EUROPEAN

FIGURE 7

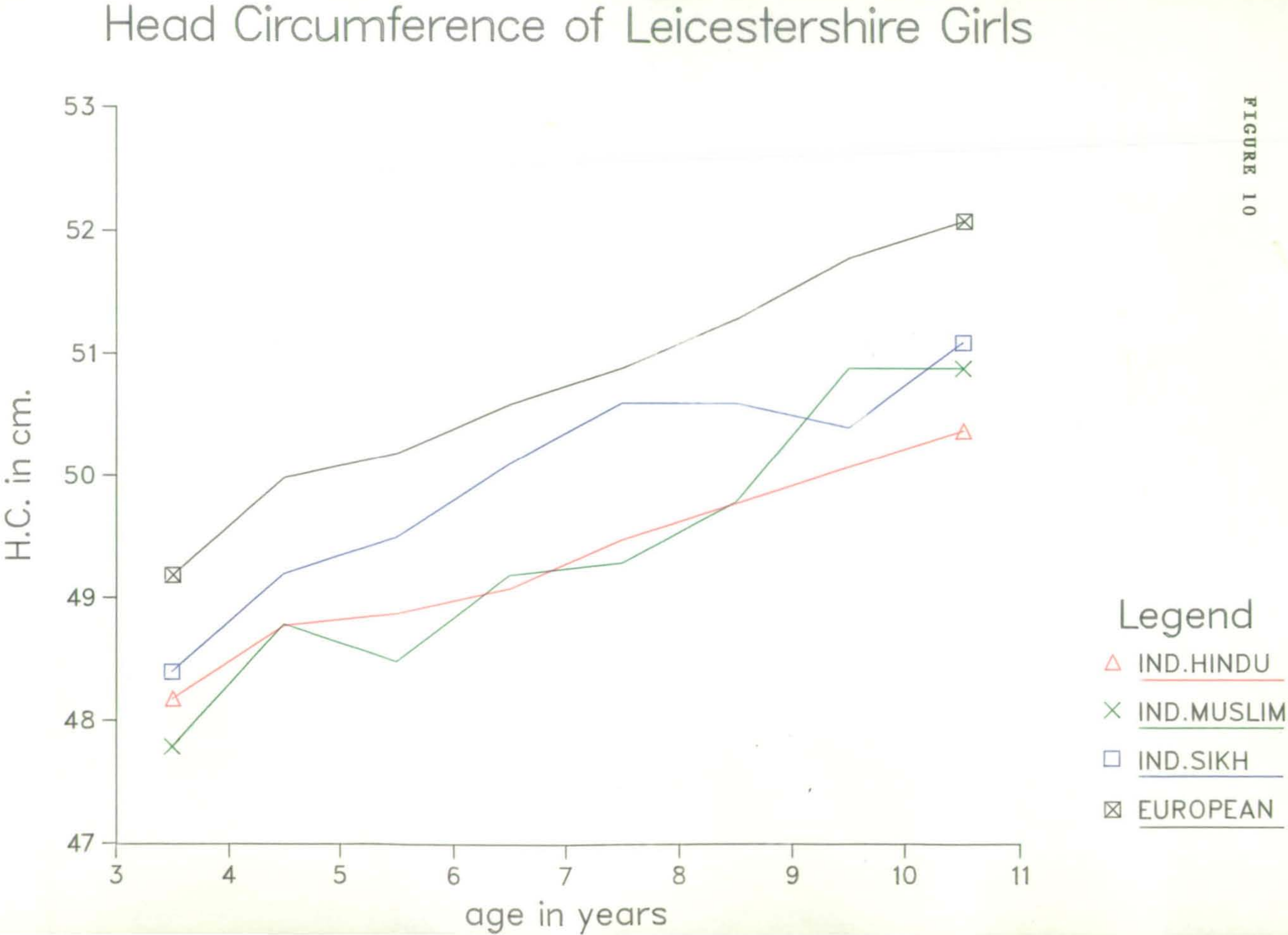
FIGURE 8

Height of Leicestershire Girls




Head Circumference of Leicestershire Boys
H.C. in cm.
53
52
51
50
49
3
4
5
6
7
8
9
10
11
age in years
Legend
IND.HINDU
IND.MUSLIM
IND.SIKH
EUROPEAN

FIGURE 9



Head Circumference of Leicestershire Girls
53
52
51
50
49
48
47
H.C. in cm.
3
4
5
6
7
8
9
10
11
age in years
Legend
IND.HINDU
IND.MUSLIM
IND.SIKH
EUROPEAN

FIGURE 10

Arm Circumference of Leicestershire Boys
A.C. in cm.
22
21
20
19
18
17
16
3
4
5
6
7
8
9
10
11
age in years
Legend
IND.HINDU
IND.SIKH
IND.MUSLIM
EUROPEAN

FIGURE 11

Arm Circumference of Leicestershire Girls

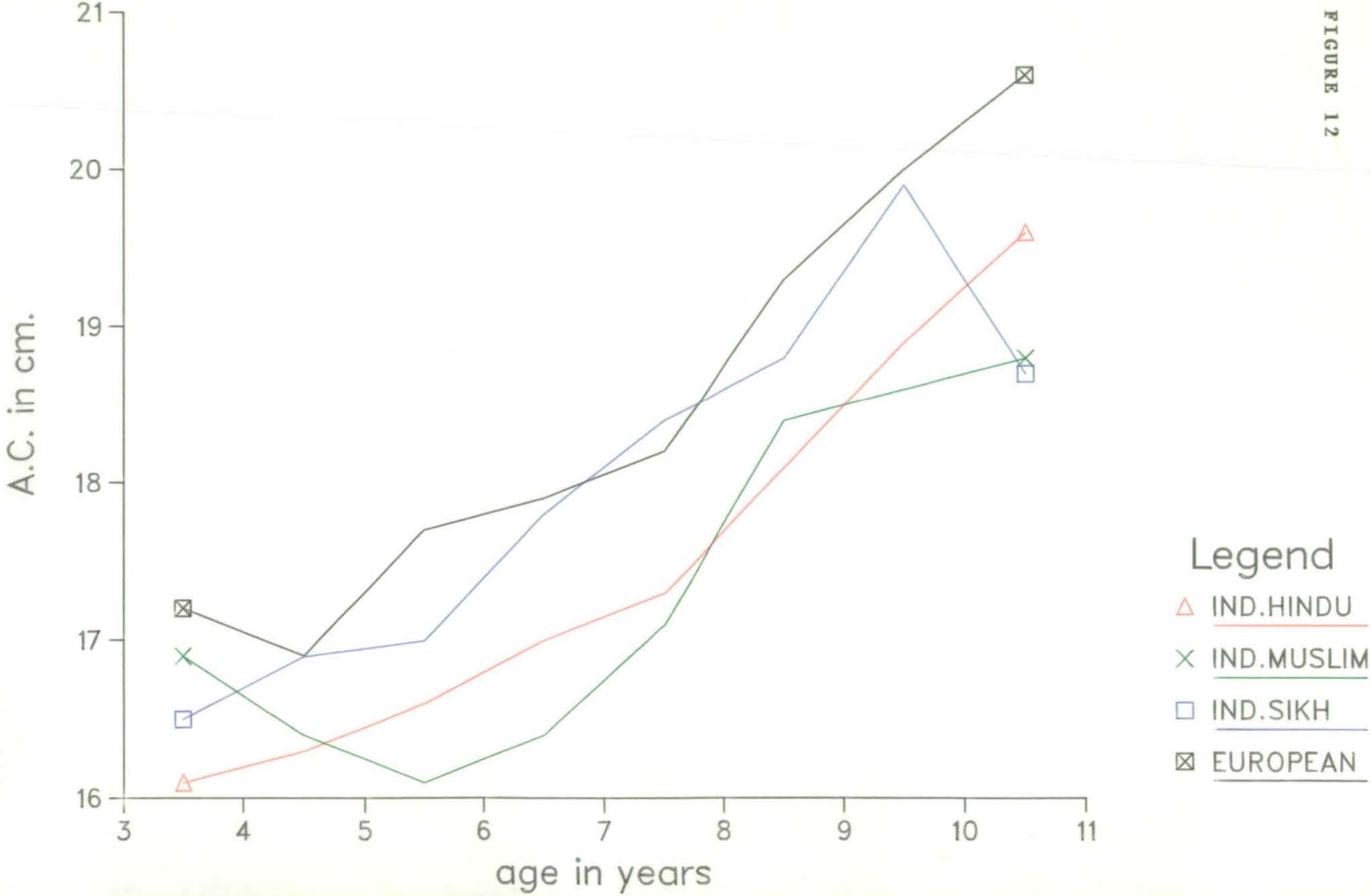


FIGURE 12


Sitting Height of Leicestershire Boys
0.75
0.70
0.65
0.60
0.55
sitting height in m.
3
4
5
6
7
8
9
10
11
age in years
Legend
IND.HINDU
IND.MUSLIM
IND.SIKH
EUROPEAN

FIGURE 13

Sitting Height of Leicestershire Girls

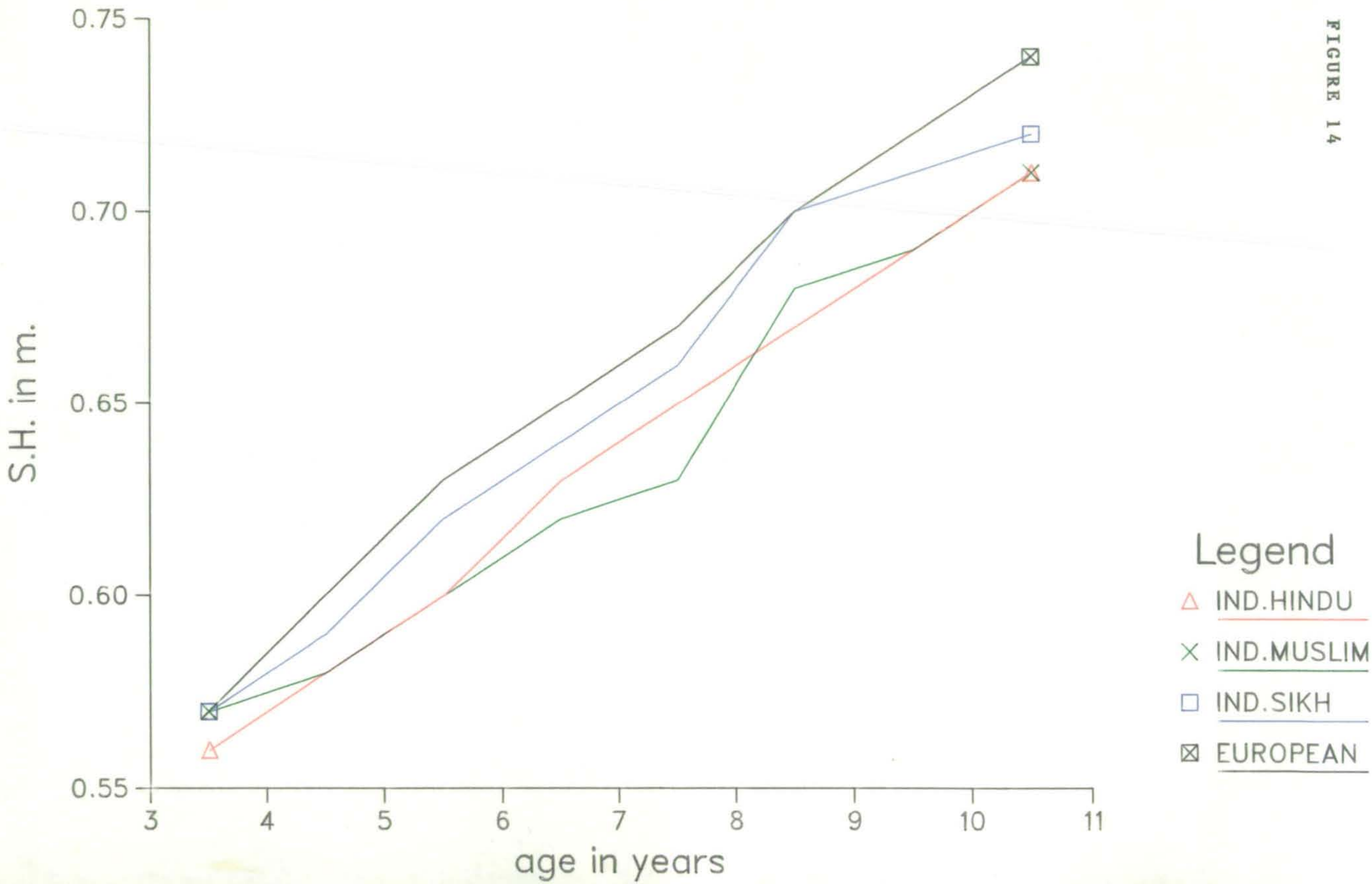


FIGURE 14

Triceps Skinfold Values in Leicestershire Boys

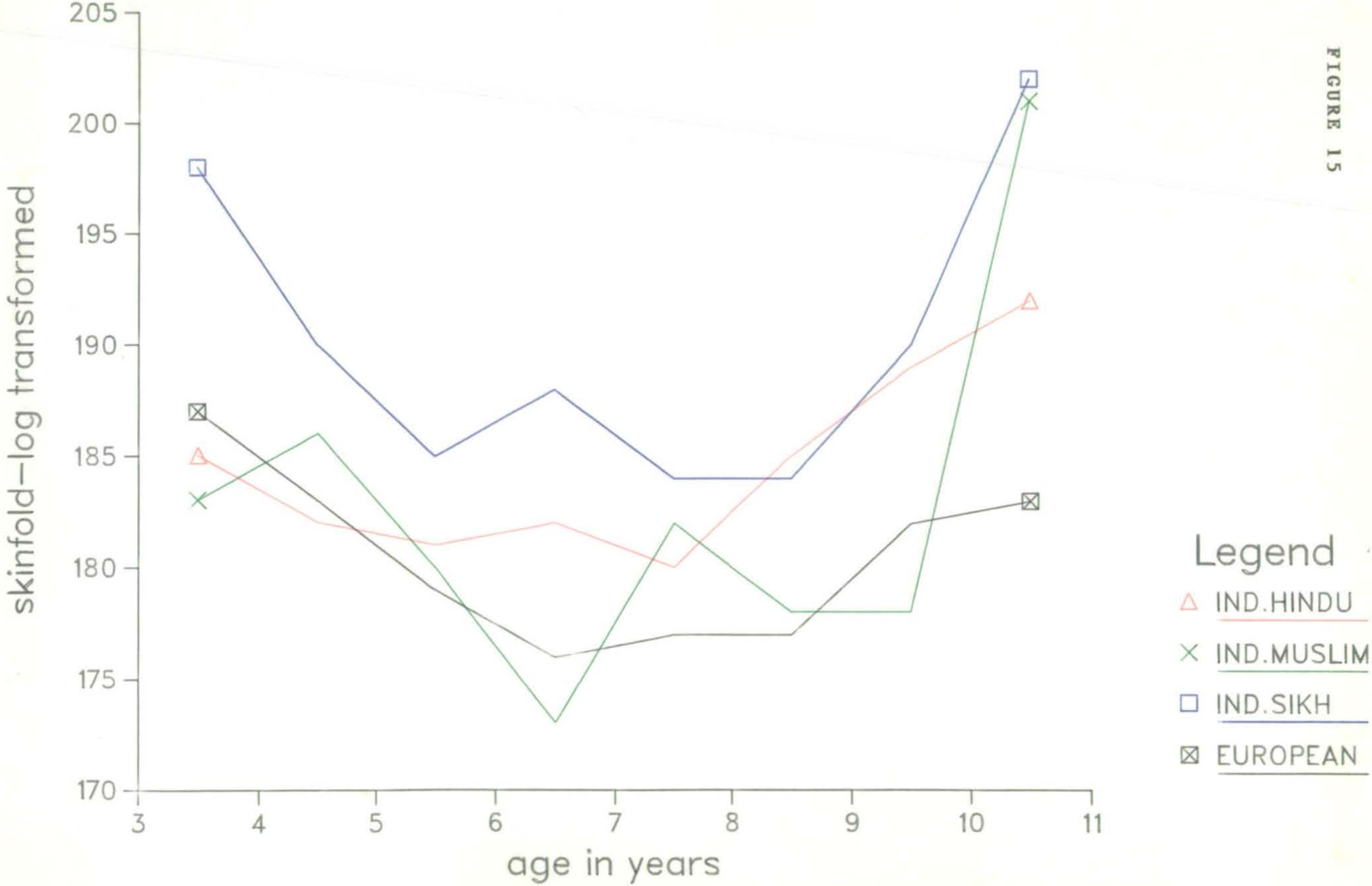


FIGURE 15

Triceps Skinfold Values in Leicestershire Girls

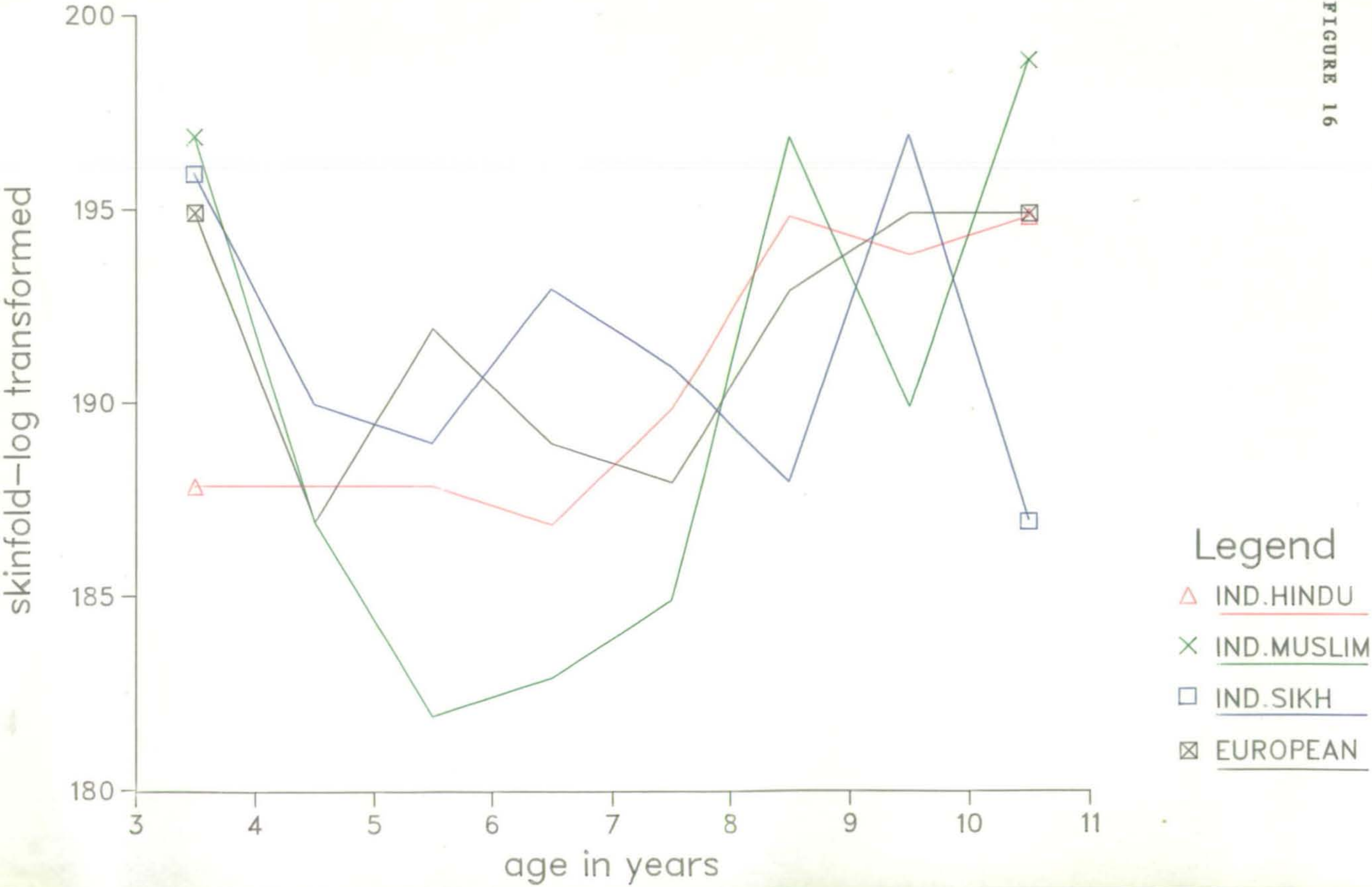


FIGURE 16


Subscapular Skinfold Values in Leicestershire Girls
200
195
190
185
180
175
170
165
skinfold-log trans.
3
4
5
6
7
8
9
10
11
age in years
Legend
IND.HINDU
IND.MUSLIM
IND.SIKH
EUROPEAN

FIGURE 18

Subscapular Skinfold in Leicestershire Boys

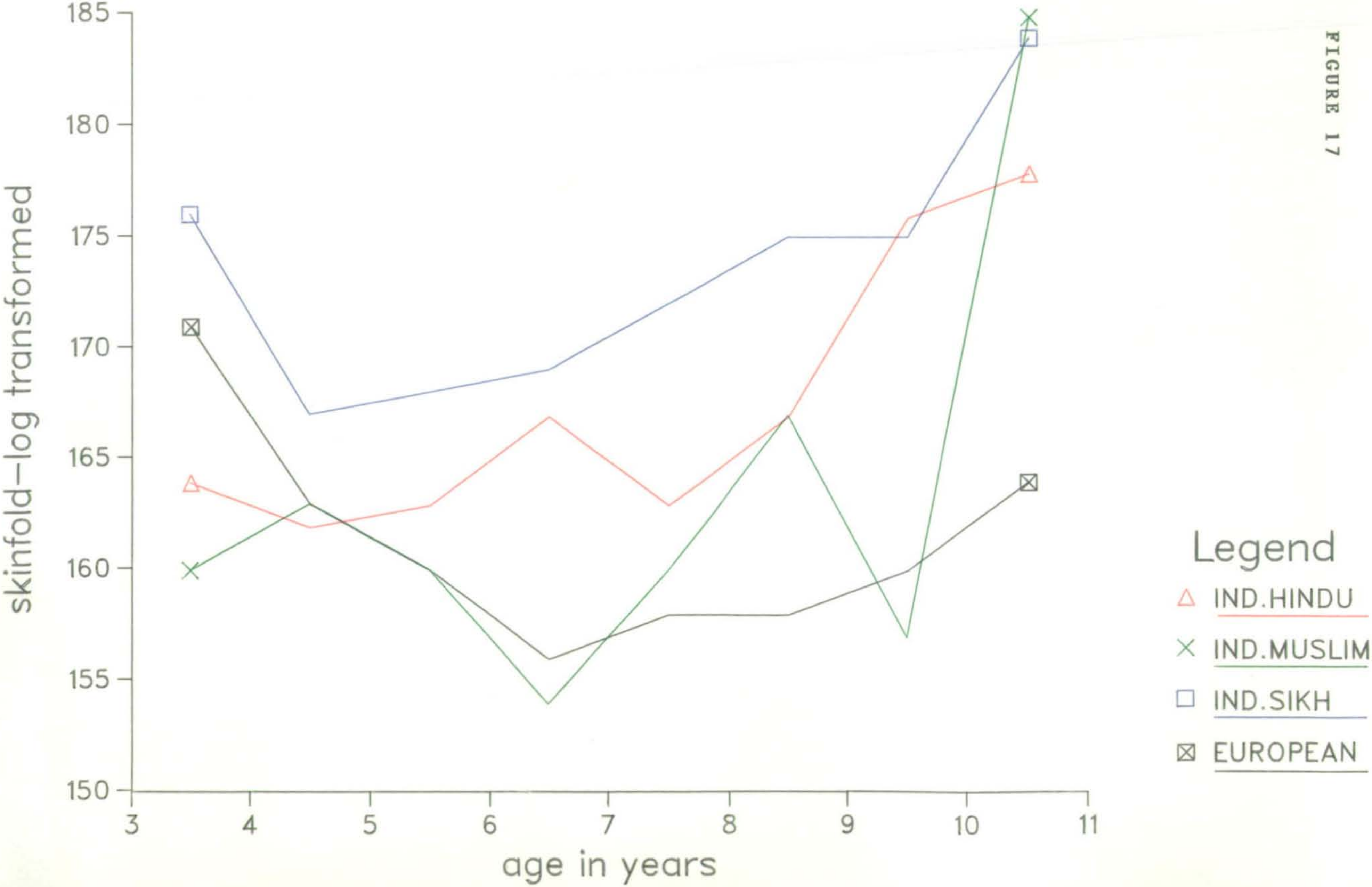


FIGURE 17

Weight of Leicestershire Boys

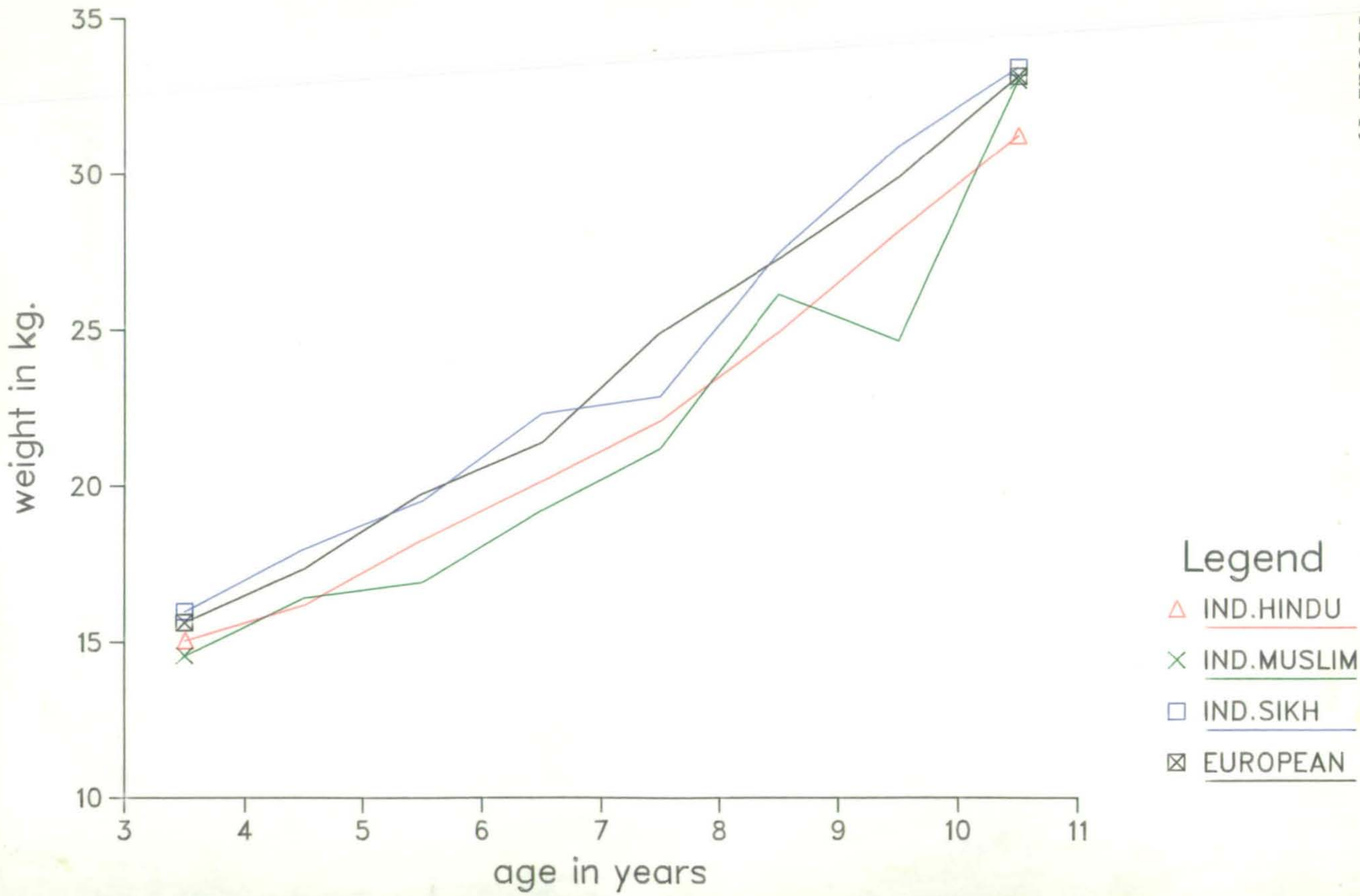


FIGURE 19


Weight of Leicestershire Girls
weight in kg.
35
30
25
20
15
10
3
4
5
6
7
8
9
10
11
age in years
Legend
IND.HINDU
IND.MUSLIM
IND.SIKH
EUROPEAN

FIGURE 20

TABLE 21

COEFFICIENT OF SKEWNESS

PARAMETER	3 YRS.	4 YRS.	5 YRS.	6 YRS.	7 YRS.	8 YRS.	9 YRS.	10 YRS
HEIGHT	*	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.
HEAD C.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*
ARM C.	N.S.	*	*	N.S.	N.S.	N.S.	*	N.S.
SIT.HT.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
TRICEPS	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
SUBSCAP.	N.S.	*	*	*	*	*	*	*
WEIGHT	N.S.	*	N.S.	*	*	N.S.	*	N.S.

COEFFICIENT OF KURTOSIS

PARAMETER	3 YRS.	4 YRS.	5 YRS.	6 YRS.	7 YRS.	8 YRS.	9 YRS.	10 YRS
HEIGHT	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
HEAD C.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	N.S.	N.S.
ARM C.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
SIT.HT.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
TRICEPS	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
SUBSCAP.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
WEIGHT	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

level of significance * < 0.05

TABLE 22

CENSUS DATA RELATING TO THE AREA SAMPLED

		LEICESTER	CHARNWOOD	L'TERSHIRE
% HOUSEHOLDS WITH A NEW COMMONWEALTH OR PAKISTAN HEAD	ACTUAL	21.3	4.2	8.4
	GROWTH STUDY	42.5	13.8	33.5
*% BORN OUTSIDE THE UNITED KINGDOM	ACTUAL	8.9	6.0	8.9
	GROWTH STUDY	28.2	14.6	28.2
% HOUSEHOLDS WITH NO CAR	ACTUAL	51.7	29.9	35.4
	GROWTH STUDY	43.2	32.8	38.3
% HOUSEHOLDS WITH MORE THAN ONE PERSON PER ROOM	ACTUAL	6.3	2.4	6.3
	GROWTH STUDY	12.0	4.2	12.0

TABLE 23

DISTRIBUTION OF INDIAN CHILDREN BY RELIGION AND ALL CHILDREN BY COUNTRY OF ORIGIN
(to the nearest whole percentage)

SCHOOL		H	M	S	E	REST	I	E/A
ABBEY	ACTUAL	90%	4%	4%	2%	1%	+	+
PRIMARY 7	G/STDY	84%	3%	5%	5%	3%	38%	48%
BELGRAVE	ACTUAL		4%		96%	-	+	+
C.of E.P. 5	G/STDY	2%	1%	2%	96%	-	-	3%
BLABY	ACTUAL		2%		98%	-	+	+
STOKES P. 4	G/STDY	<1%	<1%	-	98%	1%	-	<1%
CATHARINE	ACTUAL		85%		13%	2%	+	+
INFANT 13	G/STDY	69%	6%	11%	12%	3%	30%	50%
CATHARINE	ACTUAL	74%	8%		18%		20%	62%
JUNIOR 12	G/STDY	55%	5%	17%	16%	8%	29%	40%
EVINGTON	ACTUAL		99%		1%	-	+	+
VALLEY I.17	G/STDY	55%	4%	31%	5%	5%	43%	47%
GLENFIELD	ACTUAL		1%		99%	-	+	+
PRIMARY 2	G/STDY	1%	-	-	96%	3%	<1%	<1%
GLENHILLS	ACTUAL		1%		99%		+	+
PRIMARY 3	G/STDY	-	-	-	94%	6%	-	-
GREENLANE	ACTUAL	60%	-	35%	5%		+	+
INFANT 14	G/STDY	47%	19%	23%	8%	3%	42%	43%
HERRICK	ACTUAL	71%	1%	8%	20%		+	+
I.& J.8 & 9	G/STDY	49%	6%	11%	32%	3%	12%	51%
HIGHFIELDS	ACTUAL	+	+	+	+	+	+	+
INFANT 15	G/STDY	36%	14%	5%	12%	34%	14%	38%
LATIMER	ACTUAL		1%		97%	2%	+	+
PRIMARY 1	G/STDY	1%	-	-	98%	2%	1%	-
MELLOR	ACTUAL	60%	4%	7%	30%		1%	69%
PRIMARY 6	G/STDY	53%	6%	9%	26%	6%	30%	34%
SHAFTESBURY	ACTUAL		36%		57%	6%	+	+
JUNIOR 18	G/STDY	16%	3%	16%	54%	11%	12%	17%
ST.PATRICKS	ACTUAL		1%		99%		+	+
R.C.P. 11	G/STDY	5%	-	-	84%	11%	-	5%
UPLANDS	ACTUAL	18%	65%	2%	3%	2%	+	+
INFANT 16	G/STDY	35%	41%	3%	4%	17%	38%	40%
WYVERN	ACTUAL	29%	5%	9%	52%	4%	+	+
INFANT 10	G/STDY	35%	5%	7%	49%	3%	12%	32%
COBDEN	ACTUAL	28%	40%	-	28%	4%	+	+
INFANT	G/STDY	39%	4%	1%	35%	20%	14%	11%
COBDEN	ACTUAL	28%	40%	-	28%	4%	+	+
JUNIOR	G/STDY	27%	1%	-	28%	44%	16%	11%
MOUNTFIELDS	ACTUAL		2%		28%	4%	+	+
JUNIOR	G/STDY	-	-	-	94%	6%	-	-
RENDEL L	ACTUAL	38%	20%	>1%	40%		+	+
PRIMARY	G/STDY	37%	2%	2%	46%	13%	17%	21%
ROSEBERY	ACTUAL	18%	>1%	-	82%		3%	15%
JUNIOR	G/STDY	14%	3%	-	78%	6%	5%	12%
SHELTHORPE	ACTUAL		3%		97%		-	-
PRIMARY	G/STDY	2%	-	-	98%	-	2%	-

Origin of children: E = Europe, I = India (direct), E/A = East Africa (of Indian origin)
Religion of Indian subcontinent child: H = Hindu, M =Muslim, S = Sikh
Number of school indicates its catchment area in Figure 2. (+) = data unknown

5.1 European Children Compared with the Reference Standards

It was considered opportune to evaluate the growth of the indigenous European child population of Leicestershire by comparison with the National Growth Standards currently in use:- for height and weight (Tanner et al 1966a,b: Tanner and Whitehouse 1976); for triceps and subscapular skinfolds (Tanner and Whitehouse 1975); for arm circumference (Eveleth and Tanner 1976); for head circumference and sitting height (Tanner 1978). Chi square analysis was carried out, (Siegal 1956) on:-

(a) the numbers of subjects who had values on or below and above the 50th centile, of the reference data, for each anthropometric parameter, compared with the numbers expected in the 2 groups. This gave some indication of the distribution about the central measurement, i.e. the mean or median,

(b) the numbers of subjects who had values on or below the 10th centile, between the 10th+ and 90th centile and above the 90th centile, for each anthropometric parameter, compared with the numbers expected in each of the 3 groups. This gave some indication of the overall distribution of the population.

The results of this analysis for case (a) showing the X^2 value obtained, the level of significance, (where significant differences occured between the numbers expected and the actual numbers obtained), for each growth parameter, for all ages combined and for the individual age bands, are given in Table 24. Similarly the results for (b) excluding arm circumference, are given in Table 25. The 10th and 90th centiles were selected for comparison rather than the 3rd and 97th because the small number of subjects in some age bands made the occurrence of cases in the outer centile bands very low or even non-existent on some occasions. Also, in some instances, age bands have been combined to produce sufficient numbers in each cell for a valid chi square analysis. These age bands are indicated with a hyphen in the text, e.g. 3-5 years, 6-7 years. In both tables, where significantly different results occur, the percentage of subjects occurring within each centile band has been calculated and included in the relevant table.

a) <u>height,</u>

over the total age range studied, 3 to 10 years, there is an indication from the chi square analysis, that the Leicestershire (1986) population has significantly more taller children than the reference data used. The distribution is similar in both sexes, i.e. 8% of males and 7% of females on or below the 10th centile, and in both sexes, 44% below the 50th centile and 14% on or above the 90th centile.

The statistically significant differences between the Leicestershire (1986) childrens' 50th centile for height and the reference 50th centile, when comparing the individual age bands, occur in two age bands in each sex (for boys, $p<0.05$ for 8 year olds and $p<0.01$ for 5 year olds: for girls, $p<0.01$ for 5 and 8 year olds).

There are also some differences in the distribution of children at the outer centiles, the 10th and 90th. There is a greater preponderance of tall girls ($p<0.01$ in the 5 and 6 year old age bands, $p<0.05$ for 3-4 year olds) but only in the 8 year old boys are there more significantly taller children ($p<0.001$). The 5 and 8 year old girls sample also contained significantly less shorter children ($p<0.05$ for the 5 year olds and $p<0.01$ for the 8 year olds). Thus the results indicate a slight trend towards increased height compared with the reference values.

By converting the heights to Z scores, using the reference means and standard deviations, and comparing with Tanner et al's data (1966a,b) for height, the Leicestershire European indigenous population gave positive values for both males and females for all age groups between 3 and 10 years of age, inclusive, a similar trend to that of the Southern children measured by Rona and Altman (1977) rather than the Northern. The average Z score for males was + 0.2385 and for females - + 0.2238, with the highest mean Z scores occurring in the 8 year old males and the 5 year old females, and the lowest in the 9 year males and the 7 year females. There also appeared to be no distinct pattern between Z score value and age. Such differences between the Leicestershire European children and the standards represents a 1.0 - 1.5 cm. increase in height approximately.

A comparison between the Leicestershire indigenous European population's height and the data reported by Rona and Altman (1977) was made using chi square analysis and numbers of values within the following centile bands:- below the 10th centile, between the 10th and the 50th centile, between the 51st and the 90th centile, above the 90th centile. The following results were obtained:-

for boys;-

$X^2 = 12.97$ (d.f. = 3), significant at $p<0.005$ level, ($p_{0.005} < 12.8$),

for girls;-

$X^2 = 44.09$ (d.f. = 3), significant at $p<0.001$ level, ($p_{0.001} < 16.3$),

and the calculated percentage (to the nearest whole number) of Leicestershire European children in the 4 centile bands was as follows:-

	≥10th	11th - 50th	51st - 90th	<90th
boys	7%	38%	43%	12%
girls	7%	34%	44%	15%

thus indicating that for both sexes, the Leicestershire population contains more taller children and less shorter children than the data reported by Rona and Altman (1977).

b) <u>head circumference,</u>

the results for this parameter are mixed. The Leicestershire boys match the reference 50th centile, although the outer centile distribution is different, i.e. there are 13% below the 10th and 8% above the 90th centile. For specific age bands, differences occur in the 4 and 9 year olds $p<0.05$, and 6 year olds $p<0.01$) for the 50th centile and 3-5 years ($p<0.001$) and 6 years ($p<0.05$) in the outer centiles.

But the girls differ from the reference standards at all ages except the 3 year olds, with $p<0.05$, for 9 and 10 year olds, $p<0.01$ for 4 year olds and $p<0.001$ for 5,6,7 and 8 year olds compared with the 50th centile references. In all cases there were more girls with smaller head circumferences, i.e. 59-75% of the girls had head circumferences below the 50th. centile. A similar pattern is seen at the outer centiles for the girls, with smaller numbers than expected above the 90th, ($p<0.05$ for 5 year and 10 year olds, $p<0.001$ for 7-8 year olds). In association with this, there are greater numbers than expected below the 10th centile in several age bands ($p<0.01$ for 10 year olds, $p<0.001$ for 3-4, 7-8 and 9 year olds).

c) <u>arm circumference,</u>

for this parameter the current population of European children measured in Leicestershire do not differ much from the reference data 50th centile. For the overall population, the boys contained more children with larger arm circumferences than the 50th centile reference value (X^2 = 5.88, significant at $p<0.05$), but the overall girls population produced no significant differences from the standards. In the individual age bands difference occured in 3 age groups, ($p<0.01$ for the 6 year old boys, and $p<0.05$ for the 3 and 5 year old girls), and in all 3 cases, there were more children than expected with larger arm circumferences, than the 50th centile value of the reference data.

d) <u>sitting height,</u>

the boys' sitting heights were in close agreement with those of the standards, although the girls overall had more children with lower values than the 50th centile. In the separate age bands, there were a few discrepancies with the standards for distribution about the 50th centile, $p<0.05$ for 5, 6 and 9 year old boys and 7 year old girls, $p<0.01$ for 10 year old girls).

A similar agreement is seen at the outer centiles, although in this case the girls population matches the distribution of the standards, whilst the boys has a greater spread, i.e. there are 12% of the boys population below the 10th centile and 14% on or above the 90th centile. For the separate age bands, a few differences from the references occur, i.e. below the 10th centile ($p<0.05$ for the 7 year old girls) and above the 90th centile ($p<0.05$ for 10 year old boys and 8 and 10 year old girls), with less than expected above the 90th and more than expected below the 10th, in each case. There is one exception to this pattern, the 3 year children who had greater numbers than expected above the 90th centile ($p<0.001$ in the boys and $p<0.01$ in the girls).

e) skinfolds,

there appear to have been some changes in the amount of subcutaneous fat in children now compared with the reference standards and in the distribution. For both sexes, there were significantly more children with values lower than the standard 50th centile value for the triceps site and significantly less children than expected with values on or below the 50th centile for the subscapular site. At the outer centiles, for the triceps site, the girls distribution was comparable to that of the standards whilst the boys differed slightly in that there were less on or above the 90th centile. For the subscapular skinfold, both girls and boys had similar differences to the standard values, in that there were less than expected below the 10th centile, 3% of boys and 4% of girls (the computed chi square value being significant at the $p<0.001$ level in each case).

In the individual age bands, of the indigenous white population of Leicestershire sampled, there were more boys than expected with lower triceps skinfold values than the 50th centile reference data in 5 age bands, ($p<0.05$ for 7 and 10 year olds, $p<0.01$ for 5 and 6 year olds and $p<0.001$ for 8 year olds) but more with higher subscapular skinfold values in 4 age bands ($p<0.05$ for 3 and 6 year olds and $p<0.01$ for 4 and 5 year olds). For the girls, there are less age bands with significant differences in distribution between the standards and the current white Leicestershire population ($p<0.05$ for the 10 year old subscapular skinfold, $p<0.01$ for 10 year old triceps skinfold and $p<0.001$ for 4 year old triceps and 5 and 6 year old subscapular).

In this study, there were no differences at the outer centiles for the triceps skinfold values in the individual age bands studied, except the 6 year old males, $p<0.05$ for numbers above the 90th. For the subscapular skinfold values, where differences occur, the numbers on or below the 10th centile for both males and females are lower than expected when compared with the Tanner and Whitehouse standards, ($p<0.05$ for 8 year old girls, $p<0.01$ for 9 year old boys, $p<0.001$ for 3-6 year old boys, 3-5 year old girls and 7-8 year old boys) but the 90th centile results are approximately similar (differences occur in the girls only, $p<0.01$ for 10 year olds and $p<0.001$ in 3-5 year olds).

Overall, the triceps skinfold value appears to be smaller in the current Leicestershire indigenous population, whilst the subscapular appears larger, although the distribution of the subscapular values was still slightly skew even after using the recommended transformation of Edwards et al (1955).

f) weight,

there are no significant differences in the distribution between the children now and Tanner et al's 50th centile for weight for either sex, for the total population or for the individual age bands, with the exception of seven year old girls, where differences in the 2 distributions are significant at $p<0.05$ only.

But for the outer centiles, the boys distribution contains fewer light boys and more heavier ones than expected, compared with the reference data. In the individual age bands, there are also less light boys and more heavier ones in 4 of the age bands ($p<0.05$ for 5 and 8 year olds, $p<0.01$ for 7 year olds below the 10th centile and $p<0.05$ for 8 and 9 year olds above the 90th centile). There are greater numbers of light girls than expected in two of the age bands ($p<0.01$ for 4 year olds and $p<0.001$ for 7 year olds below the 10th centile).

TABLE 24

EUROPEAN DATA COMPARED WITH REFERENCE STANDARDS(+) 50TH CENTILE
(CHI SQUARE ANALYSIS)

MALES

AGE (YRS.)	HEIGHT	HEAD CIRCUM.	ARM CIRCUM.	SITTING HT.	TRICEPS	SUBSCAPULAR	WEIGHT
3+ - 10+	14.17*** 44%		5.88* 46%		44.29*** 60%	9.67** 45%	
3+						5.49* 32%	
4+		6.05* 64%				9.80** 33%	
5+	9.03** 38%			4.90* 41%	8.10** 61%	7.23** 39%	
6+		7.23** 62%	10.29** 36%	4.70* 59%	10.29** 64%	4.70* 41%	
7+					6.48* 60%		
8+	6.37* 40%				12.92*** 64%		
9+		3.84* 42%		6.00* 60%			
10+					5.96* 60%		

FEMALES

AGE (YRS.)	HEIGHT	HEAD CIRCUM.	ARM CIRCUM.	SITTING HT.	TRICEPS	SUBSCAPULAR	WEIGHT
3+ - 10+	14.59*** 44%	127.3*** 68%		9.66** 55%	11.24*** 55%	16.57*** 44%	
3+			8.76* 24%				
4+		10.32** 68%			19.00*** 75%		
5+	7.14** 38%	30.51*** 75%	6.22* 39%			21.46*** 29%	
6+		30.42*** 72%				12.74*** 36%	
7+		36.51*** 75%		5.23* 59%			4.51* 59%
8+	10.07** 38%	29.48*** 71%					
9+		4.83* 59%					
10+		5.90* 60%		7.05** 60%	7.90** 61%	4.12* 58%	

level of significance
- * $p < 0.05$, chi square > 3.84, for df = 1
- ** $p < 0.01$, chi square > 6.64, for df = 1
- *** $p < 0.001$, chi square > 10.83, for df = 1

numbers = computed chi square values

(%) - percentage on or below the 50th centile reference value

(+) Tanner et al (1966, 1975, 1976, 1978)

TABLE 25

EUROPEAN DATA COMPARED WITH REFERENCE STANDARDS(+) 10TH AND 90TH CENTILES (CHI SQUARE ANALYSIS)

MALES

AGE (YRS.)	%TILE	HEIGHT	HEAD CIRC.	SITTING HT.	TRICEPS	SUBSCAP.	WEIGHT
3+ - 10+	<10th	18.80*** 8%	15.83*** 13%	18.72*** 12%	7.34** 10%	65.07*** 3%	20.48*** 7%
	>90th	14%	8%	14%	8%	10%	13%
3+	<10th		14.17*** 21%			33.45*** 2%	
	>90th		14.43*** 4%	16.91*** 29%			
4+	<10th		c			c	
	>90th		c				
5+	<10th		c			c	4.44* 5%
	>90th		c				
6+	<10th		4.95* 16%			c	
	>90th		5.75* 4%		4.44* 5%		
7+	<10th					24.21*** 2%	8.18** 3%
	>90th						
8+	<10th					c	5.29* 5%
	>90th	15.71*** 19%					4.18* 15%
9+	<10th					8.12** 3%	
	>90th						4.74* 15%
10+	<10th						
	>90th			4.23* 5%			

FEMALES

AGE (YRS.)	%TILE	HEIGHT	HEAD CIRC.	SITTING HT.	TRICEPS	SUBSCAP.	WEIGHT
3+ - 10+	<10th	27.01*** 7%	151.9*** 22%			43.04*** 4%	
	>90th	14%	5%			9%	
3+	<10th		29.80*** 26%			18.52*** 2%	
	>90th	5.98* 18%		10.38** 19%		5.60*** 15%	
4+	<10th		c			c	7.64** 20%
	>90th	c				c	
5+	<10th	4.84* 6%				c	
	>90th	7.02** 17%	5.62* 4%			c	
6+	<10th					8.25** 3%	
	>90th	8.52** 17%					
7+	<10th		34.33*** 20%	6.39* 15%			14.00*** 19%
	>90th		18.06*** 3%				
8+	<10th	7.60** 4%	c			6.25* 4%	
	>90th		c	6.25* 5%			
9	<10th		58.21*** 28%				
	>90th						
10+	<10th		15.22** 16%				
	>90th		4.78* 5%	6.08* 4%		7.32** 4%	

level of significance * $p < 0.05$, chi square $>$ 3.84, for df = 1: $>$ 5.99, for df = 2
** $p < 0.01$, chi square $>$ 6.64, for df = 1: $>$ 9.21, for df = 2
*** $p < 0.001$, chi square $>$ 10.83, for df = 1: $>$ 13.82, for df = 2

numbers = computed chi square values

(%) - percentage on or below the 10th centile value or above the 90th centile value

(+) Tanner et al (1966, 1975, 1978)

c = this cell has been combined with the one above containing a value

5.2 A Comparison of the Leicestershire Indian and European Children

One of the initial considerations was to determine whether there were any statistically significant differences in certain anthropometric parameters, chosen as representative indicators of overall growth in children, between the Indian children from the Indian subcontinent living in Leicestershire and the European children residing here. An overall evaluation of differences/similarities in the anthropometric values in the 2 total population samples was made using two tailed t tests on z scores (to eliminate the influence of unequal numbers in each age band, and the predominance of European children in the older age bands), using the mean and standard deviation calculated for each age band in the pooled population. The results of the t tests on the z score values, for males and females combined were as follows;- (all mean differences are quoted in SD units),

height:-

t = 10.67, sig. at 0.000, mean diff. = 0.34 units

head circumference:-

t = 29.23, sig. at 0.000, mean diff. = 0.90 units

arm circumference:-

t = 11.55, sig. at 0.000, mean diff. = 0.37 units

sitting height:-

t = 21.64, sig. at 0.000, mean diff. = 0.66 units

triceps skinfold:-

t = -2.85, sig. at 0.0045, mean diff. =- 0.09 units

subscapular skinfold:-

t = -8.13, sig. at 0.000, mean diff. =- 0.26 units

weight:-

t = 14.02, sig. at 0.000, mean diff. = 0.44 units

Thus, it can be seen that there are statistically significant differences between the European and Indian children resident in Leicestershire, for all the anthropometric parameters studied, with the European mean data being greater in value in each case, except for the skinfolds, where the Indian children have the higher values.

For a comparison of distributions of each anthropometric parameter between the 2 sample populations, variance ratio analysis was carried out on the standard deviations (S.D.) of the z scores, calculated for each parameter, for the European children and for the Indian children. The results of this, are as follows:-

Parameter	European		Indian		F
	n	S.D.	n	S.D.	
Height	1974	0.989	1748	0.976	1.10
Head circum.	2009	0.890	1784	0.913	1.19
Arm circum.	2047	0.926	1836	1.030	1.38
Sitting ht.	2033	0.940	1834	0.946	1.12
Triceps s'fold	2047	0.945	1832	1.050	1.38
Subscapular	2047	0.894	1834	1.080	1.63
Weight	2046	0.936	1835	1.010	1.30

where;-

$F_{0.05}$ (df infinity, infinity) < 1, $F_{0.05}$ (df 120, 120) < 1.35

$F_{0.01}$ (df infinity, infinity) < 1, $F_{0.01}$ (df 120, 120) < 1.53

Therefore there is some variation in the distribution of the two populations, with the Indian sample having the larger variance in each case.

Following this overall analysis, which demonstrated that significant differences do occur between the 2 populations, and specifically in some of the anthropometric parameters more than others, comparison was made between the immigrant children from India and the indigenous population, for each age group, and each sex, using a two tailed T test. The two tailed T test was selected to determine differences between the means, because it is more suitable for testing unequal sample sizes. Table 26 and 27 give the results of this analysis, for males and females respectively. The tables include, where significant differences occur, the difference in size and direction of the difference between the means, the 95% confidence interval, the 'T' test statistic, the degrees of freedom associated with the 'T' value and the associated P value. All differences are positive unless stated.

a) height,

comparison between the two groups shows that there are statistically significant differences, for both sexes, and these differences occur through most of the age bands, although the results are more consistent for the girls than for the boys. Differences occur in the 6 and 10 ($p<0.05$), 5, 7 and 8 ($p<0.001$) year old boys and for all girls ($p<0.01$ 4 and 8 year olds, $p<0.001$ 5, 6, 7, 9 and 10 year olds) except the 3 year olds. In all cases the European children are taller than the Indian children, the differences in height between the 2 groups being fairly similar in the relevant age bands for the girls although showing greater variation in the boys.

b) head circumference,

there are significant differences in head circumference between the two groups for all ages and both sexes with the European children having larger head circumferences in every case ($p<0.001$ for all age groups except 3 year males where the differences are significant at $p<0.01$). The European childrens' head circumferences are between 1.1 and 1.7cm. larger with a slight trend towards greater mean differences with increasing age.

c) arm circumference,

differences in arm circumference also exist between the 2 sample populations. For the boys, significant differences occur in the first 5 age bands, ($p<0.05$) for the 3, 4 and 6 year olds, $p<0.01$ for the 5 year olds and $p<0.001$ for the 7 year olds. For girls, there are significant differences at all ages studied, ($p<0.05$ in the 3 and 4 year olds, $p<0.001$ in the rest- 5, 6, 7, 8, 9 and 10 year olds). In all cases, the arm circumferences of the European children are larger than those of the Indian children with mean differences ranging from 0.5 to 1.2cm..

d) sitting height,
there are highly significant differences ($p<0.001$) in both girls and boys at all ages, except the 3 year old girls, where no significant difference occurs and for the 3 and 4 year old boys where differences are significant at the $p<0.05$ level. Once again, the European children have greater sitting heights than the Indian children, the difference in mean height between the 2 groups being fairly consistent over the age range studied, approximately 2-2.5cm. which is approximately equivalent to an increase in sitting height per annum in a child. The mean differences are marginally greater between the female European and Indian children, than between the male European and Indian children. In all except 4 cases, the mean difference in sitting height is equal to or greater than the mean difference in total height, in each age band, suggesting that the reduced height of the Indian child relative to the European child of the same age, may be attributable to a smaller sitting height component.

e) skinfolds,
the differences here are not the consistent and highly significant ones that occur with head circumference and sitting height. Differences occur in boys from the age of 6 years upwards for both triceps ($p<0.05$ for 9 year olds, $p<0.01$ for 6 and 8 year olds, $p<0.001$ for 10 year olds) and subscapular skinfolds ($p<0.001$, except 7 year olds $P<0.05$ and 8 year olds $p<0.01$). For girls, there are less differences between the groups, with a difference ($p<0.01$) at 5 years only for the triceps and a difference at seven years onwards, for the subscapular ($p<0.001$ for 7 year olds, $p<0.01$ for 8 and 9 year olds and p0.05 for 10 year olds). For both sites, and each age band, where differences occur, the level of significance tends to be higher for the boys than for the girls:-

age	triceps		subscapular	
	boys	girls	boys	girls
5 years		$p<0.01$		
6 years	$p<0.01$		$p<0.001$	
7 years			$p<0.05$	$p<0.001$
8 years	$p<0.01$		$p<0.01$	$p<0.01$
9 years	$p<0.05$		$p<0.001$	$p<0.01$
10 years	$p<0.001$		$p<0.001$	$p<0.05$

The important difference with the skinfolds compared with all the other growth parameters measured, is that, with the exception of the 5 year girls' triceps skinfold value, in every case where the 2 populations are significantly different, the Indian children have the higher skinfold measurement.

f) weight,

there are significant differences in weight between the two groups for both sexes and all age bands except 3. For boys, differences occur in the first 6 age bands, ($p<0.05$ 4 and 6 year olds, $p<0.01$ for 3 year olds and $p<0.001$ 5, 7 and 8 year olds). For the girls, the differences are more consistent, ($p<0.001$) and they occur in all the age bands, except 3 year olds, i.e. 4 - 10 years inclusive. As with all other results, except skinfolds, the European children are heavier in every case, with a trend towards increased weight differences between the 2 groups with increasing age. The mean differences in weight between the two populations are also greater on average, for the girls than for the boys.

No correction was made for the fact that the children in this study were wearing some light clothing, although they have been compared in some cases with data based upon the nude weight of children (Tanner et al 1966).

For height, weight and arm circumference, there are more age bands with significant differences between the 2 groups of subjects and higher levels of significance in most cases for the girls than for the boys, (for girls $p<0.001$ in 18 age bands, $p<0.01$ in 2 cases, $p<0.05$ 2 cases: for boys, $p<0.001$ 7 cases, $p<0.01$ 2 cases, $p<0.05$ 7 cases). For skinfold results, the converse occurs (for girls $p<0.001$ 1 case, $p<0.01$ 3 cases, $p<0.05$ 1 case: for boys $p<0.001$ 4 cases, $p<0.01$ 3 cases, $p<0.05$ 2 cases). For head circumference and sitting height the results are similar for the 2 sexes.

Throughout the analysis, whilst testing for differences between the means of the two populations, and comparing them with the reference standards, F tests were carried out on the variances of the same populations to determine whether there were any differences in the range of the distribution as well as in the means. The values obtained were found to be nonsignificant in most cases (79.8%). The point must be made that the comparison of variances, one against another, is open to the same problems as those which occur when comparing t tests between several samples, i.e. the null hypothesis that the 2 variances are equal, can be expected to be rejected once in 20 tests by chance. To overcome this, a test for equality of several variances, e.g. Bartlett's test could be applied, although this was not done in this case. The variance ratio test on the variances of the 2 groups was used to assess the overall distribution, before making the individual sex, age band comparisons for each anthropometric parameter.

Table 28 gives by sex, age band and anthropometric parameter concerned, the level of significance, for those cases where significant differences occured between the European and Indian populations, (the sample variances and degrees of freedom can be obtained from tables 5 - 20).

TABLE 26

A COMPARISON OF LEICESTERSHIRE EUROPEAN AND INDIAN DATA (TWO TAILED T TESTS)

MALES

	AGE(YRS)	X DIFF	95% C.I.	T	DF	P		X DIFF	95% C.I.	T	DF	P
HEIGHT	3+						TRI.					
cm.	4+						mm.					
	5+	1.86	0.83, 2.89	3.567***	322	0.0004						
	6+	1.20	0.01, 2.39	1.980*	298	0.0486		-0.8	-1.17, -0.29	-3.126**	303	0.0019
	7+	2.71	1.33, 4.09	3.879***	231	0.0001						
	8+	2.78	1.26, 4.31	3.607***	188	0.0004		-1.1	-1.55, -0.36	-2.995**	160	0.0032
	9+							-1.3	-1.95, -0.30	-2.577*	137	0.011
	10+	1.91	0.14, 3.67	2.134*	143	0.0345		-1.9	-2.54, -0.76	-3.378***	124	0.001
HEAD C	3+	1.20	0.64, 1.77	4.245***	84	0.0001	SUBSC.					
cm.	4+	1.12	0.71, 1.54	5.335***	170	0.0000	mm.					
	5+	1.60	1.32, 1.87	11.466***	321	0.0000						
	6+	1.25	0.91, 1.58	7.315***	260	0.0000		-0.8	-0.99, -0.37	-4.017***	306	0.0001
	7+	1.65	1.31, 1.99	9.643***	235	0.0000		-0.6	-0.93, -0.11	-2.446*	206	0.0153
	8+	1.69	1.35, 2.04	9.590***	163	0.0000		-0.9	-1.26, -0.36	-3.294**	137	0.0013
	9+	1.45	1.07, 1.82	7.603***	145	0.0000		-1.6	-1.90, -0.77	-4.102***	118	0.0001
	10+	1.35	0.95, 1.75	6.652***	140	0.0000		-1.8	-2.12, -0.81	-3.886***	111	0.0002
ARM C.	3+	0.56	0.11, 1.02	2.451*	82	0.016	WEIGHT	1.05	0.26, 1.84	2.659**	82	0.0094
cm.	4+	0.50	0.11, 0.88	2.560*	191	0.0112	kg.	0.81	0.14, 1.48	2.399*	184	0.0174
	5+	0.52	0.17, 0.86	2.939**	293	0.0036		1.40	0.77, 2.04	4.345***	306	0.0000
	6+	0.46	0.09, 0.83	2.425*	306	0.0159		0.97	0.20, 1.73	2.496*	305	0.0131
	7+	0.85	0.39, 1.31	3.674***	232	0.0043		2.20	1.16, 3.24	4.161***	224	0.0000
	8+							1.95	0.85, 3.04	3.515***	162	0.0006
	9+											
	10+											
SIT.HT	3+	2.23	0.02, 4.43	2.041*	42	0.0476						
cm.	4+	1.03	0.18, 1.89	2.388*	159	0.0181						
	5+	2.33	1.78, 2.89	8.268***	319	0.0000						
	6+	1.77	1.13, 2.41	5.439***	298	0.0000						
	7+	2.89	2.19, 3.59	8.126***	219	0.0000						
	8+	2.21	1.43, 2.99	5.599***	164	0.0000						
	9+	1.76	0.93, 2.59	4.200***	146	0.0000						
	10+	2.31	1.38, 3.25	4.903***	124	0.0000						

t values significance $p < 0.05$ *
$p < 0.01$ **
$p < 0.001$ ***

positive = European > Indian
negative = European < Indian

TABLE 27

A COMPARISON OF LEICESTERSHIRE EUROPEAN AND INDIAN DATA (TWO TAILED T TESTS)

FEMALES

	AGE(YRS)	X DIFF	95% C.I.	T	DF	P		X DIFF	95% C.I.	T	DF	P
HEIGHT	3+						TRI.					
cm.	4+	1.80	0.45, 3.15	2.634**	139	0.0094	mm.					
	5+	2.85	1.58, 4.12	4.435***	228	0.0000		0.8	0.29, 1.24	3.073**	294	0.0023
	6+	2.34	1.14, 3.54	3.834***	303	0.0002						
	7+	2.35	0.97, 3.72	3.347***	284	0.0009						
	8+	2.44	0.63, 4.24	2.616**	128	0.0087						
	9+	2.70	1.12, 4.28	3.366***	186	0.0009						
	10+	3.93	1.73, 6.12	3.560***	87	0.0006						
HEAD C	3+	1.07	0.38, 1.76	3.114**	63	0.0028	SUBSC.					
cm.	4+	1.09	0.46, 1.72	3.427***	215	0.0007	mm.					
	5+	1.33	1.00, 1.66	7.930***	246	0.0000						
	6+	1.40	1.10, 1.70	9.219***	340	0.0000						
	7+	1.29	0.97, 1.60	7.922***	270	0.0000		-1.0	-1.35, -0.40	-3.403***	251	0.0008
	8+	1.37	1.01, 1.72	7.676***	147	0.0000		-1.2	-1.76, -0.32	-2.719**	136	0.0074
	9+	1.64	1.27, 2.02	8.576***	212	0.0000		-1.4	-1.99, -0.39	-2.772**	156	0.0063
	10+	1.58	1.04, 2.13	5.763***	78	0.0000		-1.3	-1.92, 0.30	-2.611*	102	0.0104
ARM C.	3+	0.80	0.12, 1.47	2.363*	72	0.0208	WEIGHT					
cm.	4+	0.51	0.09, 0.93	2.402*	144	0.0176	kg.	1.18	0.54, 1.81	3.667***	164	0.0003
	5+	1.10	0.76, 1.45	6.292***	255	0.0000		2.38	1.72, 3.04	7.130***	253	0.0000
	6+	0.85	0.49, 1.21	4.640***	332	0.0000		1.97	1.28, 2.66	5.641***	320	0.0000
	7+	0.78	0.34, 1.21	3.498***	265	0.0006		1.99	1.10, 2.87	4.413***	284	0.0000
	8+	1.09	0.55, 1.63	3.980***	160	0.0001		2.44	1.13, 3.74	3.697***	147	0.0006
	9+	1.04	0.47, 1.61	3.625***	179	0.0004		2.73	1.23, 4.23	3.585***	175	0.0004
	10+	1.21	0.55, 1.86	3.632***	104	0.0004		3.50	1.82, 5.18	4.127***	106	0.0001
SIT.HT	3+											
cm.	4+	1.79	0.99, 2.59	4.407***	133	0.0000						
	5+	2.56	1.89, 3.22	7.586***	246	0.0000						
	6+	2.09	1.49, 2.69	6.848***	295	0.0000						
	7+	2.35	1.69, 3.01	6.978***	285	0.0000						
	8+	2.47	1.66, 3.27	6.057***	159	0.0000						
	9+	2.87	2.05, 3.68	6.945***	192	0.0000						
	10+	2.51	1.44, 3.58	4.654***	88	0.0000						

t values significance $p < 0.05$ *
$p < 0.01$ **
$p < 0.001$ ***

positive = European > Indian
negative = European < Indian

TABLE 28

VARIANCE ANALYSIS BETWEEN THE DIFFERENT GROUPS

Europeans compared with:-

HEIGHT

Age	Hindu m	Hindu f	Muslim m	Muslim f	Sikh m	Sikh f
3+						0.01
4+			0.05			
5+		0.001				
6+		0.05				
7+				0.05		
8+		0.05				
9+	0.05		-			
10+		0.05	-	-		

HEAD CIRCUMFERENCE

Age	Hindu m	Hindu f	Muslim m	Muslim f	Sikh m	Sikh f
3+						
4+		0.001				
5+						
6+						
7+						
8+						
9+			-			0.05
10+			-	-		

WEIGHT

Age	Hindu m	Hindu f	Muslim m	Muslim f	Sikh m	Sikh f
3+						0.001
4+	0.05				0.05	
5+			0.001		0.01	
6+					0.05	0.05
7+				0.001	0.01	
8+						
9+			-			0.05
10+		0.01	-	-		0.05

ARM CIRCUMFERENCE

Age	Hindu m	Hindu f	Muslim m	Muslim f	Sikh m	Sikh f
3+						0.01
4+					0.05	
5+	0.001		0.05		0.001	0.05
6+	0.05				0.05	
7+		0.01		0.05	0.05	0.05
8+						
9+			-		0.001	0.05
10+	0.001		-	-	0.01	

SITTING HEIGHT

Age	Hindu m	Hindu f	Muslim m	Muslim f	Sikh m	Sikh f
3+	0.001		0.001		0.001	0.05
4+						
5+	0.05					
6+	0.05					
7+				0.001	0.05	
8+						
9+			-			
10+		0.05	-	-		

TRICEPS SKINFOLD

Age	Hindu m	Hindu f	Muslim m	Muslim f	Sikh m	Sikh f
3+						
4+						
5+		0.05			0.05	
6+					0.05	
7+					0.05	0.05
8+			0.01			0.05
9+			-			
10+			-	-		

SUBSCAPULAR SKINFOLD

Age	Hindu m	Hindu f	Muslim m	Muslim f	Sikh m	Sikh f
3+				0.05		
4+				0.05		0.001
5+		0.05				0.001
6+	0.001		0.001			0.001
7+	0.05	0.001				0.001
8+	0.001	0.05		0.05		0.01
9+			-			
10+	0.05		-	-	0.05	

numbers indicate cells where variances are significantly different and the significance level
- = sample size too small for analysis

TABLE 28 (continued)

VARIANCE ANALYSIS BETWEEN THE DIFFERENT GROUPS

Hindus compared with:-

	HEIGHT				HEAD CIRCUMFERENCE				ARM CIRCUMFERENCE				WEIGHT			
	Muslim		Sikh		Muslim		Sikh		Muslim		Sikh		Muslim		Sikh	
Age	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f
3+		0.05		0.001	0.05		0.01	0.05				0.01				0.001
4+						0.001		0.001					0.05	0.05		
5+											0.05		0.01		0.05	
6+												0.05				0.001
7+										0.01				0.001	0.05	
8+				0.01												
9+	-				-				-		0.01	0.05	-			0.05
10+	-	-			-	-			-	-			-	-	0.05	

	SITTING HEIGHT				TRICEPS SKINFOLD				SUBSCAPULAR SKINFOLD			
	Muslim		Sikh		Muslim		Sikh		Muslim		Sikh	
Age	m	f	m	f	m	f	m	f	m	f	m	f
3+						0.05				0.01		
4+	0.05									0.05	0.01	
5+											0.05	
6+	0.01		0.05									0.05
7+		0.01								0.05		
8+					0.01							
9+	-			0.05	-				-			
10+	-	-			-	-			-	-		

Muslims compared with Sikhs

	HEIGHT		H.C.		A.C.		SITTING HT.		TRICEPS		SUBSCAP.		WEIGHT	
Age	m	f	m	f	m	f	m	f	m	f	m	f	m	f
3+				0.05										0.05
4+							0.05				0.01	0.01	0.05	
5+														0.05
6+						0.05							0.05	
7+						0.01					0.05	0.05	0.001	
8+														
9+	-		-		-		-		-		-		-	0.05
10+	-	-	-	-	-	-	-	-	-	-	-	-	-	-

numbers indicate cells where variances are significantly different and the significance level
\- = sample size too small for analysis

5.3 Leicestershire Indian Children Compared with Reference Standards

The children originating from India were also compared with reference standards, Tanner et al (1966) for height and weight; Eveleth and Tanner (1975) for arm circumference; Tanner and Whitehouse (1975) for triceps and subscapular skinfolds and Tanner (1978) for head circumference and sitting height. Chi square analysis was used on the numbers of subjects occuring on and below or above the 50th centile reference value to determine whether there were any differences between these two populations. The results of this, the X^2 value, the level of significance and, where significant, the calculated percentage of subjects on or below the fiftieth centile are given in Table 29.

a) height,

there are some significant differences between the Indian children and the standards, and where these occur, there are more smaller 1980's Leicestershire Indian children than expected compared with the reference data, except for the 3 year old girls (a group, which, as has already been explained, is biased towards the older 3 year olds). All the differences are for the girls ($p<0.05$ for 3 and 10 year olds, $p<0.01$ for 6 year olds and $p<0.001$ for 7 and 9 year olds) with one exception, the 7 year old boys ($p<0.05$).

b) head circumference.

there were significantly higher numbers of Indian children of both sexes and all age groups than expected below the standard 50th centile value for head circumference ($p<0.001$). The discrepancy between the two populations was considerable, with between 83-95% of the Indian sample's head circumference value lying below that of the standard fiftieth centile.

c) arm circumference,

on the whole there were more Indian children with smaller arm circumferences with the girls showing more discrepancy compared with the standards than the boys, ($p<0.01$ for the 8, 9 and 10 year olds, $P<0.001$ for the 4, 5, 6 and 7 year old girls). For boys, the results were significantly different for the middle age bands, the 4 to 7 year olds inclusive ($p<0.001$).

d) <u>sitting height,</u>

the results of this are similar to those for head circumference. At all ages and in both sexes, with the exception of the 3 year old girls, there are more Indian children than expected who have shorter sitting heights than the standard data ($p<0.001$, except 3 year old boys $p<0.05$), For this anthropometric dimension, at a given age, 63-87% of the Indian children lie below the reference 50th centile.

e) <u>skinfolds,</u>

triceps;- there are only slight differences between the Indian childrens' triceps skinfold distribution and the standard values, with the 4, 5 and 6 year old girls all recording more children with lower values than expected ($p<0.05$ for the 6 year olds, $p<0.01$ for the 4 year olds and $p<0.001$ for the 5 year olds). Conversely, the one significant result for the Indian boys compared with the reference data has the 9 year old boys with slightly higher values than expected ($p<0.05$).

subscapular;- here there are significant differences between the standards and the Indian children with more Indian children than expected having subscapular skinfold values corresponding to the higher centiles. For all the girls, except for the 3 year olds, there are significant differences in the distribution of the values ($p<0.05$ for the 9 and 10 year olds, $p<0.01$ for the 8 year olds and $p<0.001$ for the 4 to 7 year olds inclusive, i.e. a fall in significance level with increasing age). For the boys, significant differences occur in 5 of the age bands ($p<0.05$ for 7 and 10 year olds, $p<0.001$ for the 5, 6 and 9 year olds). Only 29-40% of the Indian children lie below the reference 50th centile of Tanner and Whitehouse (1975).

f) weight,

for this parameter, there are also differences, for all the girls age bands ($p<0.05$ for the 3 year olds, $p<0.001$ for the rest) and for the 4-7 year old boys ($p<0.001$). In each case there are more children than expected below the 50th. centile, i.e. there are more lighter children in the Indian sample at a given age.

These results reiterate the results outlined so far, i.e. the Leicestershire European children match the reference data reasonably well and the Indian subcontinent children differ from the European, having smaller dimensions in all cases, except for skinfolds. The comparison of the Indian children with the reference data also shows more children with smaller dimensions than expected, except for skinfolds. Here, more Indian children than expected have the higher values (with the exception of the girls triceps skinfold, where the reverse occurs).

TABLE 29

LEICESTERSHIRE INDIAN DATA COMPARED WITH REFERENCE STANDARDS(+) 50TH CENTILE
(CHI SQUARE ANALYSIS)

MALES

AGE (YRS.)	HEIGHT	HEAD CIRCUM.	ARM CIRCUM.	SITTING HT.	TRICEPS	SUBSCAPULAR	WEIGHT
3+		30.08*** 90%		4.08* 65%			
4+		104.9*** 92%	14.83*** 66%	12.41*** 64%			16.11*** 79%
5+		109.5*** 91%	14.05*** 65%	48.01*** 77%		23.44*** 31%	21.10*** 68%
6+		129.9*** 93%	14.04*** 61%	58.45*** 79%		24.47*** 32%	16.38*** 65%
7+	4.68* 60%	66.04**8 88%	19.55*** 71%	40.44*** 80%		4.68* 40%	16.36*** 69%
8+		57.60*** 90%		23.51*** 76%			
9+		22.04*** 78%		27.13*** 80%	6.21* 36%	14.14*** 29%	
10+		22.04*** 78%		29.35*** 83%		6.39* 35%	

FEMALES

AGE (YRS.)	HEIGHT	HEAD CIRCUM.	ARM CIRCUM.	SITTING HT.	TRICEPS	SUBSCAPULAR	WEIGHT
3+	4.90* 33%	25.60*** 90%					4.90* 68%
4+		104.8*** 93%	17.61*** 68%	30.62*** 74%	8.14** 62%	12.42*** 35%	32.56*** 74%
5+		154.9*** 94%	50.00*** 75%	72.00*** 80%	16.82*** 65%	13.52*** 37%	62.72*** 78%
6+	7.57** 60%	159.4*** 95%	29.50*** 69%	106.6*** 87%	5.78* 59%	27.38*** 31%	63.53*** 78%
7+	12.78*** 65%	88.01*** 90%	27.86*** 73%	72.46*** 86%		15.33*** 33%	44.09*** 78%
8+		64.20*** 94%	7.53** 65%	36.45*** 83%		10.13** 33%	13.12*** 70%
9+	11.64*** 68%	70.12*** 94%	8.19** 65%	53.49*** 89%		5.94* 37%	17.09*** 72%
10+	5.59* 66%	30.41*** 86%	8.34** 69%	24.90*** 83%		4.41* 36%	24.90*** 83%

level of significance
- * $p < 0.05$, chi square > 3.84, for df = 1
- ** $p < 0.01$, chi square > 6.64, for df = 1
- *** $p < 0.001$, chi square > 10.83, for df = 1

numbers = computed chi square values

(%) - percentage below the 50th centile reference value

(+) Tanner et al (1966, 1975, 1976, 1978)

5.4 Indian Children Classified by Country of Origin

The children in this study originating from the subcontinent of India, were divided up into groups according to the country of origin on their protocols, e.g.Pakistan, Bangladesh, India, either direct emigrants from India or via East Africa. The Pakistani and Bangladeshi numbers were too small for analysis.

An initial comparison was made between 2 populations - Indian children who have migrated direct from India and Indian children whose last place of residence before emigration to Great Britain was East Africa. Using two tailed 't' tests on the Z score values calculated for each anthropometric parameter, for all ages and both sexes together, no significant differences were found between the 2 populations.

However, the Indian immigrant child population is not necessarily a homogenous group. The children represent the 3 major Indian religions, these may have an impact upon the growth and development of the child and representatives of the 3 religious groups may not be distributed equally between the 2 countries of origin. Further analysis between the children originating from the 2 countries to determine any impact upon growth due to country of residence has been made using children divided up by religious adherence, see section 5.8.

Secondly, the combination of country of origin and length of subsequent stay in Great Britain may make a measurable impact upon growth and this has been further considered in section 5.9.

5.5 Indian Children Classified by Religion

Peoples from the Indian subcontinent can be subdivided into into five main religious groups, Hindus, Muslims, Sikhs, Jains and Christians, but in Leicester City there are few or no Jains and few Christians (1.6% of the total Indian subcontinent population, Leicester Report 1983). The religions observed by the families in this study have been identified from the surname of each child. An analysis of variance was then carried out on the overall Indian population, split into the 3 major religions, using Z values for each anthropometric parameter, as described in section 5.2 and the results of this were as follows;-

height,	F = 38.74,	df = 2, 1745,
head circumference,	F = 30.28,	df = 2, 1781,
arm circumference,	F = 15.51,	df = 2, 1836
sitting height,	F = 34.07,	df = 2, 1828,
triceps skinfold,	F = 9.87,	df = 2, 1829,
subscapular skinfold,	F = 13.75,	df = 2, 1831,

where $F_{0.001} > 6.91$ (for degrees of freedom = 2, infinity).

Following these results which indicate that there are statistically significant differences between the 3 religious Indian groups, an analysis of variance on the anthropometric data of the children for each sex and each age band was carried out and the results are given in Table 30. Where results are statistically significant, the observed F values, associated degrees of freedom and appropiate significance level are shown plus relevant values of the F distribution. For the analysis of variance across the total age range, Z scores were used, but for the individual age bands, raw anthropometric values were used, except for skinfolds, which used transformed values. The analysis of variance shows that differences occured between the 3 religious groups, in some age bands for each anthropometric parameter, mainly for the 4 - 7 year olds. But the sample sizes are such, that other age bands, such as the 8,9 and 10 year olds, might have shown differences with greater numbers of Muslim and Sikh subjects. If the 9 and 10 year old boys and the 10 year old girls are ignored, because the numbers of Muslims are too small to give any meaningful result, it can be seen that the differences are mainly in the skeletal dimensions of height, sitting height and head circumference and also for weight. For skinfolds, there is very little difference between the 3 groups.

Since differences were found between the 3 religious groups, individual two-tailed t tests were carried out between various combinations of 2 of the 3 groups and the results for this are given in Tables 31, 32 and 33, with the mean difference, direction of the difference and the level of significance, where differences between the 2 samples are significant. Tables 31a,b - 33a,b give further information on the same two sample T test comparisons, including the 95% confidence interval, the 't' value, degrees of freedom, and the associated P value. All 't' values are positive unless stated. The 9 and 10 year old Muslim boys sample and 10 year old girls Muslim sample were discarded for this analysis because of the small numbers in each group, i.e. 2 or 3 children only.

It is recognised that with the use of so many 't' tests between different groups, there is a probability that the null hypothesis will be rejected erroneously on occasions, but having applied an over-all test - the analysis of variance, upon all the data, and upon the separate age bands, and having obtained a statistically significant rejection of the null hypothesis, there is justification for applying 't' tests between the individual samples.

a) <u>height,</u>

from the analysis of variance it can be seen that there are differences in height between the 3 religious groups ($p<0.05$ for 5 year old boys and girls, $p<0.01$ for 4, 6 and 9 year old boys and 6 year old girls, $p<0.001$ for 7 year old girls).

t tests show that these differences occur between the Sikhs and the other 2 groups, i.e.

(a) Hindu and Sikh boys differ:- $p<0.05$ for 5, 6 and 10 year

olds, $p<0.01$ for 9 year olds and $p<0.001$ for 4 year olds, with the Sikh boys being taller in each case,
(b) Muslim and Sikh boys differ:- $p<0.05$ for 5 year olds, $p<0.01$ for 4 year olds and $p<0.001$ for 6 year olds with the Sikhs taller than the Muslims,
(c) but there are no differences between the Hindu and Muslim boys.

For girls, differences occur between all 3 religious groups:-
(d) Hindu and Sikh girls differ, $p<0.05$ for 6, 7 and 8 year olds,
(e) Muslim and Sikh girls differ $p<0.05$ for 5 year olds, $p<0.01$ for 6 year olds and $p<0.001$ for 7 year olds.
(f) Hindu and Muslim girls differ $p<0.05$ for 6 year olds and $p<0.001$ for 7 year olds.
In each case, the Sikh girls are the tallest, being taller than both the Hindu and Muslim girls whilst the Muslim girls are the shortest since the Hindu girls are also taller than them.

b) head circumference,

differences between the Hindus, Muslims and Sikhs, are shown in the analysis of variance for the 4 year old boys and 5 and 7 year girls ($p<0.05$) and for 5 and 6 year old boys and 6 year old girls ($p<0.01$).

The results of the two-tailed t tests for the boys were similar to those for height, i.e. the Sikhs differed from both the Hindus and the Muslims:-
(a) Hindu boys head circumferences were significantly different from Sikh boys, and smaller in each case, $p<0.01$ for 4, 5, and 6 year olds,
(b) Muslim boys also differed from Sikh boys and had smaller head circumferences in each case ($p<0.05$ for 6 year olds, $p<0.01$ for 4 year olds,
(c) there were no significant differences between the Hindu and Muslim boys,
for the girls, similar results were obtained, i.e. the Sikhs differed from the Hindus and the Muslims:-

(d) Hindu girls had smaller head circumferences than Sikh girls ($p<0.05$ for 7 year olds, $p<0.01$ for 6 year olds).
(e) Muslim girls had smaller head circumferences than Sikh girls ($p<0.05$ for 6 and 7 year olds, $p<0.01$ for 5 year olds),
(f) there were no differences between the Hindu and the Muslim girls.

c) <u>arm circumference,</u>

overall, differences are few between the 3 religious groups, occuring in the 4 and 6 year old boys and the 6 year old girls and only at a low level of significance ($p<0.05$). When the religious groups were compared separately with each other, using 't' tests, differences were found to occur only between the Sikhs and the 2 other groups, as has already been found for the boys heights and head circumferences. In each case the Sikh arm circumferences were larger than those of the other 2 groups:-
(a) between the Hindu and Sikh boys, ($p<0.05$ for 4 and 6 year olds,
(b) between Muslim and Sikh boys, ($p<0.01$ for 6 year olds, olds,
(c) there were no differences between the Hindu and Muslim boys,

For the girls similar results are found to those for the boys, i.e. there are only differences between the Sikhs and the other 2 groups, with the Sikh arm circumferences being larger in each case:-
(d) between Hindu and Sikh girls, ($p<0.05$ for 6 year olds),
(e) between Muslim and Sikh girls, ($p<0.05$ for 5 year olds, $p<0.001$ for 6 year olds),
(f) there are no differences between the Hindu and Muslim girls.

d) <u>sitting height,</u>

the comparison of the 3 religious groups using an analysis of variance produced differences in seven of the sixteen age bands, with slightly greater differences between the girls than the boys. Statistically different results were found between the 5 and 8 year old girls and 10 year old boys ($p<0.05$), the 6 year old boys and girls and the 9 year old boys ($p<0.01$) and the 7 year old girls ($p<0.001$). However when the 3 religious groups were compared separately with each other using two-tailed t tests, differences were found between the Sikh boys and the other two groups. As with all the other anthropometric data so far described, there were no differences between the Hindu and Muslim boys. For boys:-

(a) there were differences between the Hindu and Sikh boys, ($p<0.05$ for 4 and 10 year olds, $p<0.01$ for 6 and 9 year olds),

(b) for the Muslim compared with Sikh boys, differences were found in the 5 year old ($p<0.05$) and 6 year year old ($p<0.001$) groups,

(c) no differences were found between the Hindu and Muslim boys. for the girls:-

(d) for Hindu and Sikh girls, differences were found at 6 and 8 years of age ($p<0.01$) and 4 years ($p<0.05$),

(e) Muslim versus Sikh girls showed differences at 5 and 6 years ($p<0.01$) and 7 years ($p<0.001$),

(f) for the Hindu and Muslim girls, differences occurred in the 7 year age group only ($p<0.001$).

In all cases, and for both sexes, the sitting height values for the Sikhs are greater than those for the Hindu and Muslim children.

e) <u>skinfolds,</u>

differences for this parameter, when comparing between the three religious groups, using an analysis of variance, occured in 3 cases and for boys only, ($p<0.05$ for 3 years old boys', $p<0.001$ for 6 year boys' triceps skinfold and $p<0.01$ for the 6 year old boys' subscapular skinfolds). Using two-tailed t tests, very few differences were also found between the 3 religious groups.

For boys, the triceps skinfold values differed between the Hindu and Sikh 3 year olds ($p<0.01$), between the Hindu and Muslim 6 year olds ($p<0.01$) and between the Muslim and Sikh 3 year olds ($p<0.01$) and 6 year olds ($p<0.001$). The subscapular values differed only for the 6 year olds (Hindu versus Muslim, $p<0.001$, Muslim versus Sikh $p<0.01$). For both sites, the skinfold values of the 3 religious groups were in the order Sikh>Hindu>Muslim.

For the girls, the triceps skinfold differed only between the Sikh and Muslim 6 year olds ($p<0.05$) and the subscapular values were significantly different for the Hindu and Muslim 4 year olds ($p<0.01$). In the case of the girls, on the 2 occasions only where significant differences occurred the Sikhs>Muslims, Hindus>Muslims, and the Hindus matched the Sikhs.

f) <u>weight,</u>

the analysis of variance between the three groups showed some significant differences ($p<0.05$ for the 5 year old boys and the 7 year old girls, $p<0.01$ for the 6 year old boys , $P<0.001$ for the 4 year old boys and the 6 year old girls). When the 3 religious groups were compared separately with each other, for boys:-

(a) differences were found between the Hindu and Sikh boys (5 and 6 years $p<0.05$, 4 year olds, $p<0.01$)

(b) and between Muslim and Sikh boys ($p<0.05$ for 4 year olds and $p<0.01$ for 6 year olds,

(c) there were no differences between the Hindu and Muslim boys.

For girls, a similar pattern of results is seen between the 3 religious groups in that:-

(d) the Hindu girls differ from the Sikh girls at 2 ages, $p<0.05$ for the 7 year olds and $p<0.01$ for the 6 year olds,

(e) the Muslim girls differ from the Sikh girls, $p<0.05$ for 5 year olds and $p<0.01$ for 6 and 7 year olds,

(f) there were no differences between the Hindu and Muslim girls.

For both sexes, the Sikhs were heavier than the Hindus and Muslims.

To summarize, for both sexes and for all anthropometric parameters measured, where statistically significant differences occur between the 3 religious groups, in every case:-

Sikhs > Hindus; Sikhs > Muslims;

and Hindus = Muslims with the exception of the girls height and sitting height and male and female skinfolds, when

Hindus > Muslims.

Figure 21 demonstrates the relationship described above, between the Indian children of the 3 religious groups. The mean Z score values of the data, for ages 3.0 - 10.9 years and both sexes, have been plotted for each anthropometric variable.

TABLE 30

COMPARISON OF HINDU, MUSLIM AND SIKH ANTHROPOMETRIC DATA (ANALYSIS OF VARIANCE)

MALES

AGE (YRS.)	HEIGHT	HEAD C.	ARM C.	SIT.HT.	TRICEPS	SUBSCAP.	WEIGHT	d.f.	F(a)	F(b)	F(c)
3+					4.27 *			2, 45	3.23	5.18	8.25
4+	5.35 **	4.72 *	3.68 *				7.94 ***	2, 146	3.00	4.61	6.91
5+	3.97 *	4.64 **					3.26 *	2, 162	3.00	4.61	6.91
6+	4.95 **	5.50 **	4.29 *	5.24 **	7.05 ***	5.38 **	5.15 **	2, 175	3.00	4.61	6.91
7+								2, 110	3.07	4.79	7.32
8+								2, 87	3.07	4.79	7.32
9+	5.20 **			6.21 **				2, 75	3.07	4.79	7.32
10+				3.68 *				2, 66	3.15	4.98	7.76

FEMALES

AGE (YRS.)	HEIGHT	HEAD C.	ARM C.	SIT.HT.	TRICEPS	SUBSCAP.	WEIGHT	d.f.	F(a)	F(b)	F(c)
3+								2, 37	3.23	5.18	8.25
4+								2, 139	3.00	4.61	6.91
5+	3.20 *	3.29 *		3.67 *				2, 197	3.00	4.61	6.91
6+	6.32 **	5.80 **	4.51 *	6.74 **			8.14 ***	2, 198	3.00	4.61	6.91
7+	9.36 ***	4.21 *		8.64 ***			4.44 *	2, 135	3.00	4.61	6.91
8+				4.76 *				2, 80	3.07	4.79	7.32
9+								2, 86	3.07	4.79	7.32
10+								2, 55	3.15	4.98	7.76

level of significance
* $p < 0.05$ - F(a)
** $p < 0.01$ - F(b)
*** $p < 0.001$ - F(c)

numbers = observed F values

TABLE 31

A COMPARISON OF LEICESTERSHIRE HINDU BOYS WITH MUSLIM AND SIKH (TWO TAILED T TESTS)

Age (yrs)	Muslim	Sikh	Muslim	Sikh	Muslim	Sikh	Muslim	Sikh
	HEIGHT(cm.)		ARM CIRCUM.(cm.)		TRICEPS S'FOLD(mm.)		WEIGHT(kg.)	
3+						- 2.4 **		
4+		- 4.1 ***		- 1.1 *				-2.69 **
5+		- 2.9 *						-1.79 *
6+		- 2.6 *		- 0.8 *	1.3 **			-2.03 *
7+								
8+								
9+	-	- 4.5 **	-		-		-	
10+	-	- 4.4 *	-		-		-	

Age (yrs)	Muslim	Sikh	Muslim	Sikh	Muslim	Sikh
	HEAD CIRCUM.(cm.)		SITTING HEIGHT(cm.)		SUBSCAP.S'FOLD(mm.)	
3+						
4+		- 1.2 **		- 1.5 *		
5+		- 0.9 **				
6+		- 0.9 **		- 1.6 **	1.1 ***	
7+						
8+						
9+	-		-	- 2.6 **	-	
10+	-		-	- 2.8 *	-	

A COMPARISON OF LEICESTERSHIRE HINDU GIRLS WITH MUSLIMS AND SIKHS (TWO TAILED T TESTS)

Age (yrs)	Muslim	Sikh	Muslim	Sikh	Muslim	Sikh	Muslim	Sikh
	HEIGHT(cm.)		ARM CIRCUM.(cm.)		TRICEPS FOLD(mm.)		WEIGHT(kg.)	
3+								
4+								
5+								
6+	2.3 *	- 2.9 *		- 0.9 *				- 2.3 **
7+	4.5 ***	- 3.4 *						- 2.6 *
8+		- 4.1 *						
9+								
10+	-		-		-		-	

Age (yrs)	Muslim	Sikh	Muslim	Sikh	Muslim	Sikh
	HEAD CIRCUM.(cm.)		SITTING HEIGHT(cm.)		SUBSCAP.S'FOLD(mm.)	
3+						
4+				- 1.3 *	0.9 **	
5+						
6+		- 1.0 **		- 1.5 **		
7+		- 1.1 *	2.2 ***			
8+				- 3.0 **		
9+						
10+	-		-		-	

t values significance $p < 0.05$ * — positive = Hindu > Muslim

$p < 0.01$ ** — positive = Hindu > Sikh

$p < 0.001$ ***

- = sample size too small for analysis — number = difference in mean values

TABLE 32

A COMPARISON OF LEICESTERSHIRE SIKH BOYS WITH HINDU AND MUSLIM (TWO TAILED T TESTS)

Age (yrs)	HEIGHT(cm.) Hindu	HEIGHT(cm.) Muslim	ARM CIRCUM.(cm.) Hindu	ARM CIRCUM.(cm.) Muslim	TRICEPS S'FOLD(mm.) Hindu	TRICEPS S'FOLD(mm.) Muslim	WEIGHT(kg.) Hindu	WEIGHT(kg.) Muslim
3+					2.4 **	2.8 **		
4+	4.1 ***	4.1 **	1.1 *				2.7 **	2.5 *
5+	2.9 *	3.3 *					1.8 *	
6+	2.6 *	4.2 ***	0.8 *	1.3 **		2.2 ***	2.6 *	2.7 **
7+								
8+								
9+	4.5 **	-		-		-		-
10+	4.4 *	-		-		-		-

Age (yrs)	HEAD CIRCUM.(cm.) Hindu	HEAD CIRCUM.(cm.) Muslim	SITTING HEIGHT(cm.) Hindu	SITTING HEIGHT(cm.) Muslim	SUBSCAP.S'FOLD(mm.) Hindu	SUBSCAP.S'FOLD(mm.) Muslim
3+						
4+	1.2 **	1.3 **				
5+	0.9 **			1.7 *		
6+	0.9 **	0.7 *		2.3 ***		1.5 **
7+						
8+						
9+		-		-		-
10+		-		-		-

A COMPARISON OF LEICESTERSHIRE SIKH GIRLS WITH HINDU AND MUSLIM (TWO TAILED T TESTS)

Age (yrs)	HEIGHT(cm.) Hindu	HEIGHT(cm.) Muslim	ARM CIRCUM.(cm.) Hindu	ARM CIRCUM.(cm.) Muslim	TRICEPS S'FOLD(mm.) Hindu	TRICEPS S'FOLD(mm.) Muslim	WEIGHT(kg.) Hindu	WEIGHT(kg.) Muslim
3+								
4+								
5+		3.4 *		0.9 *				1.8 *
6+	2.9 *	5.2 **	0.9 *	1.5 ***		0.9 *	2.3 **	3.3 **
7+	3.4 *	7.9 ***					2.6 *	3.7 **
8+	4.1 *							
9+		-		-		-		-
10+		-		-		-		-

Age (yrs)	HEAD CIRCUM.(cm.) Hindu	HEAD CIRCUM.(cm.) Muslim	SITTING HEIGHT(cm.) Hindu	SITTING HEIGHT(cm.) Muslim	SUBSCAP.S'FOLD(mm.) Hindu	SUBSCAP.S'FOLD(mm.) Muslim
3+						
4+			1.3 *			
5+		1.0 **		2.1 **		
6+	1.0 **	0.9 *	1.0 **	2.6 **		
7+	1.1 *	1.3 *		3.3 ***		
8+			3.0 **			
9+		-		-		-
10+		-		-		-

t values significance $p < 0.05$ *
$p < 0.01$ **
$p < 0.001$ ***

- = sample size too small for analysis

positive = Sikh > Hindu
positive = Sikh > Muslim
number = difference in mean values

TABLE 33

A COMPARISON OF LEICESTERSHIRE MUSLIM BOYS WITH HINDU AND SIKH (TWO TAILED T TESTS)

Age (yrs)	Hindu	Sikh	Hindu	Sikh	Hindu	Sikh	Hindu	Sikh
	HEIGHT(cm.)		ARM CIRCUM.(cm.)		TRICEPS S'FOLD(mm.)		WEIGHT(kg.)	
3+						- 2.8 **		
4+		- 4.1 **						- 2.5 *
5+		- 3.3 *						
6+		- 4.2 ***		- 1.3 **	- 1.3 **	- 2.2 ***		- 2.7 **
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+	-	-	-	-	-	-	-	-

Age (yrs)	Hindu	Sikh	Hindu	Sikh	Hindu	Sikh
	HEAD CIRCUM.(cm.)		SITTING HEIGHT(cm.)		SUBSCAP.S'FOLD(mm.)	
3+						
4+		- 1.3 **				
5+				- 1.7 *		
6+		- 0.7 *		- 2.3 ***	- 1.1 ***	- 1.5 **
7+						
8+						
9+	-	-	-	-	-	-
10+	-	-	-	-	-	-

A COMPARISON OF LEICESTERSHIRE MUSLIM GIRLS WITH HINDU AND SIKH (TWO TAILED T TESTS)

Age (yrs)	Hindu	Sikh	Hindu	Sikh	Hindu	Sikh	Hindu	Sikh
	HEIGHT(cm.)		ARM CIRCUM.(cm.).		TRICEPS S'FOLD(mm.)		WEIGHT(kg.)	
3+								
4+								
5+		- 3.4 *		- 0.9 *				- 1.8 *
6+	- 2.3 *	- 5.2 **		- 1.5 ***		- 0.9 *		- 3.3 **
7+	- 4.5 ***	- 7.9 ***						- 3.7 **
8+								
9+								
10+	-	-	-	-	-	-	-	-

Age (yrs)	Hindu	Sikh	Hindu	Sikh	Hindu	Sikh
	HEAD CIRCUM.(cm.)		SITTING HEIGHT(cm.)		SUBSCAP.S'FOLD(mm.)	
3+						
4+					- 0.9 **	
5+		- 0.9 **		- 2.1 **		
6+		- 0.9 *		- 2.6 **		
7+		- 1.3 *	- 2.2 ***	- 3.3 ***		
8+						
9+						
10+	-	-	-	-	-	-

t values significance $p < 0.05$ * positive = Muslim > Hindu

$p < 0.01$ ** positive = Muslim > Sikh

$p < 0.001$ ***

- = sample size too small for analysis number = difference in mean values

TABLE 31A

A COMPARISON OF LEICESTERSHIRE HINDU BOYS WITH MUSLIM AND SIKH (TWO TAILED T TESTS)

HEIGHT(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-6.4,-1.9	-3.80	26	.0008
5+					-5.1,-0.7	-2.66	29	.0127
6+					-4.7,-0.6	-2.54	64	.0136
7+								
8+								
9+	-	-	-	-	-7.6,-1.4	-2.96	29	.0061
10+	-	-	-	-	-8.4,-0.5	-2.39	14	.0312

TRICEPS SKINFOLD(mm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+					-4.4,-0.8	-3.37	12	.0056
4+								
5+								
6+	0.3, 2.3	2.81	54	.007				
7+								
8+								
9+	-	-	-	-				
10+	-	-	-	-				

HEAD CIRCUMFERENCE(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-1.8,-0.5	-3.57	26	.0014
5+					-1.4,-0.3	-3.32	34	.0022
6+					-1.4,-0.3	-3.25	59	.0019
7+								
8+								
9+	-	-	-	-				
10+	-	-	-	-				

SUBSCAPULAR SKINFOLD

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+	0.5, 2.0	3.54	72	.0007				
7+								
8+								
9+	-	-	-	-				
10+	-	-	-	-				

ARM CIRCUMFERENCE(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-2.1,-0.1	-2.29	19	.0336
5+								
6+					-1.5,-0.1	-2.26	57	.0075
7+								
8+								
9+	-	-	-	-				
10+	-	-	-	-				

WEIGHT(kg)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-4.4,-1.0	-3.26	19	.0041
5+					-3.5,-0.0	-2.10	26	.0454
6+					-3.6,-0.5	-2.66	55	.0102
7+								
8+								
9+	-	-	-	-				
10+	-	-	-	-				

SITTING HEIGHT(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-2.9,-0.1	-2.26	23	.0333
5+								
6+					-2.6,-0.6	-3.09	85	.0027
7+								
8+								
9+	-	-	-	-	-4.1,-1.0	-3.37	30	.0021
10+	-	-	-	-	-5.0,-0.7	-2.84	15	.0125

- = sample size too small for analysis

TABLE 32A

A COMPARISON OF LEICESTERSHIRE SIKH BOYS WITH HINDU AND MUSLIM (TWO TAILED T TESTS)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
HEIGHT(cm)								
3+								
4+	1.9, 6.4	3.80	26	.0008	1.7, 6.6	3.39	34	.0018
5+	0.7, 5.1	2.66	29	.0127	0.6, 5.9	2.49	45	.0166
6+	0.6, 4.7	2.54	64	.0136	1.8, 6.6	3.50	70	.0008
7+								
8+								
9+	1.4, 7.6	2.96	29	.0061	-	-	-	-
10+	0.5, 8.4	2.39	14	.0312	-	-	-	-
HEAD CIRCUMFERENCE(cm)								
3+								
4+	0.5, 1.9	3.57	26	.0014	0.5, 2.0	3.27	36	.0024
5+	0.3, 1.4	3.32	34	.0022				
6+	0.3, 1.4	3.25	59	.0019	0.0, 1.3	2.12	70	.0377
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-
ARM CIRCUMFERENCE(cm)								
3+								
4+	0.0, 2.1	2.29	19	.0336				
5+								
6+	0.1, 1.5	2.26	57	.0075	0.4, 2.2	3.05	70	.0032
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-
SITTING HEIGHT(cm)								
3+								
4+	0.1, 2.9	2.26	23	.0333				
5+					0.3, 3.1	2.47	47	.0171
6+	0.6, 2.6	3.09	85	.0027	1.2, 3.3	4.27	70	.0001
7+								
8+								
9+	1.0, 4.1	3.37	30	.0021	-	-	-	-
10+	0.7, 5.0	2.84	15	.0125	-	-	-	-

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
TRICEPS SKINFOLD(mm)								
3+	0.8, 4.4	3.37	12	.0056	0.8, 5.2	3.16	19	.0051
4+								
5+								
6+					0.8, 3.9	3.43	69	.001
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-
SUBSCAPULAR SKINFOLD(mm)								
3+								
4+								
5+								
6+					0.5, 2.7	3.16	65	.0024
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-
WEIGHT(kg)								
3+								
4+	1.0, 4.4	3.26	19	.0041	0.6, 4.2	2.77	23	.011
5+	0.0, 3.5	2.10	55	.0454				
6+	0.5, 3.6	2.66	55	.0102	1.0, 4.4	3.19	65	.0022
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-

- = sample size too small for analysis

TABLE 33A

A COMPARISON OF LEICESTERSHIRE MUSLIM BOYS WITH HINDU AND SIKH (TWO TAILED T TESTS)

HEIGHT(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-6.6,-1.7	-3.39	34	.0018
5+					-5.9,-0.6	-2.49	45	.0166
6+					-6.6,-1.8	-3.50	70	.0008
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+	-	-	-	-	-	-	-	-

TRICEPS SKINFOLD(mm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+					-5.2,-0.8	-3.16	19	.0051
4+								
5+								
6+	-2.3,-0.3	-2.81	54	.007	-3.9,-0.8	-3.43	69	.001
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+	-	-	-	-	-	-	-	-

HEAD CIRCUMFERENCE(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-2.0,-0.5	-3.27	36	.0024
5+								
6+					-1.3,-0.0	-2.12	70	.0377
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+	-	-	-	-	-	-	-	-

SUBSCAPULAR SKINFOLD(mm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+		-3.53	72	.0007	-2.7,-0.5	-3.16	65	.0024
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+	-	-	-	-	-	-	-	-

ARM CIRCUMFERENCE(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+					-2.2,-0.4	-3.05	70	.0032
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+	-	-	-	-	-	-	-	-

WEIGHT(kg)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					-4.2,-0.6	-2.77	23	.011
5+								
6+					-4.4,-1.0	-3.19	65	.0022
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+		-	-	-	-	-	-	-

SITTING HEIGHT(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+					-3.1,-0.3	-2.47	47	.0171
6+					-3.3,-0.1	-4.27	70	.0001
7+								
8+								
9+	-	-	-	-	-	-	-	-
10+	-	-	-	-	-	-	-	-

- = sample size too small for analysis

TABLE 31B

A COMPARISON OF LEICESTERSHIRE HINDU GIRLS WITH MUSLIM AND SIKH (TWO TAILED T TESTS)

HEIGHT(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+	0.1, 4.6	2.10	26	.0453	-5.3,-0.4	-2.39	34	.0225
7+	2.1, 6.8	3.86	30	.0006	-6.6,-0.2	-2.24	18	.0377
8+					-7.3,-0.9	-2.71	19	.014
9+								
10+	-	-	-	-				

TRICEPS SKINFOLD

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+								
7+								
8+								
9+								
10+	-	-	-	-				

HEAD CIRCUMFERENCE(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+					-1.6,-0.4	-3.31	37	.0021
7+					-2.0,-0.1	-2.41	16	.0281
8+								
9+								
10+	-	-	-	-				

SUBSCAPULAR SKINFOLD

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+	0.2, 1.7	2.75	76	.0075				
5+								
6+								
7+								
8+								
9+								
10+	-	-	-	-				

ARM CIRCUMFERENCE(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+					-1.7,-0.0	-2.14	34	.0398
7+								
8+								
9+								
10+	-	-	-	-				

WEIGHT

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+					-4.0,-0.6	-2.74	31	.01
7+					-5.1,-0.0	-2.14	17	.0471
8+								
9+								
10+	-	-	-	-				

SITTING HEIGHT(cm)

Age	Muslim 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+					0.4, 3.0	2.61	50	.0116
5+								
6+					-2.6,-0.4	-2.77	35	.0089
7+	1.3, 3.1	4.78	40	.0000				
8+					-4.8,-1.1	-3.47	12	.0046
9+								
10+	-	-	-	-				

- = sample size too small for analysis

TABLE 32B

A COMPARISON OF LEICESTERSHIRE SIKH GIRLS WITH HINDU AND MUSLIM (TWO TAILED T TESTS)

HEIGHT(cm)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
3+								
4+								
5+								
6+	0.4, 5.3	2.39	34	.0225	2.1, 8.2	3.41	46	.0014
7+	0.2, 6.6	2.24	18	.0377	4.3,11.5	4.53	26	.0000
8+	0.9, 7.3	2.71	19	.014				
9+					-	-	-	-
10+					-	-	-	-

TRICEPS SKINFOLD(mm)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
3+								
4+								
5+								
6+					0.2, 3.9	2.26	46	.0286
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-

HEAD CIRCUMFERENCE(cm)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
3+								
4+								
5+					0.3, 1.7	2.78	45	.008
6+	0.4, 1.6	3.31	37	.0021	0.1, 1.8	2.17	44	.0353
7+	0.1, 2.0	2.41	16	.0281	0.2, 2.5	2.36	28	.0255
8+								
9+					-	-	-	-
10+					-	-	-	-

SUBSCAPULAR SKINFOLD(mm)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
3+								
4+								
5+								
6+								
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-

ARM CIRCUMFERENCE(cm)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
3+								
4+								
5+					0.2, 1.6	2.60	50	.0121
6+	0.0, 1.7	2.14	34	.0398	0.5, 2.5	3.04	46	.004
7+								
8+								
9+					-	-	-	-
10+					-	-	-	-

WEIGHT(kg)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
3+								
4+								
5+					0.4, 3.3	2.58	44	.0133
6+	0.6, 4.0	2.74	31	.01	1.3, 5.3	3.37	45	.0015
7+	0.0, 5.1	2.14	17	.0471	1.1, 6.3	2.99	18	.0079
8+								
9+					-	-	-	-
10+					-	-	-	-

SITTING HEIGHT(cm)

Age	Hindu 95% C.I.	T	df	P	Muslim 95% C.I.	T	df	P
3+								
4+	-3.0,-0.4	-2.62	50	.0116				
5+					0.5, 3.6	2.73	49	.0087
6+	0.4, 2.6	2.77	35	.0089	1.0, 4.2	3.23	39	.0025
7+	1.1, 4.8	3.47	12	.0046	1.9, 4.7	4.82	24	.0000
8+								
9+					-	-	-	-
10+					-	-	-	-

- = sample size too small for analysis

TABLE 33B

A COMPARISON OF LEICESTERSHIRE MUSLIM GIRLS WITH HINDU AND SIKH (TWO TAILED T TESTS)

HEIGHT(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+	-4.6,-0.1	-2.10	26	.0453	-8.2,-2.1	-3.41	46	.0014
7+	-6.8,-2.1	-3.86	30	.0006	-11.1,-4.3	-4.53	26	.0000
8+								
9+								
10+	-	-	-	-	-	-	-	--

TRICEPS SKINFOLD(mm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+								
6+					-3.9,-0.2	-2.26	46	.0286
7+								
8+								
9+								
10+	-	-	-	-	-	-	-	-

HEAD CIRCUMFERENCE(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+					-1.7,-0.3	-2.78	45	.008
6+					-1.8,-0.1	-2.17	44	.0353
7+					-2.5,-0.2	-2.36	28	.0255
8+								
9+								
10+	-	-	-	-	-	-	-	-

SUBSCAPULAR SKINFOLD(mm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+	-1.7,-0.2	-2.75	76	.0075				
5+								
6+								
7+								
8+								
9+								
10+	-	-	-	-	-	-	-	-

ARM CIRCUMFERENCE(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+					-1.6,-0.2	-2.60	50	.0121
6+					-2.5,-0.5	-3.04	46	.004
7+								
8+								
9+								
10+								

WEIGHT(kg)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+					-3.3,-0.4	-2.58	44	.0133
6+					-5.3,-1.3	-3.37	45	.0015
7+					-6.3,-1.1	-2.99	18	.0079
8+								
9+								
10+	-	-	-	-	-	-	-	-

SITTING HEIGHT(cm)

Age	Hindu 95% C.I.	T	df	P	Sikh 95% C.I.	T	df	P
3+								
4+								
5+					-3.6,-0.5	-2.73	49	.0087
6+					-4.2,-1.0	-3.23	39	.0025
7+	-3.1,-1.3	-4.78	40	.0000	-4.7,-1.9	-4.82	24	.0000
8+								
9+								
10+	-	-	-	-	-	-	-	-

- = sample size too small for analysis

5.6 Leicestershire Indian Children classified by Religion, compared with European Children.

Since the two-tailed t tests between the Indian children and European children produced significant differences between the 2 groups, and since the analysis of variance and two-tailed t tests between the 3 religious groups into which the Indian children can be divided, also produced specific differences, within those 3 groups, an analysis of variance was also carried out between the European children and the Indian children divided into religious subgroups. For the total population, Z scores were used, but for each individual age band, raw data was used, with the exception of the skinfolds which were transformed first.

The results of an overall analysis of variance, on the 4 groups, with combined ages and sexes, for each anthropometric parameter, were as follows;-

height,	observed F = 25.9,
head circumference,	observed F = 310.5,
arm circumference,	observed F = 60.2,
sitting height,	observed F = 181.5,
triceps skinfold,	observed F = 9.9,
subscapular skinfold,	observed F = 33.6,
weight,	observed F = 92.8,

the degrees of freedom were 3 and 3800(approximately) in each case, and $F_{0.001} < 5.42$, (for df = 3, infinity).

Table 34 shows the results of the analysis of variance for each sex separately and for each yearly age band, and includes, where significant, the observed variance ratio value 'F' the level of significance, degrees of freedom and the value at which F is significant for the given degrees of freedom.

From Table 34 it can be see that differences exist between the 4 groups at nearly all ages, for the skeletal dimensions of height, sitting height and head circumference. Differences also occur between the 4 groups for weight and to a lesser extent for arm circumference and skinfolds.

Since differences were found between the 4 groups, and having already shown that the Indian children are not a homogenous group, but also differ in their anthropometric dimensions, when categorised by religious adherence, two tailed 't' tests were carried out between the European and each religious Indian group, for each sex, and at each age band. The same comment concerning probability of rejecting the null hypothesis that was made in 5.5 also applies in this case. Comparison of the Europeans with the 9 and 10 year old male and 10 year female Muslims was not made, because of the small subject numbers of Muslims in those 2 age bands. The results of this analysis are given in table 35 for the boys and Table 36 for the girls. In each case, where statistically significant differences occur, the tables include the mean difference, the direction of the difference and the level of significance. Further information, including the 95% confidence interval, the 't' value, the degrees of freedom, and the associated P value on the same t tests is given in the associated Tables 35A and 36A. The value of the mean difference is positive unless otherwise stated, i.e. the means of the European data are greater than those of the groups with which they are being compared.

(a) <u>height</u>

from the analysis of variance it can be seen that there are significant differences between the 4 groups. When the sexes and age bands are considered separately, significant differences occur in all cases except the 3 year olds.

When the European data are compared with each of the 3 religious Indian subcontinent groups, in turn, the results for the boys are as follows:-

(a) European boys were significantly taller than Hindu boys at all ages except 3 and 4 years, (for 6 and 9 year olds $p<0.05$, for 5 and 10 year olds $p<0.01$, for 7 and 8 year olds $p<0.001$),

(b) European boys also differed form Muslim boys, at 5 and 6 years ($p<0.01$), 7 years ($p<0.05$), being taller in each case,

(c) European boys only differ from the Sikh boys at one age, ($p<0.01$ at 4 years old) and in this case they were shorter than the Sikh boys.

For the girls:-

(d) European girls were taller than Hindu girls, with significant differences found at all ages except the 3 year olds, (for 4, 7 and 8 year olds $p<0.01$, and for 5, 6, 9 and 10 year olds $p<0.001$),

(e) European girls were also taller than Muslim girls, with differences occurring at 5, 6 and 7 year olds ($p<0.001$),

(f) European girls did not differ statistically from the Sikh girls.

(b) head circumference

the results of the analysis of variance for head circumference show significant differences between the mean head circumference in the 4 groups, at all ages in both sexes, ($p<0.001$ in each case, with the exception of 3 and 4 year girls - $p<0.05$).

In the 't' tests, there were differences between the Europeans and each of the other groups. For boys:-

(a) European boys have larger head circumferences than Hindu boys, with statistically significant differences at all age bands ($p<0.001$),

(b) European boys also have larger head circumferences than Muslim boys, ($p<0.05$ for 3 and 7 year olds, $p<0.01$ for 8 year olds and $p<0.001$ for 4, 5 and 6 year olds),

(c) European boys also have slightly larger head circumferences than Sikh boys, ($p<0.05$ for 6 and 10 year olds, $p<0.01$ for 7 and 8 year olds and $p<0.001$ for 5 and 9 year olds).

For girls, there are similar results:-

(d) European girls have larger head circumferences than Hindu girls, ($p<0.001$ for all ages except 3 year olds - $P<0.05$ and 4 year olds - $p<0.01$),

(e) European girls head circumferences are larger than those of Muslim girls, ($p<0.01$ for 3 and 8 year olds and $p<0.001$ for 4 to 7 year olds inclusive),

(f) European girls have slightly larger head circumferences than Sikh girls, ($p<0.05$ for 4 and 5 year olds, $p<0.01$ for 9 year olds).

The mean differences between the European and Sikh groups are not as great as those between the European and Hindu and European and Muslim children, i.e. the average mean difference across all age bands where significant differences occured was 1.4-1.6cm. between the Europeans and the Hindus or Muslims, but for the Sikhs it was 1.0cm.

c) Arm Circumference

for arm circumference there are differences between the 4 groups, with more statistically significant differences within the female population, i.e. $p<0.01$ for 4, 5 and 6 year boys and $p<0.001$ for 7 year boys. For girls, differences are shown at all age bands except the 3 year olds, $p<0.05$ for 4 year olds, $p<0.01$ for 9 and 10 year olds and $p<0.001$ for 5 to 8 year olds.

From the 't' tests, for boys is can be seen that:-

(a) European boys have slightly larger arm circumferences than Hindu boys, ($p<0.05$ for 3 and 6 year olds, $p<0.01$ for 4 and 5 year olds and $p<0.001$ for 7 year olds),

(b) European boys also have slightly larger arm circumferences than Muslim boys, ($p<0.05$ for 6 and 8 year olds and $p<0.01$ for 7 year olds),

(c) there are no statistically significant differences between the European and Sikh boys.

For girls there are more age groups with significant differences and higher levels of significance, where differences occur:-

(d) the European girls have larger arm circumferences than the Hindu girls, ($p<0.05$ for 4 year olds, $p<0.01$ for 3 and 10 year olds $p<0.001$ for 5 to 9 year olds)

(e) European girls have larger arm circumferences than Muslim girls, ($p<0.05$ for 9 year olds, $p<0.01$ for 7 year olds and $p<0.001$ for 5 and 6 year olds),

(f) the differences between the European and Sikh girls are smaller and only occur for the 5 year olds ($p<0.05$) and 10 year olds ($p<0.01$).

For this dimension of arm circumference there is a distinct sexual variation between the groups, in that the mean differences between the male groups are smaller than those between the female groups.

c) Sitting height

this dimension shows similar results for both sexes in the analysis of variance, with all age bands showing differences, significant at $p<0.001$, (except 3 and 4 year boys - $p<0.05$, and 3 year girls - result not significant).

From the 't' tests, for the boys, it can be seen that:-
(a) European boys have greater sitting heights than Hindu boys, $p<0.001$ at all ages except 3 year olds - result not significant and 4 year olds - $P<0.01$),
(b) European boys also have greater sitting heights than Muslim boys, ($p<0.05$ for 3 year olds and $p<0.001$ for 5 to 7 year olds),
(c) European boys differ very slightly from Sikh boys and have significantly larger sitting heights only in the 5 and 7 year age bands ($p<0.05$).
For the girls, the results are similar:-
(d) European girls have greater sitting heights than Hindu girls, ($p<0.001$ for all age bands except 3 years, where the values are not statistically different),
(e) European girls have greater sitting heights than Muslim girls, $p<0.05$ for 4 year olds, $p<0.001$ for 5 to 7 year olds,
(f) the European girls have similar sitting heights to those of Sikh girls. A statistically significant difference was found in one age band only - 5 years, and significant only at $p<0.05$.

e) Skinfolds

the analysis of variance showed less significant differences between the skinfolds than for any other anthropometric parameter. For both skinfolds there were more and greater differences among the male population than the female population and for the boys the differences occurred in the older age groups only. For the triceps fold, the boys showed significant differences in 4 age bands, $p<0.05$ for 8 and 9 year olds, $p<0.01$ for 10 year olds and $p<0.001$ for 6 year olds, whilst for the girls there were differences only for the 5 year olds ($p<0.01$). For the subscapular skinfold, boys showed differences at 7 years ($p<0.05$), 8 years ($p<0.01$) and 6, 9 and 10 years ($p<0.001$). Girls differed at 4, 8 and 9 years ($p<0.05$) and 7 years ($p<0.001$).

For the 't' test comparison between the European sample and each Indian religious group, for the boys' triceps skinfold:-

(a) the European boys differed from the Hindus, in 4 age groups, $p<0.05$ for 9 and 10 year olds and $p<0.01$ for 6 and 8 year olds,

(b) the European boys differed very slightly from the Muslim boys, - $p<0.05$ for 3 year olds, only,

(c) European boys also differ only slightly from Sikh boys, $p<0.01$ for 6 and 10 year olds.

For the girls:-

(d) European girls show few differences from Hindu girls, $p<0.05$ for 3 and 5 year olds,

(e) The European girls differ only in the 5 year age band from the Muslim girls, $p<0.01$,

(f) there are no differences between the European and Sikh girls, for the triceps skinfold.

There is an interesting sexual dichotomy here, in that for the boys, the European children all have smaller triceps skinfold values than the Hindus, Muslims and Sikhs, whilst for the girls, the Europeans have marginally higher triceps skinfold values, where significant differences occur, although this is only in 3 age bands.

For the subscapular skinfold site, there is a similar pattern to that for the triceps skinfold site, with the exception that, for the girls, for this site, the direction of the mean difference is reversed and the European girls (like the boys) also have smaller skinfold values than the Indian groups.

For the boys:-

(a) European boys have smaller subscapular skinfold values than the Hindu boys, ($p<0.05$ for 7 year olds, $p<0.01$ for 6,8 and 10 year olds and $p<0.001$ for 9 year olds),

(b) European boys subscapular skinfolds are similar to those for Muslim boys. There is only one age band in which a small significant difference occurs between the values, - 3 year olds, $p<0.01$, and in this case the European boys have the larger skinfold,

(c) for European compared with Sikh boys, there are only slight differences, with the Europeans having the smaller skinfold, $p<0.05$ for 9 year olds and $p<0.01$ for 6 year olds.

For the girls:-

(d) the European girls have smaller subscapular skinfold values than the Hindu girls, ($p<0.05$ for 4, 9 and 10 year olds, $p<0.01$ for 7 and 8 year olds),

(e) there are no differences between the European girls and either the Muslim or the Sikh girls.

f) <u>Weight</u>

The comparison at the individual age band level produced statistically significant differences between the 4 groups, at all age bands and both sexes, $p<0.001$, (with the exception of 3, 9 and 10 year boys and 3 year girls, where no significant differences were found, and 4 and 10 year girls where the level of significance was $p<0.01$).

From the 't' tests, it could be seen, that, for boys:-

(a) the European boys were statistically heavier than the Hindu boys at all ages except 3 and 10 year olds, ($p<0.05$ for 9 year olds, $p<0.01$ for 4 and 6 year olds and $p<0.001$ for 5, 7 and 8 year olds),

(b) the European boys were also heavier than the Muslim boys, $p<0.05$ for 3,5 and 7 year olds and $p<0.01$ for 6 year olds,

(c) there were no differences between the European and Sikh boys.

For girls, a similar pattern is seen, but the mean weight differences are higher between each group, the level

of significance is higher and more age bands differ statistically in their mean weights:-
(d) European girls are heavier than Hindu girls, $p<0.001$ for 4 to 10 year age bands, $p<0.05$ for the 3 year olds,
(e) the European girls are heavier than the Muslim girls, $p<0.01$ for 4 year olds, $p<0.001$ for 5 to 7 year olds,
(f) European girls are slightly heavier than Sikh girls, $p<0.05$ for 5 and 10 year age bands only.

To summarize, for all anthropometric parameters, except skinfolds, where significant differences occur,

Europeans > Hindus; Europeans > Muslims;
but Europeans > Sikhs; for head circumference only,
and Europeans = Sikhs (approximately) for height, arm circumference, sitting height and weight.

For skinfolds,

Europeans < Hindus,
except Europeans = Hindus (approximately, for girls triceps)
Europeans = Muslims;
Europeans = Sikhs (for girls)
but Europeans < Sikhs (for boys).

Figure 21 shows the relationship described above between the European and 3 Indian religious groups, using male and female data combined, and Z scores calculated from the overall Leicestershire population sampled.

TABLE 34

A COMPARISON OF LEICESTERSHIRE EUROPEAN AND INDIAN RELIGIOUS GROUPS (ANALYSIS OF VARIANCE)

Males

Age(yrs.)	HEIGHT	HEAD C.	ARM C.	SIT.HT.	TRICEPS	SUBSCAP.	WEIGHT	df
3+		6.54 ***		3.02 *				3, 85
4+	3.26 *	12.81 ***	4.81 **	3.11 *			7.63 ***	3, 225
5+	6.97 ***	47.78 ***	4.68 **	25.03 ***			9.02 ***	3, 321
6+	4.66 **	22.35 ***	4.97 **	13.16 ***	8.59 ***	9.94 ***	5.65 ***	3, 307
7+	6.09 ***	32.10 ***	5.90 ***	23.58 ***		3.10 *	7.30 ***	3, 267
8+	4.61 **	33.15 ***		13.20 ***	3.57 *	4.90 **	5.59 ***	3, 250
9+	2.98 *	20.81 ***		10.41 ***	2.89 *	7.71 ***		3, 324
10+	3.08 *	14.95 ***		11.43 ***	4.79 **	6.08 ***		3, 206

Females

Age(yrs.)	HEIGHT	HEAD C.	ARM C.	SIT.HT.	TRICEPS	SUBSCAP.	WEIGHT	df
3+		2.86 *						3, 69
4+	3.04 *	2.69 *	2.72 *	7.00 ***		3.06 *	4.61 **	3, 314
5+	8.88 ***	23.83 ***	14.99 ***	22.38 ***	4.67 **		18.97 ***	3, 322
6+	8.97 ***	32.89 ***	10.37 ***	20.83 ***			16.27 ***	3, 349
7+	9.31 ***	24.27 ***	5.91 ***	21.81 ***		5.66 ***	9.46 ***	3, 284
8+	4.18 **	21.40 ***	5.52 ***	15.45 ***		3.16 *	5.49 ***	3, 246
9+	4.70 **	22.93 ***	5.00 **	16.13 ***		3.45 *	5.73 ***	3, 237
10+	5.77 ***	15.98 ***	4.67 **	9.60 ***			5.27 **	3, 218

level of significance * $p < 0.05$, $F > 2.60$, for df 3, infinity
** $p < 0.01$, $F > 3.78$, for df 3, infinity
*** $p < 0.001$, $F > 5.42$, for df 3, infinity

numbers = observed F values

TABLE 35

A COMPARISON OF LEICESTERSHIRE EUROPEAN BOYS WITH 3 RELIGIOUS INDIAN GROUPS (TWO TAILED T TESTS)

Age(yrs.)	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh
	HEIGHT(cm.)			ARM CIRCUMFERENCE(cm.)			TRICEPS SKINFOLD(mm.)		
3+				0.7 *				- 2.4 *	
4+			- 3.7 **	0.7 **					
5+	2.2 **	2.5 **		0.6 **	0.8 *				
6+	1.4 *	3.0 **		0.5 *	1.0 **		- 0.9 **		- 1.9 **
7+	2.8 ***	4.2 *		0.9 ***	1.4 *				
8+	3.0 ***						- 1.2 **		
9+	1.9 *	-			-		- 1.3 *	-	
10+	2.6 **	-			-		- 1.6 *	-	- 3.7 **
	HEAD CIRCUMFERENCE(cm.)			SITTING HEIGHT(cm.)			SUBSCAPULAR SKINFOLD(mm.)		
3+	1.3 ***	1.2 *			3.1 *			1.1 *	
4+	1.3 ***	1.3 ***		1.3 **					
5+	1.8 ***	1.5 ***	0.9 ***	2.4 ***	2.9 ***	1.2 *			
6+	1.5 ***	1.3 ***	0.6 *	1.9 ***	2.6 ***		- 1.0 **		- 1.3 **
7+	1.8 ***	1.2 *	1.3 **	2.8 ***	4.0 ***	2.6 *	- 0.5 *		
8+	1.8 ***	1.7 **	1.3 **	2.5 ***			- 0.8 **		
9+	1.5 ***	-	1.1 ***	2.4 ***	-		- 1.8 ***	-	- 1.6 *
10+	1.5 ***	-	0.9 *	2.8 ***	-		- 1.6 **	-	
	WEIGHT(kg.)								
3+		1.4 *							
4+	1.2 **								
5+	1.6 ***	1.9 *							
6+	1.2 **	1.9 **							
7+	2.4 ***	3.2 *							
8+	2.3 ***								
9+	1.8 *	-							
10+		-							

t values significance p < 0.05 *
p < 0.01 **
p < 0.001 ***
- = sample size too small for analysis

positive = European > Hindu, Muslim, Sikh
negative = European < Hindu, Muslim, Sikh
number = difference in mean values

TABLE 36

A COMPARISON OF LEICESTERSHIRE EUROPEAN GIRLS WITH 3 RELIGIOUS INDIAN GROUPS (TWO TAILED T TESTS)

Age(yrs.)	HEIGHT(cm.)			ARM CIRCUMFERENCE(cm.)			TRICEPS SKINFOLD(mm.)		
	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh
3+				1.1 **			1.3 *		
4+	2.2 **			0.6 *					
5+	2.9 ***	4.1 ***		1.1 ***	1.6 ***	0.7 *	0.7 *	1.7 **	
6+	2.5 ***	4.8 ***		0.9 ***	1.5 ***				
7+	2.1 **	6.6 ***		0.9 ***	1.1 **				
8+	3.0 **			1.2 ***					
9+	3.6 ***			1.1 ***	1.4 *				
10+	4.5 ***	-		1.1 **	-	1.9 **		-	

Age(yrs.)	HEAD CIRCUMFERENCE(cm.)			SITTING HEIGHT(cm.)			SUBSCAPULAR SKINFOLD(mm.)		
	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh
3+	1.1 *	1.4 **							
4+	1.1 **	1.1 ***	0.8 *	2.0 ***	1.7 *		- 0.8 *		
5+	1.3 ***	1.7 ***	0.8 *	2.6 ***	3.5 ***	1.4 *			
6+	1.6 ***	1.5 ***		2.2 ***	3.3 ***				
7+	1.4 ***	1.6 ***		2.2 ***	4.4 ***		- 1.1 **		
8+	1.5 ***	1.5 **		2.9 ***			- 1.4 **		
9+	1.7 ***		1.4 **	3.0 ***			- 1.3 *		
10+	1.7 ***	-		2.8 ***	-		- 1.5 *	-	

Age(yrs.)	WEIGHT(kg.)		
	Hindu	Muslim	Sikh
3+	1.2 *		
4+	1.3 ***	1.2 **	
5+	2.4 ***	3.2 ***	1.3 *
6+	2.2 ***	3.2 ***	
7+	2.1 ***	2.2 ***	
8+	2.8 ***		
9+	3.0 ***		
10+	3.5 ***	-	3.3 *

t values significance $p < 0.05$ *
$p < 0.01$ **
$p < 0.001$ ***
- = sample size too small for analysis

positive = European > Hindu, Muslim, Sikh
negative = European < Hindu, Muslim, Sikh
number = difference in mean values

TABLE 35A

A COMPARISON OF LEICESTERSHIRE EUROPEAN BOYS WITH 3 RELIGIOUS INDIAN GROUPS
(TWO TAILED T TESTS)

	Hindu				Muslim				Sikh			
	HEIGHT(cm)											
Age	95% C.I.	T	df	P	95% C.I.	T	df	P	95% C.I.	T	df	P
3+												
4+												
5+	1.1, 3.3	3.81	239	.0002	4.4, 0.7	2.75	41	.089	-1.5,-6.0	-3.23	30	.003
6+	0.0, 2.8	1.99	212	.0482	1.1, 4.9	3.19	57	.0023				
7+	1.4, 4.3	3.80	173	.0002	0.6, 7.7	2.54	13	.0248				
8+	1.4, 4.7	3.60	139	.0004								
9+	0.1, 3.7	2.06	119	.0418	-	-	-	-				
10+	0.7, 4.5	2.70	105	.0082	-	-	-	-				
	HEAD CIRCUMFERENCE(cm)											
3+	0.8, 1.9	4.63	59	.0000	0.3, 2.1	2.73	23	.012				
4+	0.8, 1.7	5.38	175	.0000	0.7, 1.9	4.39	56	.0001				
5+	1.5, 2.1	11.20	233	.0000	1.1, 1.9	6.87	47	.0000	0.4, 1.4	3.64	29	.001
6+	1.1, 1.8	7.75	236	.0000	0.8, 1.8	4.99	67	.0000	0.1, 1.1	2.27	62	.0266
7+	1.4, 2.1	9.51	174	.0000	0.3, 2.2	2.79	12	.0164	0.5, 2.2	3.43	14	.004
8+	1.4, 2.1	8.80	117	.0000	0.7, 2.6	3.97	7	.0054	0.6, 2.1	3.96	9	.0033
9+	1.1, 2.0	6.99	91	.0000	-	-	-	-	0.5, 1.7	3.96	24	.0006
10+	1.0, 1.9	6.50	98	.0000	-	-	-	-	0.1, 1.7	2.55	12	.0256
	ARM CIRCUMFERENCE(cm)											
3+	0.1, 1.3	2.54	48	.0144								
4+	0.3, 1.1	3.23	178	.0015								
5+	0.2, 1.0	2.97	193	.0034	0.1, 1.5	2.45	36	.0195				
6+	0.9, 0.9	2.40	206	.0174	0.4, 1.7	3.17	51	.0026				
7+	0.4, 1.4	3.68	176	.003	0.3, 2.4	2.84	14	.013				
8+												
9+					-	-	-	-				
10+					-	-	-	-				
	SITTING HEIGHT(cm)											
3+					0.7, 5.5	2.64	48	.0112				
4+	0.4, 2.2	2.88	163	.0045								
5+	1.8, 3.0	7.46	216	.0000	1.9, 4.0	5.78	40	.0000	0.1, 2.3	2.22	26	.0355
6+	1.2, 2.7	4.87	201	.0000	1.8, 3.5	6.16	70	.0000				
7+	2.0, 3.5	7.35	162	.0000	2.3, 5.7	5.08	12	.0000	0.2, 5.0	2.36	12	.036
8+	1.7, 3.4	5.85	121	.0000								
9+	1.5, 3.3	5.29	100	.0000	-	-	-	-				
10+	1.8, 3.8	5.54	91	.0000	-	-	-	-				

- = sample size too small for analysis

TABLE 35A(continued)

A COMPARISON OF LEICESTERSHIRE EUROPEAN BOYS WITH 3 RELIGIOUS INDIAN GROUPS
(TWO TAILED T TESTS)

	Hindu				Muslim				Sikh			
	TRICEPS SKINFOLD(mm)											
Age	95% C.I.	T	df	P	95% C.I.	T	df	P	95% C.I.	T	df	P
3+					-1.6,-0.5	-3.05	10	.0123				
4+												
5+												
6+	-1.5,-0.1	-3.29	224	.0012					-3.2,-0.7	-3.47	45	.0012
7+												
8+	-2.0,-0.4	-3.17	126	.0019								
9+	-2.7,-0.2	-2.31	88	.0233	-	-	-	-				
10+	-3.1,-0.3	-2.51	89	.0138	-	-	-	-	-7.4,-1.0	-3.16	11	.0091
	SUBSCAPULAR SKINFOLD(mm)											
3+					0.2, 3.0	2.35	27	.0252				
4+												
5+												
6+	-1.5,-0.5	-4.29	176	.0000					-2.3,-0.4	-3.18	42	.0028
7+	-1.1, 0	-2.04	152	.0428								
8+	-1.6,-0.2	-2.76	104	.0068								
9+	-3.0,-0.7	-3.72	76	.0004	-	-	-	-	-3.1,-0.3	-2.41	20	.0256
10+	-2.9,-0.6	-3.29	83	.0015	-	-	-	-				
	WEIGHT											
3+					0.3, 2.6	2.58	27	.0157				
4+	0.6, 4.2	3.25	175	.0014								
5+	2.3, 0.9	4.72	239	.0000	0.4, 3.4	2,53	41	.0164				
6+	0.4, 2.1	2.78	207	.0059	0.8, 3.0	3.32	58	.0016				
7+	1.3, 3.4	4.26	169	.0000	0.6, 5.7	2.72	13	.0176				
8+	1.1, 3.5	3.76	119	.0003								
9+	0.1, 3.5	2.06	99	.0417	-	-	-	-				
10+					-	-	-	-				

- = sample size too small for analysis

TABLE 36A

A COMPARISON OF LEICESTERSHIRE EUROPEAN GIRLS WITH 3 RELIGIOUS INDIAN GROUPS
(TWO TAILED T TESTS)

	Hindu				Muslim				Sikh			
	HEIGHT(cm)											
Age	95% C.I.	T	df	P	95% C.I.	T	df	P	95% C.I.	T	df	P
3+												
4+	0.7, 3.6	2.94	156	.0038								
5+												
6+	1.3, 3.7	3.94	292	.0001	2.5, 7.1	4.26	29	.0002				
7+	0.6, 3.6	2.81	227	.0054	4.3, 8.9	5.86	27	.0000				
8+	1.0, 5.1	2.93	95	.0043								
9+	1.4, 4.6	3.69	158	.0003								
10+	2.0, 7.0	3.57	62	.0007	-	-	-	-				
	HEAD CIRCUMFERENCE(cm)											
3+	0.2, 1.8	2.66	51	.0104	0.5, 2.2	3.28	27	.0029				
4+	0.3, 1.9	2.38	147	.0056	0.5, 1.7	3.43	65	.001	0.1, 1.5	2.25	30	.0322
5+	1.0, 1.7	7.48	256	.0000	1.2, 2.2	6.68	53	.0000	0.1, 1.4	2.47	34	.0185
6+	1.2, 1.9	9.63	296	.0000	0.7, 2.1	4.40	25	.0002				
7+	1.0, 1.7	8.15	211	.0000	0.8, 2.4	4.27	19	.0004				
8+	1.6, 1.8	7.42	109	.0000	0.5, 2.4	4.06	5	.0097				
9+	1.3, 2.1	8,53	174	.0000					0.7, 2.1	4.36	8	.0024
10+	1.1, 2.4	6.50	98	.0000	-	-	-	-				
	ARM CIRCUMFERENCE(cm)											
3+	0.4, 1.8	3.15	44	.0029								
4+	0.1, 1.0	2.56	157	.0113								
5+	0.7, 1.4	5.7	262	.0000	1.0, 2.1	5.49	48	.0000	0.1, 1.2	2.42	38	.0204
6+	0.5, 1.3	4.72	299	.0000	0.8, 2.2	4.65	28	.0000				
7+	0.4, 1.3	3.46	188	.0007	0.5, 1.8	3.57	27	.0014				
8+	0.6, 1.8	3.99	120	.0001								
9+	0.5, 1.7	3.74	150	.0005	0.1, 2.7	2.55	6	.0437				
10+	0.3, 1.8	2.74	71	.0078	-	-	-	-	0.8, 3.0	3.84	11	.0028
	SITTING HEIGHT(cm)											
3+												
4+	1.1, 2.8	4.62	144	.0000	0.4, 3.0	2.62	50	.0116				
5+	1.9, 3.3	7.21	252	.0000	2.3, 4.6	5.83	46	.0000	0.2, 2.6	2.29	34	.028
6+	1.6, 2.8	6.97	288	.0000	1.9, 4.7	4.89	25	.0000				
7+	1.5, 2.9	5.96	234	.0000	3.5, 5.2	9.85	37	.0000				
8+	2.0. 3.8	6.63	120	.0000								
9+	2.2, 3.8	7.13	165	.0000								
10+	1.6, 4.0	4.65	63	.0000	-	-	-	-				

- = sample size too small for analysis

TABLE 36A(continued)

A COMPARISON OF LEICESTERSHIRE EUROPEAN BOYS WITH 3 RELIGIOUS INDIAN GROUPS
(TWO TAILED T TESTS)

	Hindu				Muslim				Sikh			
	TRICEPS SKINFOLD(mm)											
Age	95% C.I.	T	df	P	95% C.I.	T	df	P	95% C.I.	T	df	P
3+	0.2, 2.9	2.49	47	.0186								
4+												
5+	0.1, 1.4	2.38	269	.018	0.8, 3.5	3.37	39	.001				
6+												
7+												
8+												
9+												
10+					-	-	-	-				
	SUBSCAPULAR SKINFOLD(mm)											
3+												
4+	-1.5,-0.1	-2.44	168	.0156								
5+												
6+												
7+	-1.8,-0.4	-3.24	17	.0014								
8+	-2.6,-0.4	-2.81	102	.006								
9+	-2.6,-0.2	-2.42	126	.0171								
10+	-2.9,-0.3	-2.61	70	.0112	-	-	-	-				
	WEIGHT(gm)											
3+	0.2, 2,2	2.43	48	.0178								
4+	0.6, 2.0	3.68	169	.0003	0.4, 2.1	3.01	62	.0038				
5+												
6+	1.5, 2.9	6.12	295	.0000	0.8, 3.0	3.32	58	.0016				
7+	1.2, 3.1	4.33	222	.0000	0.6, 5.7	2.72	13	.0176				
8+	1.3, 4.2	3.84	110	.0002								
9+	1.5, 4.6	3.90	148	.0001								
10+	1.5, 5.4	3.59	72	.0006	-	-	-	-	0.62, 6.0	2.69	12	.0198

- = sample size too small for analysis

A Profile of the Leicestershire Child Population, 3–10 years

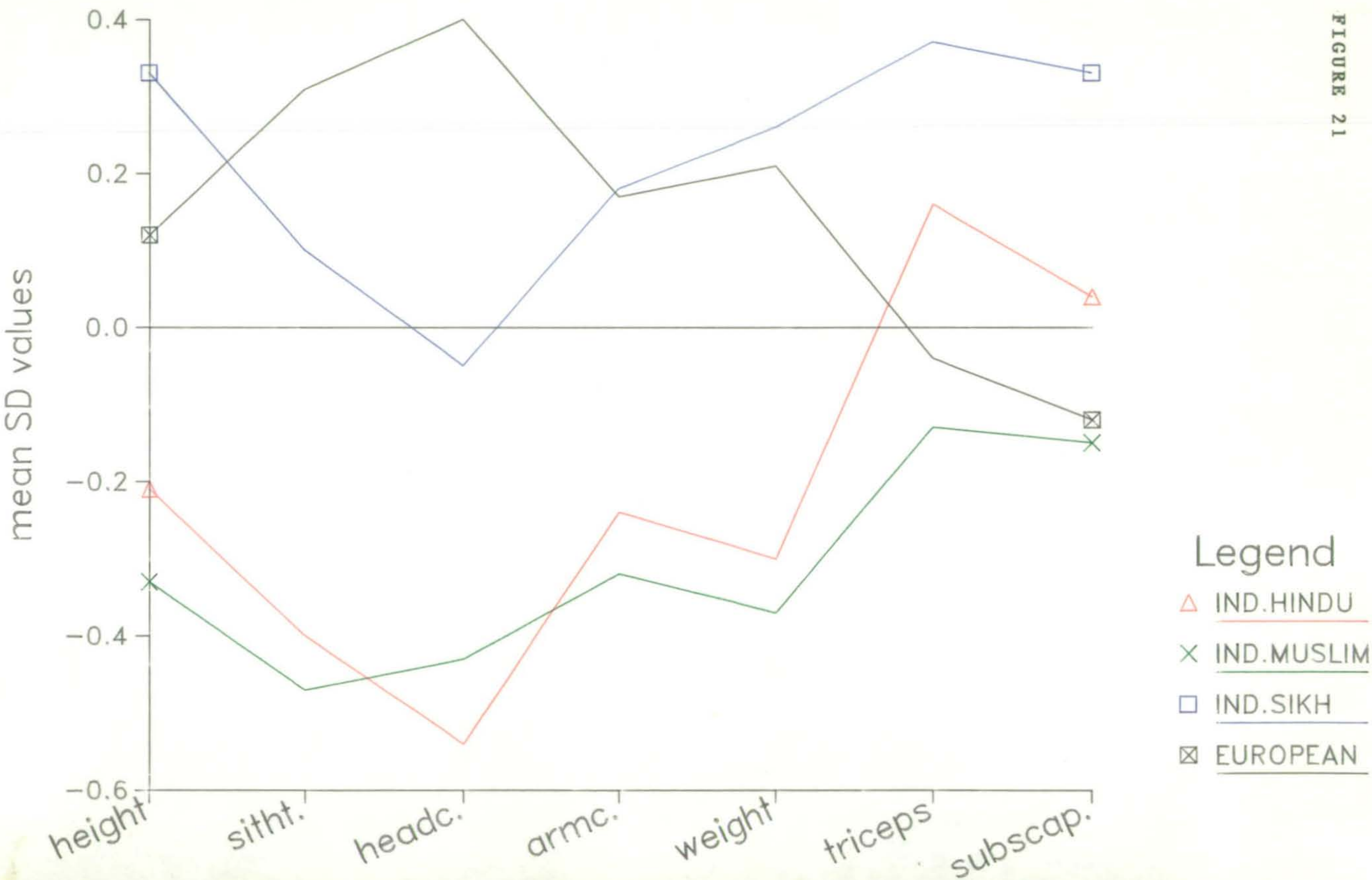


FIGURE 21

5.7 Leicestershire Indian Children compared with Indian Reference Data.

A comparison was made between the Leicestershire children from the Indian subcontinent and published growth data on Indian children resident in India. The Indian Council of Medical Research (I.C.M.R.)(1972) compiled a report based upon the survey of the physical growth and development of a large sample of children in several Indian states. This study has now been superceded by other, more up to date, surveys, although in the absence of a good reference standard, I.C.M.R. data are often used as representative of the normal growth pattern of Indian children. It has been considered as a reference standard for comparison with this study, because it is still the most comprehensive study that has been carried out in India, to date.

Table 37 shows a comparison, based upon religious categories, between the Sikh, Hindu and Muslim Indians in Leicestershire and those in India (I.C.M.R. 1972) for height and weight, using a chi square analysis. The table gives the calculated chi square value, the level of significance and the calculated percentage of subjects below the 50th centile of the reference data used. Some age bands in each religious group, for either sex, have been grouped together because of limited subject numbers;- for height: Hindu boys and girls 3-5 years, boys 9-10 years, Muslim boys 3-10 years and girls 3-6 years and 7-10 years, Sikh boys and girls 3-10 years. For weight: Hindu boys and girls 3-4 years and boys 9-10 years, Muslim boys 3-10 years, girls 3-6 years and 7-10 years and Sikh boys 3-10 years, girls 3-7 years and 8-10 years.

For all three religious groups, both sexes and for both height and weight, there are differences significant at $p<0.001$, (except for 8-10 year old female Sikhs for weight and 7-10 year old female Muslims for height $p<0.01$), between the two population samples. The percentage of subjects below the fiftieth centile is far lower than expected, if the Leicestershire Indians heights and weights had been comparable to their religious counterparts in India. It would appear that the Indians, resident in Great Britain now, whether adherents of the Hindu, Muslim or Sikh faith, have all increased in both their height and weight, i.e. the population as a whole are both taller and heavier, when compared age for age, with their contemporaries in India.

In a comparison of the Leicestershire Indian Sikhs with more recent data from Punjabi children (Prakash and Cameron 1981), using a chi square analysis the following results were obtained:-

For females,
the Leicestershire Sikhs matched the Chandigarh Punjabis at 6 and 7 years of age, but for the 8, 9 and 10 year olds, the Leicestershire population contained more children who were both taller
(chi square = 5.5 with 1 degree of freedom, $X^2_{0.05}<3.84$, for df =1)
and heavier
(chi square = 5.5 with 1 degree of freedom, $X^2_{0.05}<3.84$ for df = 1) with 27% of the Leicestershire population falling below the Chandigarh means and 73% above, in each case.
For males, the Leicestershire Sikhs matched the Chandigarh Punjabis at 6, 7 and 8 years of age for height, but for the 9 and 10 year olds, the Leicestershire population contained significantly more taller Sikhs
(chi square = 10.8 with 1 degree of freedom, $X^2_{0.01}<6.63$ for df = 1), with 20% below and 80% of the sample above the Chandigarh mean values.
For weight, the Leicestershire Sikhs matched the Chandigarh population at all ages.

The religious adherence of Prakash and Cameron's (1981) Punjabi subjects was not stated but they have been assumed to be Sikhs, for this comparison and the data quoted for the Chandigarh Punjabis was half a year out of phase with the Leicestershire data. So to maintain continuity with this study, the yearly increments in weight and height for the Chandigarh Punjabis were assumed to be linear and a new value computed midway between the data given for each year band, for the comparison.

TABLE 37

HEIGHTS AND WEIGHTS OF INDIAN CHILDREN IN LEICESTERSHIRE
COMPARED WITH I.C.M.R. (1972) 50th CENTILE
(CHI SQUARE ANALYSIS)

MALES

	HEIGHT			WEIGHT		
Age(yrs.)	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh
3+	183*** 4%	111*** 6%	108*** 5%	89*** 7%	104*** 7%	111*** 4%
4+	c	c	c	c	c	c
5+	c	c	c	73*** 7%	c	c
6+	73*** 8%	c	c	73*** 8%	c	c
7+	56*** 9%	c	c	63*** 7%	c	c
8+	41*** 12%	c	c	47*** 9%	c	c
9+	87*** 5%	c	c	73*** 8%	c	c
10+	c	c	c	c	c	c

FEMALES

	HEIGHT			WEIGHT		
Age(yrs.)	Hindu	Muslim	Sikh	Hindu	Muslim	Sikh
3+	208*** 4%	38*** 9%	88*** 7%	85*** 6%	32*** 11%	73*** 5%
4+	c	c	c	c	c	c
5	c	c	c	88*** 10%	c	c
6	108*** 6%	c	c	76*** 13%	c	c
7	62*** 9%	8** 27%	c	46*** 14	c	c
8	38*** 11%	c	c	35*** 13%	c	8** 23%
9	50*** 9%	c	c	44*** 12%	c	c
10+	23* 12%	c	c	23*** 12%	c	c

level of significance
$p < 0.05$ *, chi square $\geqslant 3.8$, for degrees of freedom = 1
$p < 0.01$ **, chi square $\geqslant 6.63$, for degrees of freedom = 1
$p < 0.001$ ***, chi square $\geqslant 10.8$, for degrees of freedom = 1

(%) on or below 50th centile value

c - this cell has been combined with the one above containing a value

number = calculated chi square value

5.8 Classification of Indians by Country of Origin and Religion

By using one religious group only, the effects of any dietary variation that is dictated by religion should be eliminated or at least reduced, and differences that occur can be attributed to other environmental factors such as country of origin, length of time spent in the new country and change in environment, including socioeconomic conditions. Analysis from the protocols of the area of India from which the East African Indians originated, produced the following results,

Gujarat	47%
Punjab	5%
Bombay	4%
unknown	44%

so a tentative assumption can be made that the majority of East African Indians may well be of a similar genetic stock to those families who have migrated direct to the United Kingdom from Gujarat State, India, and these are predominantly families that follow the Hindu religion.

Since the Indian and East African populations both contained a mix of Hindus, Muslims and Sikhs, further analysis was carried out on a comparison of the anthropometric data of subjects grouped in a combination of country of origin and religion, using chi square analysis on the data, coded from standard centiles as previously described and two tailed t tests on the anthropometric data converted to 'Z' scores.

For the two tailed t tests on the Z scores, for each religion, and each anthropometric parameter, sexes combined, the results are as follows;-

Comparison of Indian and East African Hindu, Muslim and Sikh Children

(using two tailed t tests on Z values)

	Hindu	Sikh	Muslim
Height	t = -2.486 *	t = -2.417 *	n.s.
Head circumference	n.s.	n.s.	n.s.
Arm circumference	n.s.	n.s.	n.s.

Sitting height	n.s.	n.s.	n.s.
Triceps skinfold	n.s.	n.s.	n.s.
Subscapular skinfold	n.s.	n.s.	n.s.
Weight	t = -3.468 ***	n.s.	n.s.

From this it can be seen that differences occurred for height ($p<0.05$), sitting height and weight ($p<0.001$) for the Hindu Indians from India compared with the Hindu Indians from East Africa. The only other significant difference was found between the Sikh Indian and East African children for height, (although the small numbers in the Muslim and Sikh groups may have contributed to this lack of significant results, i.e. Sikhs: n = 204 for India, n = 26 for East Africa,
Muslims: n = 92 for India, n = 136 for East Africa, compared with:
Hindus: n = 759 for India, n = 1053 for East Africa).

In each case where differences occured, the Hindu and Sikh children who had migrated direct from India were smaller and the Hindu children were lighter than those who had come to Great Britain from East Africa.

The results of the chi square analysis on the Hindu data is shown in Table 39, 3rd. column. The chi square analysis of the distribution of the Indian children's anthropometric data produced significant differences for height ($p<0.05$) and sitting height ($p<0.01$), between the Indian and East African Hindus, with the following calculated percentages of subjects in the 3 centile bands listed.

		Indian Hindus	East African Hindus
Height -	>10th	18%	14%
	>50th	63%	56%
	<90th	3%	9%
Sitting - height	>10th	41%	32%
	>50th	86%	79%
	<90th	0.5%	3%

The Indian Leicestershire sample population who have migrated direct from India contained more shorter and lighter children than the Indian sample population who have come to Great Britain via East Africa. Chi square analysis was not performed on the Sikhs and Muslims because of the small subject numbers.

5.9 Classification of the Indians by Generation

Since environmental conditions are different in this country for the Indians who have emigrated from the subcontinent of India, compared with those in their home country, then the growth of those Indians who have lived in this country the longest may have been most influenced by the different environment and may show this in the growth that they have achieved for a given age, compared with that achieved by the more recent immigrants to this country. The children from India were grouped by length of time of residence in this country as measured by number of generations in the family who have resided here:-

children born in India but growing up in Great Britain - generation A,

children born in Great Britain of parents and grandparents born abroad and therefore the first generation of immigrant parents to this country - generation B,

children born in Great Britain of parents born in Great Britain but with grandparents born abroad, and therefore second generation children of immigrants to this country - generation C. There may be differences in growth between these three groups, dictated by the long term change in environmental circumstances.

Further analysis on the Hindu children only, using analysis of variance on the Z scores for each anthropometric parameter, with combined data from both sexes and all ages, was carried out. The subjects were analysed collectively and then split by country of origin and generation and re-examined using analysis of variance. In the latter split, in some cases there were no children in a generation and country of origin block, for an analysis of variance, and in such cases a two tailed t test was carried out between the 2 remaining generation blocks.

The following results were found,- analysis of variance on the Z scores produced no significant differences between the 3 generations, all Hindu children, disregarding country of origin, with the exception of:-

head circumference, $F = 8.91$, $F_{0.001} = 6.91$, $df = 2, 1176$
subscapular skinfold, $t = 2.44$, associated P value = 0.0159, df = 135, (there was no data for generation C children for this parameter, so a two-tailed t test was performed upon generation A and generation B only).

When split by country of origin, t tests had to be performed on the East African origin group, as there was no data on children of the category of generation C in this group. The following significant results were obtained;-

(a) children emigrating to Great Britain direct from India, comparison of generation A, B, and C,
no significant differences,

(b) children emigrating to Great Britain from East Africa, generation A compared with B only:-
head circumference, $t = 4.207$, associated P value = 0.003, df = 267.

Chi square analysis on the distribution of the anthropometric data between the 3 groups, when coded against reference data, as described previously, produced the results shown in table 38. The table gives the computed chi square value, the associated degrees of freedom, the level of significance and the calculated percentage of children within reference centile bands. Significant differences in distribution were found for arm circumference and head circumference both for the migrants direct from India, ($p<0.05$ and $p<0.01$ respectively), and for the East African Indian migrants ($p<0.001$ for both dimensions) and for weight ($p<0.05$ for the East African Indians only). The comparison of all Hindu children, whether from India or East Africa, produced significant differences between the 2 sample populations - Generation A and Generation B, for head circumference only ($p<0.01$).

Generation C however contained only 3 subjects who could be categorised as Hindu, according to their names, and who had emigrated direct from India. The rest, 6 others, were either Muslims, Sikhs, or 2 Hindus who had come to Great Britain via East Africa, and in some cases data was missing on the latter 2, so generation C could not be regarded as a representative sample for comparison.

Table 39 makes a similar chi square analysis of Hindu children, comparing country of origin, when the subjects are split into the 3 separate generation categories also. As can be seen from the table, differences were found between the Indian and East African Indian generation A Hindu children for arm circumference ($P<0.001$), and between the Indian and East African Indian generation B Hindu children for height and sitting height ($p<0.01$). The table also gives the calculated percentage of subjects within the reference centile bands for generation A and B Indian and East African Indian children.

Two tailed t tests on the calculated z values for each anthropometric parameter, for the Hindu children for each generation, comparing Indian with East African origin, produced the following results;-

for generation A;-

no significant differences.

for generation B;-

height,

$t = -2.573$, associated P value = 0.0102, df = 700

weight,

$t = -3.256$, associated P value = 0.0012, df = 722

sitting height,

$t = -3.908$, associated P value = 0.0001, df = 682

In summary, from the comparison of generation A and B data, it would appear that the increase in time spent in this country, i.e. being of generation B rather than of generation A, has produced a trend towards an increase in body dimensions, i.e. there are slightly less of the population from generation B in the lower centiles bands and slightly more of generation A, and conversely, more of generation B in the higher centile bands and less of generation A. This appears to be regardless of whether the child has come from India or East Africa as the trend is similar in the samples from both countries of origin. However, although there are significant changes in the distribution of the population for some anthropometric parameters, any changes in the absolute values of the dimension that might occur between the two generations do not diverge sufficiently to produce significant mean differences, with the exception of head circumference, compared in generation A and B East African Indians and head circumference and subcutaneous skinfold, if country of origin is ignored.

The impact of length of stay in East Africa has also had an effect upon the Indian child, in that for either generation, the East African Indian distribution has less children in the lower centile bands and more in the higher centile bands, where significant differences in distribution occur compared with the Indians direct from India. When comparing absolute values, generation A (the children who have resided in Great Britain the shortest length of time) show no differences, when compared by country of origin. But for generation B, those children who were born here, of parents who came from either India direct or East Africa, there is a marked difference in the anthropometric parameters of weight and sitting height and to a lesser extent differences in height.

Figure 22 shows the differences between the Indian Hindu children, when divided up by country of origin and generation, using male and female data combined and Z scores calculated from the Leicestershire child population sampled. It can be seen from Figure 22 that the Generation A children, whether from India or East Africa, tend to be very similar in their anthropometric dimensions, with the exception that the children from East Africa have the larger skinfolds. Generation B children also tend to follow a similar pattern for their anthropometric dimensions, with, once again, a convergence in the skinfold values and the East African origin children having the larger subcutaneous fat levels. Overall, the children who were born in Great Britain (Generation B) have the largest dimensions, and the Generation A children (also from East Africa) have the smallest dimensions (although there is little difference between the East African and Indian children of Generation A).

Thus, the biggest impact upon growth, i.e. that which shows the most significant variation in distribution and the highest number of anthropometric parameters that differ in absolute values is the population that falls into the category of generation B from East Africa, i.e. those children who have lived in Great Britain the longest, i.e. all their lives, but whose parents have spent some time in East Africa.

E/A. gen. B > Ind. gen. B > Ind. gen. A > E.A. gen. A

Thus, the longest length of stay in this country relative to the overall lifespan of the child, coupled with an interim stay by the parents in East Africa, appears to be the most influential combination upon growth. But length of stay in this country, relative to the overall life span of the child appears to be slightly more influential than country of origin, in that the second group also includes generation B children but those from India. The category exerting the least impact upon growth appears to be that containing children, who have lived here for varying lengths of time, although they were not born here, and their country of origin and that of their parents was India or East Africa.

But it must be remembered that, by definition, Generation B, in this study, although not born here, could have come to this country soon afterwards and consequently have spent most of their life here. Alternatively, some of the children in Group B could have been measured only days after emigrating from India. Conversely, Generation A may contain some children who have spent some of the intervening time between their birth in Great Britain and the date of measurement in long visits to India.

Finally, a two way analysis of variance, for country of origin and generation, using the z score values, was considered, but with such unequal numbers in the 4 categories it was not pursued.

TABLE 38

A COMPARISON OF GENERATION A AND B LEICESTERSHIRE HINDU CHILDREN
(CHI SQUARE ANALYSIS)

	INDIAN HINDUS N=370			E/A. HINDUS N=820			ALL HINDUS N=1190		
	CHI.SQ.	DF	SIG.	CHI.SQ.	DF	SIG.	CHI.SQ.	DF	SIG.
HEIGHT	1.74	2		5.21	4		0.98	4	
SIT.HT.	1.43	2		2.62	4		0.22	3	
HEAD C.	8.36	2	*	17.85	2	***	15.83	3	**
ARM C.	9.36	2	**	13.61	4	***	3.87	4	
TRICEPS	0.73	2		3.31	3		2.94	3	
SUBSCAP.	1.92	2		4.37	3		5.98	3	
WEIGHT	4.12	2		9.86	4	*	2.33	4	

level of significance:-

	* p < 0.05;	** p < 0.01;	*** p < 0.001
for df = 2, chi square >	5.59	9.21	13.8
df = 3	7.81	11.3	16.3
df = 4	9.49	13.3	18.5
df = 5	11.1	15.1	20.5

CALCULATED PERCENTAGE OF SUBJECTS WITHIN REFERENCE (+) CENTILE BANDS

CENTILE	HEAD CIRCUM - I		HEAD CIRCUM - E/A		WEIGHT - E/A	
	GEN. A	GEN. B	GEN. A	GEN. B	GEN. A	GEN. B
< 3	55%	33%	47%	30%	23%	12%
3 - 10	7%	27%	27%	24%	16%	16%
>10 - 50	38%	40%	27%	47%	37%	41%
>50 - 90	c	c	c	c	15%	24%
>90 - 97	c	c	c	c	9%	7%
> 97	c	c	c	c	c	c

CENTILE	ARM CIRCUM - I		ARM CIRCUM - E/A	
	GEN. A	GEN. B	GEN. A	GEN. B
< 3	4%	21%	12%	6%
3 - 10	c	c	22%	11%
>10 - 50	77%	46%	32%	47%
>50 - 90	19%	33%	27%	27%
>90 - 97	c	c	8%	10%
> 97	c	c	c	c

(+) Tanner et al (1966, 1975, 1976, 1978)
c = this cell has been combined with the one above containing a value

TABLE 39

A COMPARISON OF INDIAN AND EAST AFRICAN INDIAN HINDU CHILDREN
(CHI SQUARE ANALYSIS)

	GENERATION A N=110			GENERATION B N=1090			BOTH A AND B N=1190		
	CHI.SQ.	DF	SIG.	CHI.SQ.	DF	SIG.	CHI.SQ.	DF	SIG.
HEIGHT	1.81	2		15.41	5	**	14.41	5	*
SIT.HT.	1.11	2		17.08	4	**	11.93	3	**
HEAD C.	5.06	2		5.28	3		4.49	3	
ARM C.	14.07	2	***	4.70	5		3.57	5	
TRICEPS	2.24	2		4.44	5		5.42	5	
SUBSCAP.	0.35	2		3.15	4		3.30	4	
WEIGHT	4.00	3		10.07	5		8.71	5	

level of significance:-

	* $p < 0.05$;	** $p < 0.01$:	*** $p < 0.001$
for df = 2, chi square >	5.99	9.21	13.8
for df = 3	7.81	11.3	16.3
for df = 4	9.49	13.3	18.5
for df = 5	11.1	15.1	20.5

CALCULATED PERCENTAGE OF SUBJECTS WITHIN REFERENCE (+) CENTILE BANDS

CENTILE	HEIGHT - GEN B		SITTING HT. - GEN B		ARM CIRCUM - GEN A	
	I	E/A	I	E/A	I	E/A
< 3	6%	3%	20%	15%	4%	33%
3 - 10	11%	10%	21%	16%	c	c
>10 - 50	44%	44%	45%	48%	77%	32%
>50 - 90	36%	34%	14%	18%	19%	35%
>90 - 97	2%	6%	1%	3%	c	c
>97	1%	3%	c	c	c	c

(+) Tanner et al (1966, 1975, 1976, 1978)

c = this cell has been combined with the one above containing a value

A Profile of the Leicestershire Hindu Child Population, 3–10 years

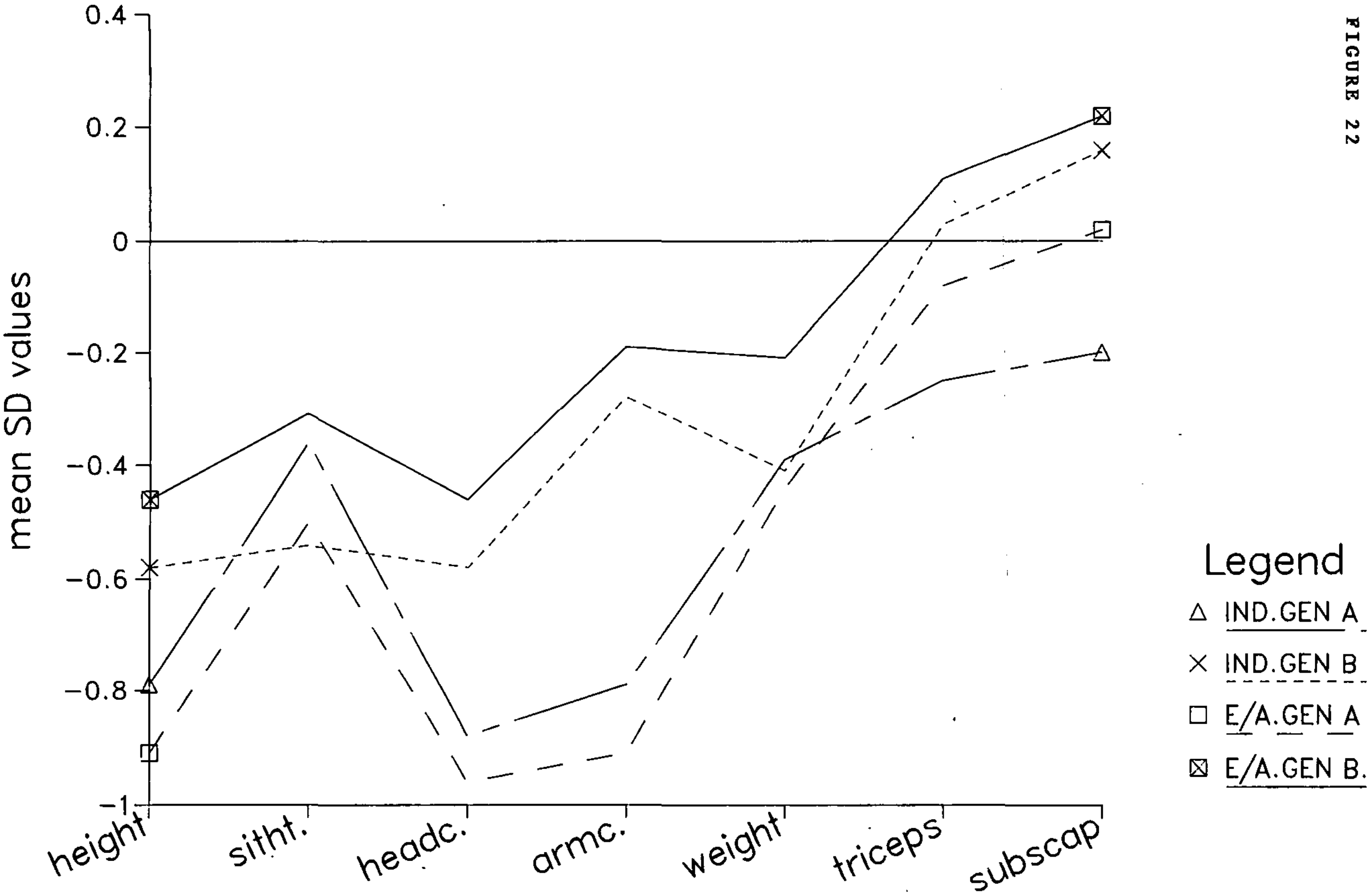


FIGURE 22

5.10 Body Proportions in Leicestershire White and Indian Children

To examine the skeletal growth pattern, the sitting height and leg length relationship was considered in the different ethnic groups. Regression analysis was carried out on sitting heights and leg lengths of the Indian and European children living in Leicestershire. Leg length was derived from stature minus sitting height. The Indian population was subdivided by religious adherence, generation and country of origin. A comparison of the regression equations for the Hindus direct from India was made with those of the Indians who came via East Africa, using an analysis of covariance (Brownlee 1965). For each sex, the lines were shown to be not only parallel but also coincident, so, it was concluded that the two populations were similar in the growth pattern of their sitting height:leg length relationship. Because of this result, for further analysis the Hindus were treated as a homogenous group.

The following regression equations were therefore obtained;-

Males	Indian -	Hindu	$Y = 0.24 + 1.21X$	$r^2=71\%$
		Muslim	$Y = 0.14 + 1.03X$	$r^2=57\%$
		Sikh	$Y = 0.25 + 1.22X$	$r^2=80\%$
	European		$Y = 0.32 + 1.29X$	$r^2=78\%$
Females	Indian -	Hindu	$Y = 0.21 + 1.17X$	$r^2=71\%$
		Muslim	$Y = 0.15 + 1.07X$	$r^2=59\%$
		Sikh	$Y = 0.29 + 1.28X$	$r^2=82\%$
	European		$Y = 0.24 + 1.18X$	$r^2=74\%$

r^2 explains the percentage of the variation in Y. The high correlation in each case indicate low variation in the Y values. The variance ratio, F, was calculated for each regression line to test for association between X and Y. Under the null hypothesis, $B = 0$, all F values were significant at $p<0.001$ level, indicating that sitting height and leg length values are highly associated.

The regression lines for the male and female Hindus were also compared and these lines proved to be parallel but not coincident, which suggests a similar relationship in growth of the two variables but the magnitude of one component differs in relation to the second. In this case, for a given sitting height, female leg length is smaller than the male leg length. A plot of the regression lines for the male and female Hindus and the male and female Europeans is shown in figure 23.

Using an analysis of covariance, the regression lines for the males from the three Indian religious groups were compared. This was repeated for the females. For both sexes, the regression lines were statistically parallel, in the three religious groups, but the means did not lie on the least squares line. When the three religious groups were compared with the European data, in a further analysis of covariance, the regression lines were found to be not parallel, in each sex, which indicated that the growth pattern and relationship between the two variables was not similar in the four groups. Plots of the comparison of the three Indian religious groups for each sex and the relationship between the 3 religious groups and the Europeans for each sex, are shown in figures 24 and 25.

Analysis of generation A versus generation B data for sitting height:leg length for each sex was not pursued, because of a dissimilarity in the variances of the two populations, when using either country of origin, i.e. East African Indians or Indians direct from India, in each generation group, or in a comparison of generation groups, irrespective of country of origin.

Sexual and Racial Differences in Body Proportions in Children
leg length in m.
1.4
1.2
1
0.8
0.6
0.4
0.2
0.0
0.2
0.4
0.6
0.8
sitting height in m.
Legend
HINDU MALE
HINDU FEMALE
EUROPEAN MALE
EUROPEAN FEMALE

FIGURE 23

Body Proportions in Indian Boys, 3–10years, in Leicestershire

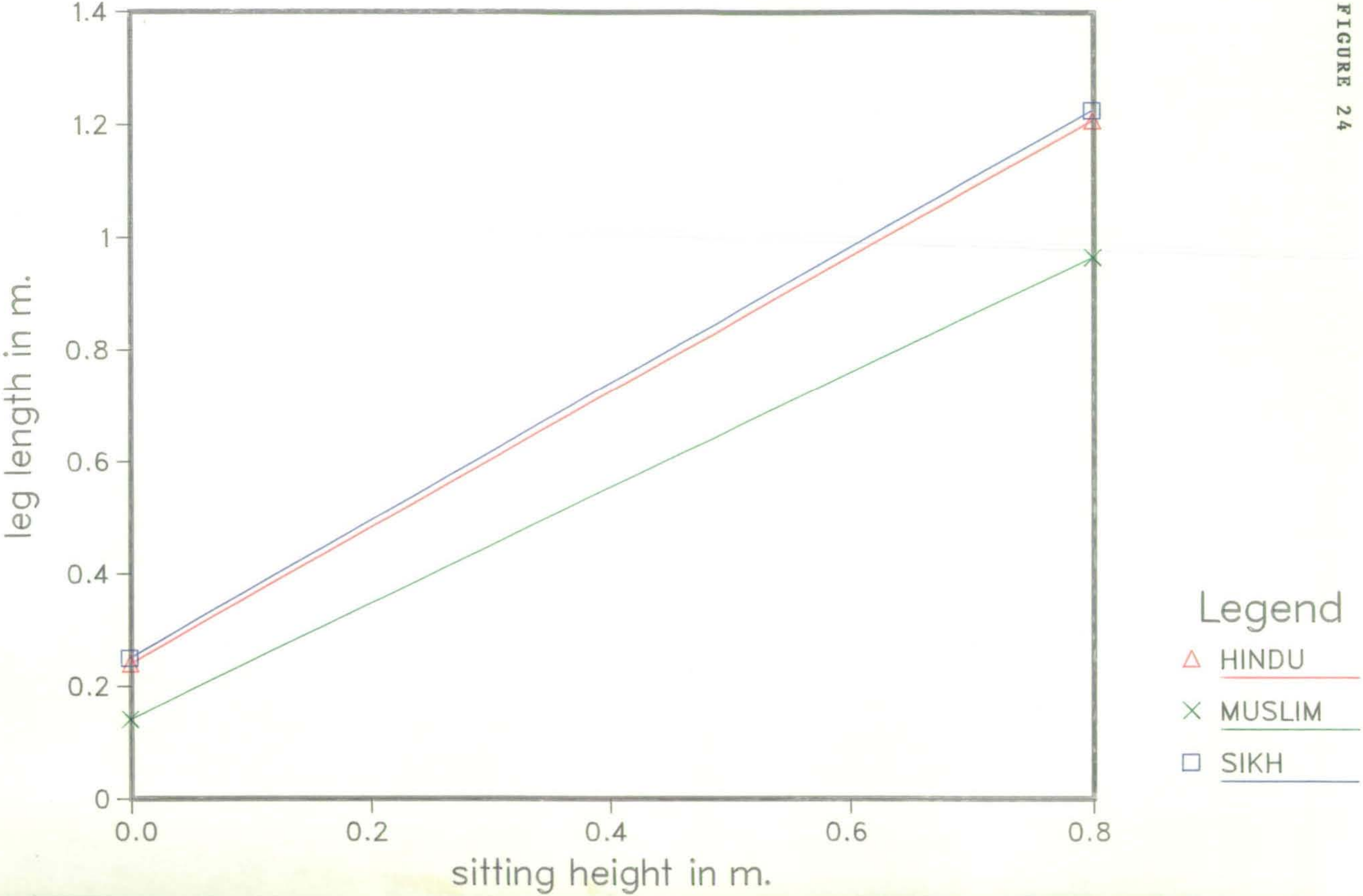


FIGURE 24

Body Proportions in Indian Girls, 3–10years, in Leicestershire

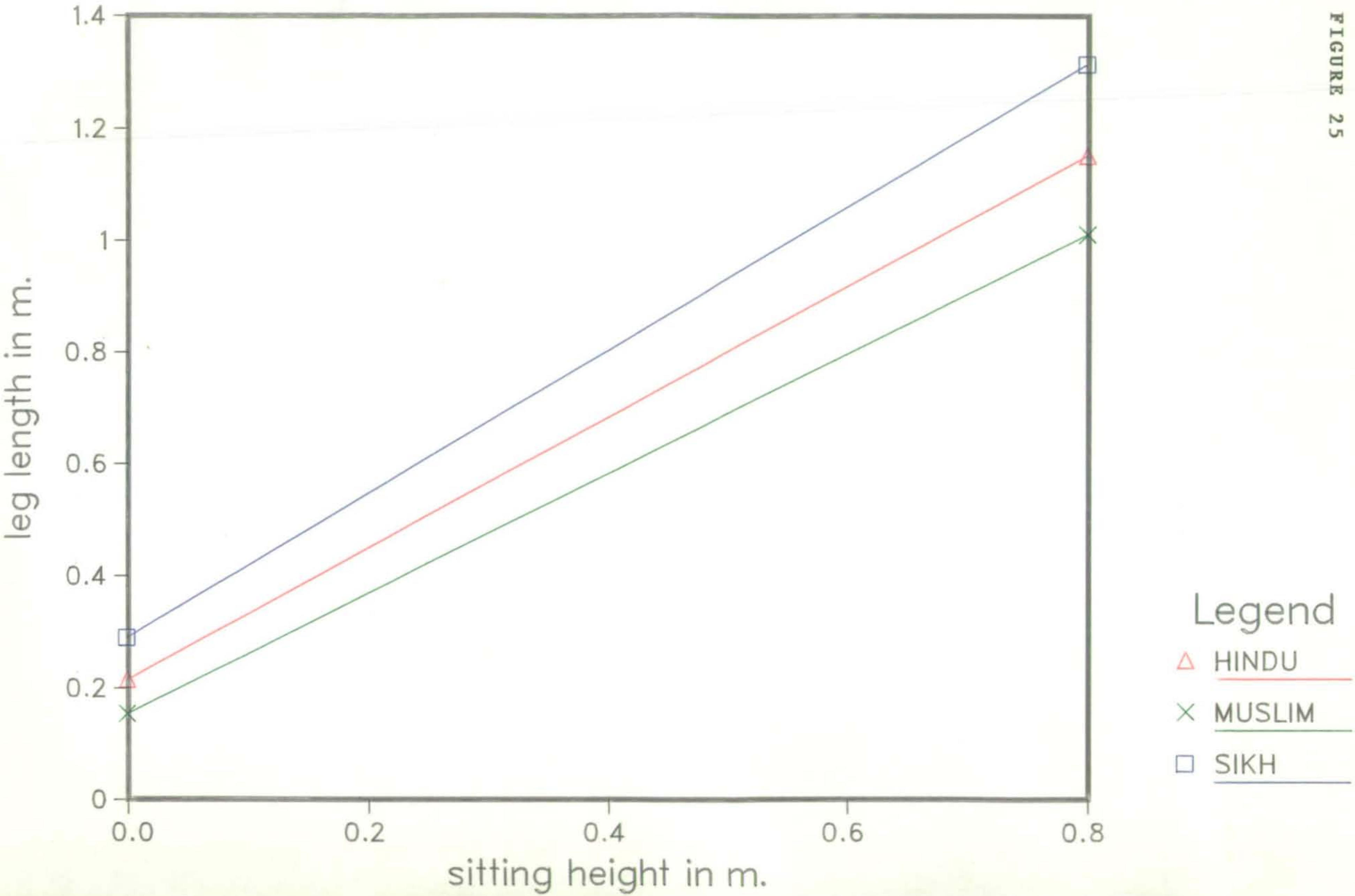


FIGURE 25

5.11 Upper arm composition compared in Leicestershire European and Indian Children

Using the method of Frisancho (1974) arm bone and muscle area (AMA) and arm fat area (AFA) were calculated for each sex, for the Hindus, Moslems, Sikhs, and European groups, and additionally for generation 'A' and 'B' Hindus. The distributions of the calculated AMA and AFA were found to be skew and normality was obtained by multiplying the values by log 10. An analysis of variance was performed on the normalised AMA and AFA data, for the Hindu, Muslim, Sikh and European groups, for year bands from 4 to 8 years inclusive. In all cases, the AMA results were found to be statistically significant at the 0.01 level (4 year males and females) or 0.001 level (5 to 8 year olds inclusive, males and females) but the AFA results only differed significantly on 3 occasions, $p<0.01$ for 6 year females, $p<0.001$ for 5 year females and 6 year males. The results are given in Table 40. Since it has already been shown that there are anthropometric differences between the Sikh, Hindu and Muslim children, differences between the European and some of the Indian children, and similarities between the European and Sikh children in some instances, two tailed t tests were performed upon the AMA and AFA data for combinations of Indian and European children, in order to determine if the differences that were shown in the analysis of variance, between the 4 groups, are specifically attributable to certain groups from the sample population only. The results of the two-tailed t tests between the 3 religious groups and the Europeans are given in Table 41 for the boys and Table 42 for the girls. Both tables include the mean differences, 95% confidence intervals, t values, degrees of freedom and associated P value for each age band.

From the t tests it can be seen that the differences lie predominantly between the European and the Hindu populations, and European and Muslim populations. For all age bands, and both sexes (with the exception of Muslim 8 year males) there are significant differences in AMA between these groups, whilst there are no differences for AMA between the Hindus and Muslims. There are some differences between the Sikhs and the Hindus, ($p<0.05$ for 6 year old males and 6 and 7 year old females, $p<0.01$ for 8 year old females), and between the Sikhs and Muslims ($p<0.05$ for 6 and 7 year old males and 5, 6 and 7 year old females). In each case, where differences occur, the Europeans have greater values for AMA than the Hindus and Muslims, and the Sikhs have greater values for AMA than the Hindus and Muslims.

For AFA, there are very few differences between the Indian and European data and within the Indian groups. Differences only occur between the female Europeans and Hindus ($p<0.05$ for 6 year olds, $p<0.001$ for 5 year olds), between the female Europeans and Muslims ($p<0.05$ for 6 year olds, $p<0.001$ for 5 year olds) and between the male Europeans and Sikhs ($p<0.01$ for 6 year olds). Other differences are sporadic between the groups, i.e. $p<0.05$ between 6 year old Hindu and Muslim boys, 5 year old Hindu and Muslim girls, 4 year old Hindu and Sikh boys, 5 and 6 year old Sikh and Muslim girls, and $p<0.001$ between Sikh and Muslim boys.

Thus, in summary, differences in the muscle and bone components of the arm, (which may be representative of the total body lean body mass) occur between the European and Indian populations, but specifically for the Hindu and Muslim Indians only, not for the Sikhs. For subcutaneous fat in the arm, (which may be representative of total body fat), there are no obvious ethnic differences between the Indian and European groups, or within the Indian child population, when categorised by religious adherence.

Since the Hindu and Muslim Indian children are smaller than the Sikh Indian children or the European children, for a given chronological age, the relationship between the skeletal dimension of height and arm muscle area was also examined. Regression lines were calculated from raw data of stature and log arm muscle area, at each age, 4-8 years inclusive, for each religious group of Indians and for the Europeans, and the following equations were obtained;-

Males	Indian -	Hindu	Y = 2.59 + 0.53X	r^2=49.4
		Muslim	Y = 2.66 + 0.48X	r^2=35.5
		Sikh	Y = 2.59 + 0.54X	r^2=41.6
	European		Y = 2.66 + 0.51X	r^2=56.9
Females	Indian -	Hindu	Y = 2.66 + 0.45X	r^2=37.5
		Muslim	Y = 2.71 + 0.42X	r^2=32.5
		Sikh	Y = 2.60 + 0.52X	r^2=56.2
	European		Y = 2.66 + 0.50X	r^2=51.2

r^2 explains the percentage of the variation in Y. The correlation varies, between the different groups and is not necessarily low because of small sample size, as the Sikh groups, who, along with the Muslims, contain only one quarter the number of subjects compared with the Hindus, have a higher correlation than the Muslims. A similar regression of stature with arm fat area produced r^2 values of 3-12%. The variance ratio F was calculated for each regression line to test for association between X and Y. Under the null hypothesis, B = 0, all F values were significant at $p<0.001$ level, indicating that stature and arm muscle area values are highly associated. The calculation of r^2 and the F value were carried out using the raw data.

A plot of the regression lines for the 3 religious Indian groups and the Europeans, for both sexes, are given in Figures 26 and 27. An analysis of covariance on the raw data of stature and AMA, for the 3 religious Indian groups and the Europeans, found that;-

for males, the null hypothesis that the 4 lines were parallel, was rejected,

$F = 5.51$ (df = 3, 1913), $F_{0.01} < 5.42$ (df = 3, infinity)

for females, the null hypothesis that the 4 lines were parallel was accepted,

$F = 0.16$ (df = 3, 1961).

Further, test whether the individual group means lay on the least squares line, produced the following results,

for males, $F = 3310$ (df = 1, 1913)

for females, $F = 1007$ (df = 1, 1961),

for both cases, it was concluded that the lines for the 4 groups differ.

From these 2 graphs can be seen that for a given height, the Indian children have less arm muscle than the European. The Sikhs and Europeans, whose mean values for arm muscle area and arm fat area were not statistically different, (with the exception of 6 year old males, $p<0.05$ for AMA and $p<0.01$ for AFA, and 5 year old females, $p<0.05$ for AMA), both have more arm muscle for a given height than do the Muslims and Hindus. Since the Indian Muslims and Hindus are also generally smaller for a given chronological age than the Sikhs and Europeans, they have even less muscle relative to their peers of a similar age. The Hindus and Muslims have similar amounts of muscle for a given age.

TABLE 40

DIFFERENCES IN ARM MUSCLE AREA (AMA) AND ARM FAT AREA (AFA) BETWEEN HINDU, MUSLIM AND SIKH INDIAN AND EUROPEAN CHILDREN, AGED 4+ - 8+ YEARS (ANALYSIS OF VARIANCE)

		MALES		FEMALES	
AGE-YR.	GROUP	ARM MUSCLE AREA	ARM FAT AREA	ARM MUSCLE AREA	ARM FAT AREA
4+	HINDU	F = 5.04		F = 4.32	
	MUSLIM	(DF = 3, 226)		DF = 3, 217)	
	SIKH				
	EUROPEAN	**		**	
5+	HINDU	F = 9.07		F = 15.56	F = 8.11
	MUSLIM	(DF = 3,323)		(DF = 3, 324)	(DF = 3, 324)
	SIKH				
	EUROPEAN	***		***	***
6+	HINDU	F = 13.48	F = 6.57	F = 18.50	F = 4.07
	MUSLIM	(DF = 3, 311)	(DF = 3, 311)	(DF = 3, 348)	(DF = 3, 348)
	SIKH				
	EUROPEAN	***	***	***	**
7+	HINDU	F = 20.22		F = 14.25	
	MUSLIM	(DF = 3, 270)		(DF = 3, 287)	
	SIKH				
	EUROPEAN	***		***	
8+	HINDU	F = 11.77		F = 23.30	
	MUSLIM	(DF = 3, 260)		(DF = 3, 248)	
	SIKH				
	EUROPEAN	***		***	

level of significance * $p < 0.05$, for F (df 3,inifinity) > 2.60
** $p < 0.01$, for F (df 3, infinity) > 3.78
*** $p < 0.001$, for F (df 3, infinity) > 5.42

TABLE 41

A COMPARISON OF LEICESTERSHIRE EUROPEAN AND INDIAN RELIGIOUS GROUPS FOR ARM MUSCLE AND FAT AREA
(TWO TAILED T TESTS)

EUROPEAN MALES COMPARED WITH:-

	AGE(YRS)	X DIFF	95% C.L.	T	DF	P		X DIFF	95% C.L.	T	DF	P
HINDU	4+	.0449	0.025, 0.065	4.44 ***	178	0.0000	HINDU					
A.M.A.	5+	0.041	0.022, 0.061	4.30 ***	181	0.0000	A.F.A.					
	6+	0.049	0.031, 0.067	5.48 ***	209	0.0000						
	7+	0.062	0.044, 0.081	6.66 ***	165	0.0000						
	8+	0.52	0.034, 0.069	5.73 ***	126	0.0000						
MUSLIM	4+	0.353	0.007, 0.067	2.54 *	49	0.0144	MUSLIM					
A.M.A.	5+	0.050	0.021, 0.08	3.48 **	37	0.0014	A.F.A.					
	6+	0.056	0.03, 0.083	4.30 ***	52	0.0001						
	7+	0.106	0.053, 0.138	4.87 ***	13	0.0000						
	8+											
SIKH	4+						SIKH					
A.M.A.	5+						A.F.A.					
	6+	0.026	0.005, 0.047	2.48 *	64	0.0159		-0.098	-0.017,-0.029	-2.88 **	44	0.0062
	7+											
	8+											

HINDU MALES COMPARED WITH:-

	AGE(YRS)	X DIFF	95% C.L.	T	DF	P		X DIFF	95% C.L.	T	DF	P
MUSLIM	4+						MUSLIM					
A.M.A.	5+						A.F.A.					
	6+							0.076	0.016, 0.136	2.55 *	58	0.0135
	7+											
	8+											
SIKH	4+						SIKH	-0.072	-0.152, -0.01	-2.41 *	23	0.0246
A.M.A.	5+						A.F.A.					
	6+	-0.23	-0.046,-0.001	-2.06 *	82	0.0424						
	7+											
	8+											

MUSLIM MALES COMPARED WITH:-

	AGE(YRS)	X DIFF	95% C.L.	T	DF	P		X DIFF	95% C.L.	T	DF	P
SIKH	4+						SIKH					
A.M.A.	5+						A.F.A.					
	6+	0.031	0.001, 0.06	-2.06 *	66	0.0434		0.143	0.061, 0.225	-3.48 ***	68	0.0009
	7+	0.068	0.011, 0.125	-2.47 *	23	0.0214						
	8+											

level of significance * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
numbers are logged

TABLE 42

A COMPARISON OF LEICESTERSHIRE EUROPEAN AND INDIAN RELIGIOUS GROUPS FOR ARM MUSCLE AND FAT AREA (TWO TAILED T TESTS)

EUROPEAN FEMALES COMPARED WITH:-

	Age(yrs)	X DIFF	95% C.L.	T	DF	P		X DIFF	95% C.L.	T	DF	P
HINDU	4+	0.04	0.02, 0.07	3.30 ***	157	0.0012	HINDU					
A.M.A.	5+	0.05	0.04, 0.07	6.06 ***	244	0.0000	A.F.A.	0.06	0.02, 0.09	3.49 ***	270	0.0006
	6+	0.05	0.04, 0.07	6.78 ***	287	0.0000		0.04	0.01, 0.08	2.31 *	296	0.0219
	7+	0.06	0.04, 0.08	5.96 ***	197	0.0000						
	8+	0.08	0.06, 0.10	8.65 ***	140	0.0000						
MUSLIM	4+	0.03	0.00, 0.06	2.14 *	68	0.0444	MUSLIM					
A.M.A.	5+	0.07	0.04, 0.10	4.50 ***	47	0.0000	A.F.A.	0.11	0.06, 0.16	4.42 ***	42	0.0001
	6+	0.07	0.04, 0.10	5.28 ***	27	0.0000		0.08	0.02, 0.15	2.70 *	27	0.0119
	7+	0.05	0.02, 0.09	3.68 **	24	0.0012						
	8+	0.07	0.00, 0.13	2.64 *	5	0.0463						
SIKH	4+						SIKH					
A.M.A.	5+	0.03	0.01, 0.06	2.42 *	44	0.02	A.F.A.					
	6+											
	7+											
	8+											
HINDU FEMALES COMPARED WITH:-												
MUSLIM	4+						MUSLIM					
A.M.A.	5+						A.F.A.	0.056	0.004, 0.108	2.18 *	43	0.035
	6+											
	7+											
	8+											
SIKH	4+						SIKH					
A.M.A.	5+						A.F.A.					
	6+	-0.03	-0.06,-0.00	-2.15 *	40	0.0373						
	7+	-0.06	-0.10,-0.01	-2.63 *	19	0.0166						
	8+	-0.06	-0.10,-0.02	-3.61 **	11	0.0041						
MUSLIM FEMALES COMPARED WITH:-												
SIKH	4+						SIKH					
A.M.A.	5+	-0.04	-0.07,-0.00	-2.13 *	50	0.0378	A.F.A.	-0.08	-0.15,-0.01	-2.21 *	48	0.0316
	6+	-0.05	-0.08,-0.01	-2.64 *	46	0.0112		-0.12	-0.21,-0.03	-2.61 *	46	0.0121
	7+	-0.05	-0.01,-0.00	-2.12 *	26	0.0435						
	8+											

level of significance * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Height and Arm Muscle Area in Leicestershire Girls aged 4–8 years

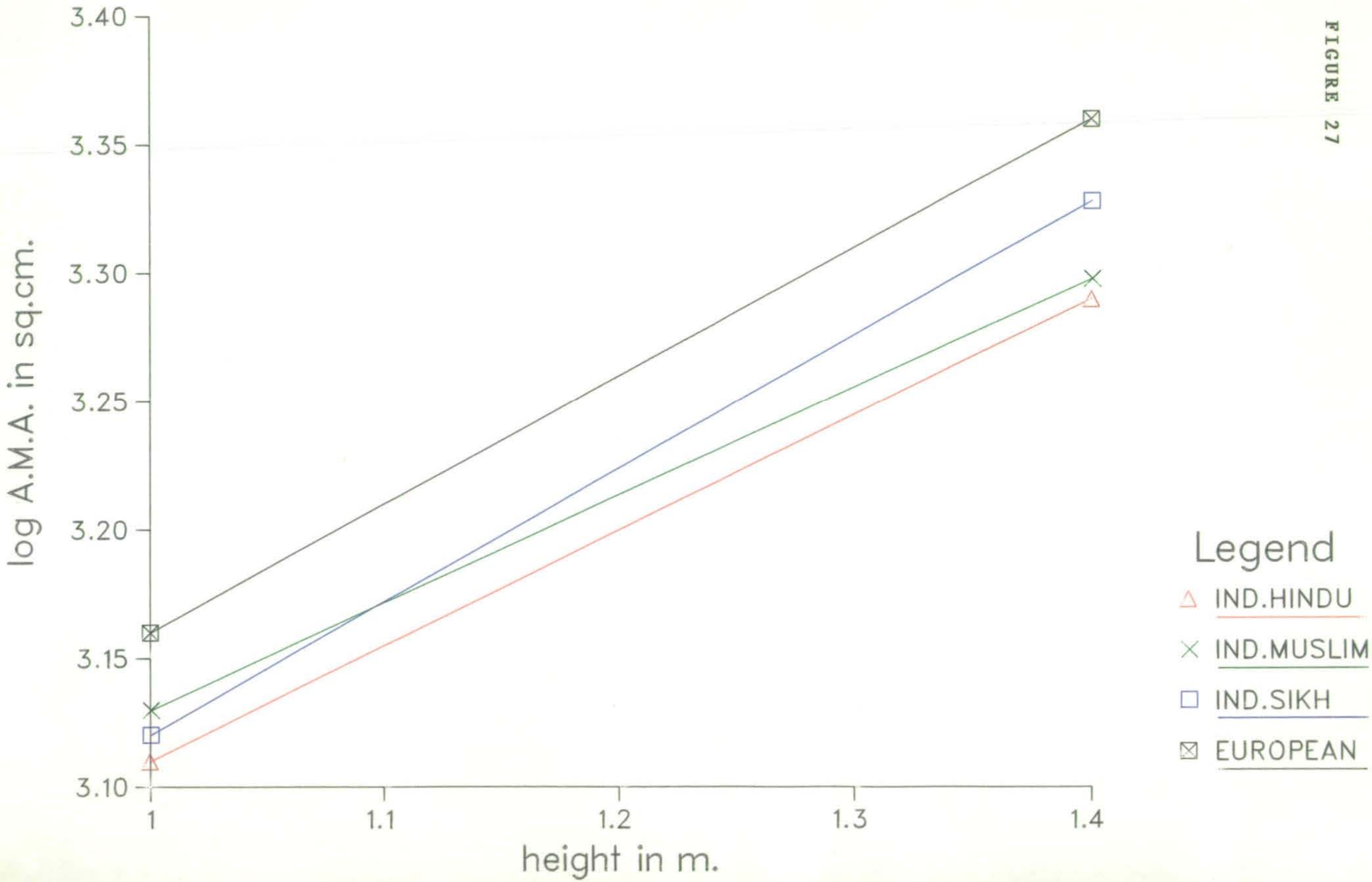
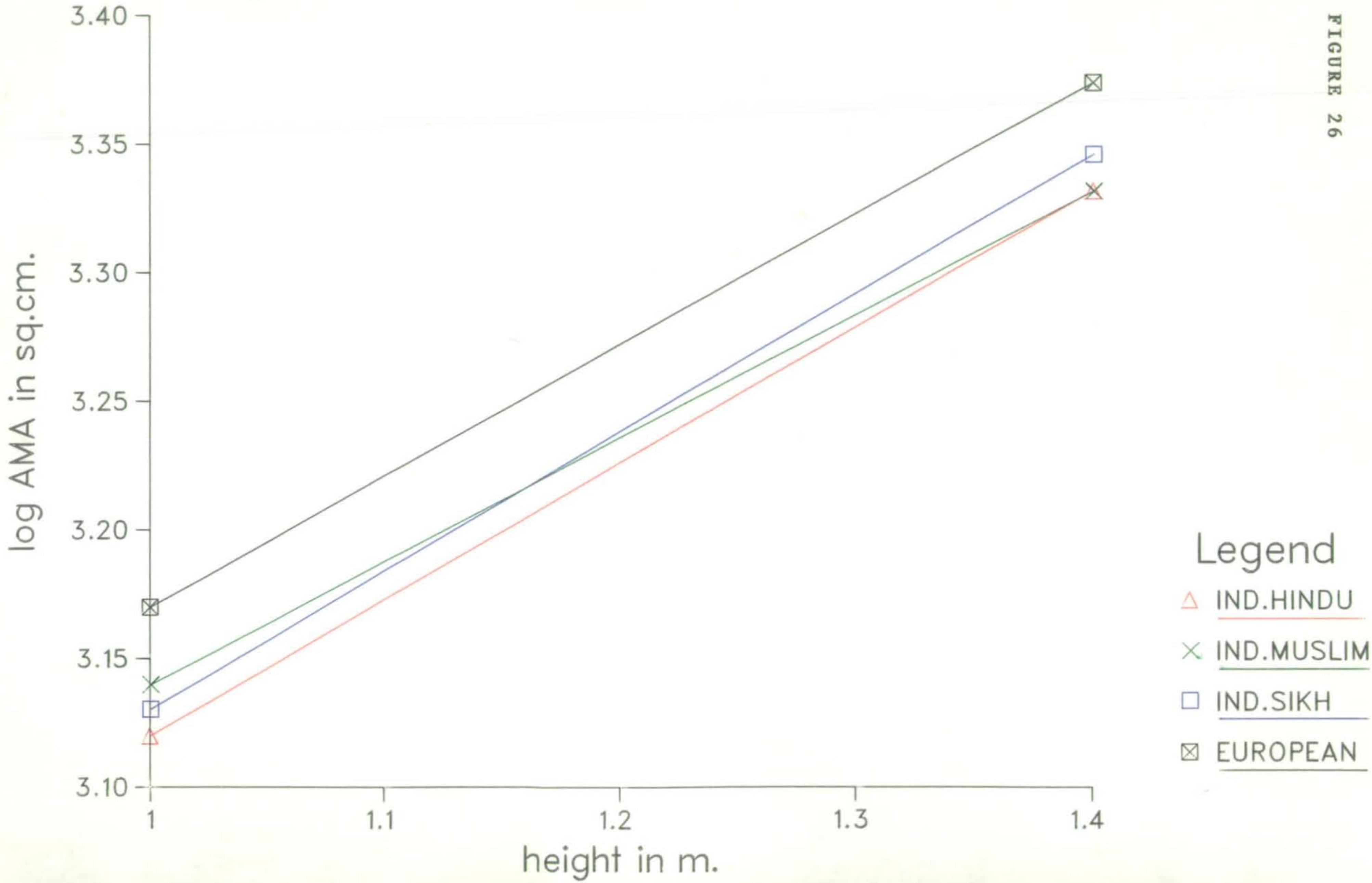


FIGURE 27

FIGURE 26

Height and Arm Muscle Area in Leicestershire Boys aged 4–8 years



5.12 Summary of Results

1) There are some differences between the European children currently living in Leicestershire and the reference standards in that the Leicestershire children are taller but not heavier. There are also slight differences in subcutaneous fat distributions based upon triceps and subscapular sites and the Leicestershire girls appear to be a population with smaller than expected head circumferences.

2) The anthropometric parameters measured differ in the Leicestershire Indian and European children. In each case, the European children have the larger values, with the exception of skinfolds, for which the Indian children have the higher values.

3) The Leicestershire Indian children do not match the reference data either. There are more children than expected falling in the lower half of the distribution, with the exception of the subscapular skinfold site.

4) There are no differences in the anthropometric parameters measured between the children who migrated to Great Britain direct from India and those who came via East Africa, but these results are somewhat misleading as the 2 sample populations can be divided further into a number subgroups.

5) The Leicestershire Indian children can be divided up by religious adherence and differences in anthropometric parameters can be seen between the 3 major religions, i.e.

   Sikhs > Hindus; Sikhs > Muslims;
   Hindus = Muslims;

   except in the latter case, Hindus > Muslims for female height, sitting height and male and female skinfolds.

6) The Leicestershire Indian children, when divided up by religious adherence also show specific differences between certain religious groups and the Leicestershire European children, i.e.

For, height, sitting height, arm and head circumference and weight:-
Europeans > Hindus; Europeans > Muslims; and
Europeans = Sikhs;
except for head circumference, Europeans > Sikhs.

For skinfolds:-
Europeans < Hindus
(except for female triceps, Europeans = Hindus),
Europeans = Muslims;
Europeans = Sikhs (female); Europeans < Sikhs (male).

7) Indian children in India have been shown to differ in certain growth characteristics, such differences being attributable to religious adherence and/or location of habitat. The Leicestershire Indian children have not only maintained these differences between the 3 religious groups, but for all 3 religious groups, the Leicestershire Indian children have shown increases in height and weight, such that there far are more children than expected in the upper half of the reference data from India.

8) Change in country of residence has not only had an effect upon growth, but the stay for one or more generations in East Africa before coming to live in Great Britain, is also related to increased values in certain anthropometric variables. Secondly, the length of stay in Great Britain, and specifically if that length of stay has been from birth onwards, appears to be related to an increase in some anthropometric dimensions.

9) Finally, there are differences in

(a) body proportions, between the Leicestershire European and Indian children, with the Indian children having smaller leg lengths for a given sitting height, and

(b) body composition, as assessed by upper arm composition. The Hindu and Muslim children have smaller amounts of the bone and muscle component of the upper arm, when assessed by cross-sectional area compared with the Sikh and European children.

CHAPTER 6

DISCUSSION

DISCUSSION

The Leicestershire European Children

The comparison of the European children with the reference standards suggests that there have been some growth changes in the last 20 years, but, on the whole, the standards currently used, are still applicable. Goldstein (1971) found no differences between his 7 year old children from the National Child Development Study (N.C.D.S.) and Tanner et al's (1966a,b) standards for males and only 0.3cm. for females for the 50th centile. But the children in the N.C.D.S., although sampled nationally, were also born over 20 years ago (in 1958). More recently, Rona and Altman (1977) also found that the heights and weights of their English children in the National Study of Health and Growth (N.S.H.G.), which sampled 22 areas in England and 6 in Scotland, were similar to those of Tanner et al (1966a,b). The heights of the 1980's Leicestershire indigenous children however, show some differences and indicate that this population is now taller than that upon which the reference standards were based suggesting that a positive secular trend in height has continued over the last 20 years. Cameron (1979) found no change in height and weight between 1959-1966 and suggested that the positive secular trend in height and weight between 1905 -1959 in London schoolchildren had ceased by 1959. Rona and Altman (1977) found that, for their children, aged 5 - 11 years, the Scottish children were shorter and lighter than English children but the English sample, from 22 areas in England, which represented a cross-section of almost all of the country except the south east, matched Tanner et al's (1966) data and suggested that this also supported the cessation of secular trend. However, Chinn and Rona (1984) following up the children reported by Rona and Altman (1977) on a longitudinal basis, have confirmed that a positive secular trend in height continued in the 1970's. They also found that the trend was greater at age 8 than at age 5 although this study of Leicestershire white children has found similar percentages of taller or less short children at all ages, where significant differences occurred. The children in this study were born approximately 10 years later than the population studied by Chinn and Rona (1984), and a comparison with the N.S.H.G. data showed that the Leicestershire population contained more tall children, thus suggesting that in Leicestershire at least, a positive secular trend in height has continued, even though Rona and Altman (1977) postulated that the trend could have ceased or even reversed by the 1980's. The fact that there are no differences between the 3 year old sample and the reference data, in spite of the fact that the median age for that group is higher than in any other group, and obviously contains proportionally more older children, may be accounted for by the fact that all the three year old white children measured will be from day nurseries and nursery units of schools. Such nursery units were attached only to the inner city schools and in such catchment areas white families of social classes III to V are the predominant residents. Reduced height with increasing social class number is documented (Goldstein 1971).

The weights of the European children in this study do not appear to differ from those of the reference data of Tanner et al (1966a,b) thus supporting the finding of Rona and Altman (1977) and endorsing their statement that a positive secular trend in weight had ceased in England. In our study no correction was made for the fact that the children were wearing some light clothing, although they have been compared in some cases with data based upon the nude weight of children (Tanner et al 1966a,b). Rao and Sastry (1976) found a coefficient of variation of approximately 1.5% and a standard deviation of 0.2kg. in childrens' weight, when measuring their subjects at the same time of the day on repeated occasions. The measurements in this study were taken over the whole school attendance period, i.e. soon after breakfast for some children, just pre-lunch for others, immediately after lunch and up to 2-3 hours after that, in many cases. Variation in weight due to the time of measurement, over which there was no control, plus an expected variation of 1.5% will be greater than the difference in weight between partially clothed and nude children of approximately 0.5kg. No opportunity was available to ensure that the subjects evacuated their bladder or bowels prior to measurement.

The differences in head circumference between the Leicestershire white population and the standards are somewhat difficult to explain. The differences cannot be attributable merely to a difference in technique because then there should be a similar discrepancy between each sex and the reference data, but it is in the girls data predominantly that significant differences occur with the head circumference being smaller than expected. There was a small difference in the measuring technique in that in this study the tape was placed just over the brows and parallel to the Frankfort plane, without adjusting for maximum circumference which means that the Leicestershire data will record slightly smaller head circumferences. Some recent work on Oxford children has shown evidence of a secular trend in head circumference, with Oxford children, from 3-4 years onward, having larger head circumferences than are represented in Tanner's charts (Ounsted et al 1985) but the Leicestershire children appear to give no indication of such a trend towards increased size.

There appear to have been some changes in the amount of subcutaneous fat in children now compared with the reference standards (1975). Changes were also found by Rona and Altman (1977) but they found only slight differences in skinfold values for the triceps site, with agreement in the 50th and 97th centiles for males and 97th for females. Their 3rd. centile males and 3rd. and 50th centile female values were higher than the reference values. In the Leicestershire children, agreement occurs between the females outer centiles and the reference data, but differences occur at the 50th centile and the males differ at both the 50th and the outer centiles. One further major difference is that for the Leicestershire children, the triceps skinfold distribution is lower than the reference data, in each case, which is in total opposition to Rona and Altman's findings. However, conversely, our subscapular skinfold distribution was higher than the 50th centile reference values and also differed from the 10th centile in both sexes, although there was agreement at the 90th centile. It is documented that a slight change in site of measurement for the triceps skinfold can produce differences in fatfold value (Ruiz et al 1971), and indeed, Rona and Altman attributed the discrepancy between their values and those of Tanner and Whitehouse (1975) as due to a slightly different method of measurement. It is possible that the differences in subscapular values can possibly be explained in a similar manner or alternatively they may reflect a change in fat patterning and a trend towards greater subcutaneous trunk fat deposits in children. But, there was also a problem in normalizing the Leicestershire skinfold data. Rona and Altman (1977) found that Edwards et al's (1955) log-transformation did not successfully normalize their triceps data totally for either sex. For the Leicestershire data, Edwards et al's (1955) transformation was adequate for the triceps values but left the subscapular data still skewed and a modification of the log transformation:-

$$\text{skinfold transform} = \log_{10}(\text{reading in 0.1mm.} - 30)$$

produced a more successful conversion of the subscapular skinfold data to a normalised distribution. Shepherd et al (1969) reported that skewness was more marked in their subscapular skinfold than in their triceps, for Canadian children, aged 10 - 12 years. The fact that the Leicestershire skinfold data were still slightly skewed, after applying Edwards et al's equation, may account for some of the differences found between the 2 populations, although the discrepancy between the 2 populations was found at the lower and 50th centile not at the 90th.

As judged by external manifestations, puberty starts in contemporary western youth at approximately 10-11 years in girls and 11-12 years in boys, although there is wide variability (Katchadourian, 1977). Tanner (1962) quotes an average age for the adolescent growth spurt, which affects height and weight, for males 13-15$^1/_2$ years, and for females 11-13$^1/_2$ years. More recently, Marshall(1978) quoted the mean age of peak height velocity for English girls as 12.14 years, with a standard deviation of 0.88 years, and for boys, 14.06 years, with a standard deviation of 0.92 years and Marshall and Tanner (1969) quote the mean age of stage 2 breast development in girls, (which is usually the first outward sign of puberty) as 11.2 years + 2.2 years (+ 2S.D.). Since this study involves measurements that encompass anthropometric parameters that are involved in the adolescent growth spurt it is inevitable that a few of our European subjects will be pubertal and their dimensions, and therefore the measurements recorded, will reflect this fact.

Work by Prakash and Cameron (1981) showed a pattern of skeletal maturity and attained height of children in Punjab, North India, reflecting a general parity with the British standards of Tanner, Whitehouse, Marshall, Healy and Goldstein's TW2 method (1975) and Tanner et al (1966a,b), and Sidhu and Phull (1974) quote an average age of 14.5 years for the adolescent growth spurt in rural male Punjabis. On the basis of this information, and the fact that, for European females, skeletal maturity correlates more closely with the onset of menarche, than does chronological age, (although for development of other pubertal stages, in males and females there are no obvious correlations between skeletal age and the timing of the pubertal stages, Marshall 1974) the children from India and the European children in this study have been treated as prepubertal, although it is acknowledged that for a small proportion of this population, onset of puberty will be earlier than 10.999 years of age, the top age analysed in this study.

Furthermore, since Prakash and Cameron (1981) found skeletal maturation to be on a par in their Indian children with British data (Tanner et al 1975), it has been assumed that the tempo of growth between the 2 groups is also comparable, and that the demonstrated anthropometric differences between the Leicestershire indigenous and Indian child population are not due to differences in rates of maturation.

The Leicestershire Asian Children

The initial comparison of the Leicestershire European children with children from the subcontinent of India supports the comments heard in many staff rooms visited during the Growth study, that the Asian children were perceived to be smaller and thinner. From the results in this study it can be seen that there are pronounced differences in the anthropometric parameters of height, head circumference, arm circumference, sitting height and weight with the European children's values being higher in each case. For skinfolds, there is less discrepancy between the two populations and, in this case, the Indian children have the higher values.

However it has already been documented that Indian children of mixed socioeconomic standing fall considerably short of the Harvard (American) reference standards (Naik et al 1976) for weight and to a lesser extent for height although those from well-to-do families were found to be as tall as the British reference data (Rao et al 1976) or the American (Raghavan et al 1971: Banik et al 1972) at least up to adolescence (Rao and Sastry 1977). The Indian children in this study are assumed to be of mixed socioeconomic background. If it is assumed that a good environment, such as that obviously experienced by well-to-do Indian families in India, produces a taller, heavier Indian child, it might be that the environment in Great Britain (even though not ideal by British standards - see problems for immigrants in Great Britain, chapter 2) but also experienced by the indigenous population measured, offers an improvement upon living conditions in India.

Country and Area of Origin

But, the children from India living in Leicestershire are not a homogenous group. They can be split up by area of the country from which they have migrated. There is evidence of differences in growth of children in the different states in India, i.e. All India Study (I.C.M.R. 1972) found children from Punjab and Delhi taller and heavier than those from the other states that they sampled and Agarwal et al (1970) found differences, with his children, (assumed to be from Delhi but unstated), heavier than those from 3 other areas, Poona, Bombay and Vellore. In Leicestershire, the children of Indian origin come from the North West of India mainly, the 2 States of Gujarat and Punjab, areas which have different historic backgrounds of invasion and cultural development (Gupta 1971: Bhatt 1972). Unfortunately Gujarat State, from which the majority of the Leicestershire Hindus originate was not represented in the All India Study, so a comparison of the growth data on children in the Punjab and Gujarat, with the Leicestershire children from both those 2 states was not possible.

However, to complicate a possible genetic distinction between the peoples in the 2 states, during Partition (1947) many Muslim Indians crossed the border to live in Pakistan and many Hindus moved south to live in India, so compounding, over a period of time, classification by country of origin and the genetic mix. This migration of religious groups, suggests other factors that might contribute to a division of the population into separate groups as reflected by the growth characteristics of each group.

Religious Adherence

Peoples from the Indian subcontinent can be subdivided into five main religious groups, Hindus, Muslims, Sikhs, Jains and Christians, although in Leicester City there are few or no Jains (Leicester Report 1983).

The religions practised by the families in this study from the Indian subcontinent were identified from the surname of each child and coded onto the protocol. But, by its very method of analysis, this system of classification ignores any Christian conversions in the sample measured, of this population. However, although the Christian population has shown the fastest growth in India from 1921 onwards, with a 33% increase between 1961 and 1971 (Bhattacharjee and Shastri 1976), its numbers are still very small relative to the numbers of Hindus and Muslims. Of the population in India, there are 82.7% Hindus, 11.2% Muslims, 2.6% Christians, 1.9% Jains, 0.5% Sikhs, and 0.4% other religions, (Bhattacharjee and Shastri 1976), and therefore our sample, using the same proportions, could have misclassified 41 children from our Indian population as Muslims or Hindus. Alternatively, there are 1.6% Christians among the Asian families living in Leicester (Leicester Report 1983), (62.0% Hindus, 18.4% Muslims, 16.7% Sikhs) which means that 25 children of our Indian Muslim and Hindu families could be unidentified Christians, using the Leicester Report (1983) data. Since Sikhs have modified their name from the original caste name to one which contains the title 'singh' in males and 'kaur' in females, all the Sikhs were easily identified.

There are certainly differences within the Leicestershire Indian population, when they are divided up by religious affiliation. The Sikhs are taller, heavier, and have greater head circumferences, arm circumferences and sitting heights than their fellow Muslims and Hindus, although there are very few differences between the Muslims and Hindus. Similar differences between the 3 religious groups have also been found in the newborn in Leicester i.e. Sikh newborn were heavier and longer than the Muslim and Hindu (Chetcuti et al 1985), and they also found that the Sikhs had greater head circumferences than the Muslims although not greater than the Hindus. In Harrow, McFadyen et al (1984) found a difference between their Hindu and Muslim newborn, with the Hindu lighter than the Muslim, and lighter than their European newborn. Chetcuti et al's comparison of their Indian data with the white newborn also showed a similar pattern of differences in the 2 populations, to ours on the older children in Leicestershire, i.e. the white newborn were heavier than all Indian babies and had larger heads. However, this is not a new phenomenon, the All India Study (1972) also documented differences between their religious groups, in India, with mean values for height and weight of Sikh children highest for both sexes, and lowest for children belonging to the Jain and Christian religions. The Muslim and Hindu mean values were similar and fell between the 2 extremes. Sikh children also had the largest head circumferences.

Religion and Diet

It is not known how exactly religion could influence the growth of a child, it may be due to differences in the diet or social or religious customs, specific to each religion (All India Study 1972). Certainly the diet of the individual is very much dictated by his religion, and since growth or the lack of it is considerably influenced by diet, the method of analysis of the growth of Indian children by classification based upon religious adherence, may be useful.

One of the main differences between the three religions is the dietary restriction and intake in each case, and it maybe that the Sikh diet, which has far fewer restrictions, has contributed to the differences observed in growth when comparing the three religious groups with reference data. Work supporting this supposition was carried out by McCarrison (1927). He noticed differences in adult size between two groups of Indians, both racially alike, one high caste with good food intakes and the other, an untouchable, with poor living conditions and poor food. He then fed laboratory rats either a Sikh diet of meat, vegetables, grain and milk or a Madrassi diet of vegetables, rice, coffee and betal nuts. The Sikh diet animals were larger and better developed for their age and healthier.

More recently, Wharton et al (1984) analysed the food intake of Hindu, Sikh, Bangladeshi Moslem and Pakistani Moslem pregnant women and found that the Sikhs had the highest intake of most nutrients and a greater variety of common foods in general use. The Hindus, had a quantitative intake and pattern of food consumption similar to that of the Sikhs, except that more meat, chicken and fish were consumed and more rice eaten. The Pakistani and Bangladeshi Moslems had lower intakes of nutrients than the other two groups with the Bangladeshis being the lowest. There were also differences in size between the women. Although the differences in mean energy intake were not large, there was a substantial difference in type and range of food selected, resulting in a marked difference in intake of certain nutrients.

Chetcuti et al (1985) also suggested that dietary factors may account for the differences seen between the Hindus, Sikhs and Muslims although this did not explain the differences seen in their Leicester newborn between the Muslim and Sikh babies who were both born to meat eaters and the similarities between the Hindus and Muslims who had dissimilar diets.

A comparison made with the All India Study (I.C.M.R. 1972) to see whether the differences in our sample between the 3 religious groups was merely a continuation of those differences already in existance in India, and which have simply been transferred to the new country with migration, or whether other differences have been superimposed by change in country of habitation, showed that in each case the Hindus, Muslims and Sikhs are now taller and heavier than those measured in the All India Study (I.C.M.R. 1972).

There are reservations that must be applied to these results in that the Indian data were compiled approximately 20 years before the Leicestershire Indian data, and the phenomenon of secular trend towards greater height and weight is documented in India (Madhavan et al 1964) as well as in some countries in the western world (Rona and Chinn 1984). Also, the Indian data were compiled from the whole country, with a few exceptions, whereas the children resident in Leicestershire originate almost entirely from the 2 states of Gujarat and Punjab. To reduce the effects of secular trend, which is thought to be attributable to good socioeconomic conditions and nutrition, a comparison was made with Prakash and Cameron's (1981) more recent study on Punjabi Indian children of high socioeconomic status. They found that the female height stayed close to Tanner et al's (1966) 50th centile while the weight matched the 25th centile. For males, the height and weight both started on the 50th centile but fell to the 25th after the age of 9. The religious adherence of the subjects was not stated but the Leicestershire Sikhs, who originate predominantly from Punjab State, had similar heights and weights at the younger ages (6-7 years in the girls and 6-8 years in the boys) but at the older ages both sexes were taller and the girls were also heavier. Whether the older children from the Sikh population have lived in Great Britain for longer and the effects of longer term residence in Great Britain are being exhibited is not known, as specific time of residence in this country is not known. Eveleth and Tanner (1976) commenting on the findings of Raghavan et al (1971) noted that the well-to-do children in India tended to fall back in height and weight with age from 10-12 years of age onwards, depending upon sex and Rao and Sastry (1977) found smaller peak height velocities and peak weight velocities in their Indian children compared with British reference data, which resulted in differences in height after 14 years of age and even greater differences in weight (even with adequate nutrition and no disease stress). However, Hauspie et al (1980) in a longitudinal study of Bengali children aged 0-14 years, found peak growth velocities similar in size and timing to those found in British children. The comparison of the Leicestershire Indian data with Tanner et al's (1966) standards for height and weight produced no distinct age related differences. Clarson et al (1982) have found evidence of a secular change in birth weight in Asian babies born in Birmingham (although their results showed greater changes for Pakistani babies than for Indian ones) and they suggest that genetic factors are unlikely to be the major reason why differences occur between the indigenous and immigrant population and environmental factors play an important role.

Other Environmental Factors

But all the Indians by migrating to this country and now resident in Leicestershire have undergone considerable changes in environment, e.g. changes in climate, lifestyle, availablility of food comparable to that in their old country, housing, all of which will involve psychological factors as well as the physical differences. It is well documented that environmental conditions affect growth, e.g. Roberts (1960) on the effect of climatic conditions, Banik et al (1970a) on the effects of socioeconomic conditions, Madhavan et al (1967) on the effects of dietary conditions, and all these may conspire to produce a change in the growth characteristics of the Asian child from the Indian subcontinent now residing in Leicestershire.

Habitation - Residence in East Africa

If environmental conditions are responsible for the differences seen between the European and Indian children in Leicestershire, and between the Indian subgroups, by using one religious group only, dietary variation as dictated by religion should be eliminated or at least reduced and a study of other environmental factors implicated in the immigrants change of country of habitation can be made. An analysis of Hindu children only was made, partly because of limited subject numbers in the Muslim and Sikh subgroups, but also because the Hindu religion does not exhibit such overt sexual discrimination between males and females as does Islam, in terms of feeding patterns (males first) and in terms of dress restriction leading to limited exposure to sunlight in females and tendency to vitamin D deficiency (D.H.S.S. 1980).

Some of the Indian community now resident in Leicestershire, spent some years in East Africa before settling in the United Kingdom and those who have come from East Africa may well differ in their growth characteristics compared with those who have migrated direct from India, because of the intervening different environment, even though the people originated initially from the same fatherland. Of the Leicester population, over a quarter of the population of Asian origin were born in the United Kingdom but of the Asians born outside the United Kingdom, there is an equal split with 7.8% born in East Africa and 7.8% in the Indian subcontinent (Leicester Report 1983). A comparison of the Hindu Indian children by last country of habitation before coming to the United Kingdom showed some significant changes in height and weight, with these 2 dimensions being greater in the East African Indians than the Indians emigrating directly from India. Ashcroft and Desai (1976) claimed that dividing a population up by country of habitation rather than country of origin is not necessarily valid. In a study of infants and children of African, Indian, Chinese and European origin in Guyana and Jamaica, to compare the influence of ethnic origin and environment, including nutrition, on anthropometric measurements, they found differences between the races, which could not be explained by nutritional or other environmental causes and showed that ethnic origins cannot be disregarded when assessing nutritional status by anthropometric measurements. However, McFadyen et al (1984), found differences between Hindu Indian and East African newborn. The babies of their Hindu meat-eating East African mothers were lighter than the Hindu from India although there were no differences in birth weights between vegetarians from the 2 countries.

But, Habicht et al (1974) claimed that environmental factors have a greater impact upon growth of preschool children than racial or ethnic factors and Johnston, Wainer, Thissen and MacVean (1976), in a study of older children, suggested that growth differences among prepubertal children reflected environmental factors and that genetic factors seemed to be less important in this age group, although during adolescence they found that height related most closely to the ethnic group, which suggested that a genetic component emerges at adolescence. The Indians, many of whom were from Gujarat, who settled in East Africa became successful businessmen (Tandon 1973) and were only forced to leave that country because of political pressures. This is in contrast with many of the Indians who came to Great Britain direct from India, who came to this country in search of "wealth" to supplement their meagre family income and support their families in their own country. Thus there may be a difference in affluence between the 2 groups although the East African Indian, in many cases had to leave without most of his material possessions.

It is possible that the Indian Hindus and the East African Hindus are of different ethnic stock but since the Indian Hindus living in Leicestershire come mainly from Gujarat and since, of those children from East Africa for whom details were known, 47% came from Gujarat compared with 5% from Punjab, 4% from Bombay and 44% unknown, (the 44% unknown may be distributed in a similar manner to the other 56% which are known) it is possible that the genetic stock of both groups is representative of that found in Gujarat. It may also be a family tradition that produced emigration for work in the 1800's to East Africa and emigration in the 1960's to Great Britain thus reinforcing the idea that the stock is comparable. The period of stay in East Africa, for most of the families where information was available was for one generation, i.e. parents were born in East Africa but grandparents were born in India and it was the grandparents who had migrated to East Africa. This is a negligible length of time in terms of environmental influences upon evolutionary change.

Socioeconomic Status

Because a specific decision was made not to obtain details of occupation of the parents involved in the Leicestershire Growth Study, information on socioeconomic status is not available and differences that occur because of these socioeconomic differences cannot be evaluated. It is well documented for English children that there have been differences in height between those children whose fathers were social class I and II and children whose fathers fell in the category of class IV and V, with those in social class I and II being taller (Douglas 1964; Goldstein 1971; Bogin and McVean 1978; Barnes 1983; Billewicz et al 1983) and for Indian children, living in India, similar results have been reported (Rao et al 1976). But, Rona and Chinn (1982) found that social class made little contribution to the variation in triceps skinfold values and weight for height and in a more recent study, they found that father's social class made almost no independent contribution to variation in a child's height in a mixed ethnic sample of Caucasian, Afro-Caribbean and Indo-Pakistani children (Rona and Chinn 1986). For this analysis it has been assumed that both the indigenous and the Indian population comprise families of all social classes. Rose (1969) stated that most castes, from the White Jats, who could raise mortgages on their property to pay for their emigration passage, to former untouchables, were represented in the immigrant population to Great Britain, from the subcontinent of India, although his reference does not appertain specifically to the Asian immigrant population in Leicestershire. However, recent work in Leicestershire suggests that all social classes are represented in the Asian population (pers.comm. Clarke 1986) in this county. The area sampled in the Leicestershire Growth Study included inner wards of Leicester and Loughborough and school catchment areas just outside the city boundaries, thus for white children all social classes also should be represented.

Whilst a comparison based upon current socioeconomic background might not be valid, because the immigrant has been known to take any job, often manual or unskilled labour, even when more qualified than necessary for such work and likely to have been doing jobs of a more skilled nature in his original country, there may be socioeconomic differences between the 2 groups. A number of researchers (e.g. Banik et al 1970a, Raghavan et al 1971) have shown that Indian children in India from the higher social classes have greater growth in terms of being taller and heavier than those from the middle and lower social classes although McFadyen et al (1984) found no consistent relationship between birthweight and social class in their Asian population of Hindus and Muslims from India, Pakistan and East Africa now living in Harrow. Rona and Chinn (1986) in a study of children belonging to a number of different ethnic groups living in Great Britain, found social class as an assessment of social factors unhelpful, but mother's educational level and household overcrowding were significantly associated with an Asian child's height. They suggest that mothers with low educational achievement finished their education before emigration to Great Britain and therefore represent social family characteristics in the country of origin thus giving an indication of social and cultural characteristics pre emigration. Household overcrowding, which is related to family economy level and perception of ideal family size, they suggest, reflects the current post immigration state.

Habitation - Period of Residence in Great Britain

But the impact of a stay of 1-2 generations in East Africa may be responsible for the slight differences found in growth observed in the 2 samples, and it is possible therefore that the length of stay or lack of it in this country may have a similar impact upon growth, i.e. contribute to the differences found in subscapular fat deposits and head circumference. Apart from the identification of a secular trend in birth weight (Clarson et al 1972), little work appears to have been done upon studying the impact on growth with increased length of stay in the host country by the Indian immigrant community. Davis, Apley, Fill and Grimaldi (1978) found that there is a dramatic increase in mean height in the second generation of immigrants into rich countries.

Another factor affected by change in environment has been the tempo of growth, i.e. the rate at which a child progresses towards physical maturity, which can be measured, for example, by the change in body proportions with age. Work by Greulich (1957, 1958) on Japanese children in California, U.S.A. showed that the more favourable environment produced an accelerated rate of growth, i.e. advanced skeletal maturity, and a relatively longer leg length at a given age in the immigrant children compared with children in the country of origin, and the immigrant children were closer in size to that of the indigenous Californian population. Kim (1982) in a similar study on Korean children in Japan showed similar results which he also attributed to the more favourable environment. But subsequent analysis of the same Japanese children in California as adults (Greulich 1976) showed much closer agreement in those body measurements between the immigrant group and the similar ethnic group in their native land. Another study (Kano and Chung 1975) concluded that there had been considerable convergence in physical growth patterns between American born Japanese and the native Japanese children, and that this convergence was due largely to the improved environmental conditions in Japan in recent years. Prakash and Cameron (1981) found that well off Indians from Punjab had a mean maturity score which reflected a general parity with British Standards anyway. If the Indians experience a more favourable environment with migration, which results in a faster rate of maturation, the leg lengths of the Indians who have experienced the better environment over some time may be longer relative to those who have lived in the more favourable environment for a shorter time. For those Indians whose environment is the most favourable, whichever country of residence, a faster rate of maturation might be seen compared with that of the Indians who experience unfavourable conditions. In this study it was found that the Sikh leg length was relatively longer than that of the Muslim or Hindu, but no significant differences were found between the sitting height:leg length relationship of the Indian and East African Indian Hindu.

Nutrition and Body Composition

If the environmental conditions are favourable, then the nutritional intake will be adequate and one aspect of growth that is readily affected by nutritional intake is the level of body fat and lean body mass. To examine the body composition, on a limited scale, the bone and muscle components of the upper arm were studied. If the protein requirements for growth of body tissues and energy requirements are met in the dietary intake, and protein availability occurs over and above these requirements, then the musculature will be well maintained since this is a major factor in determining body and muscle growth. The assumption is made that this is the case, with the population in this study. With such options as availability of free school meals, social services, monitoring of children with school and clinic medicals, it should be a valid assumption for most if not all of the children (although Rona and Chinn (1986) found that in their Asian sample, the uptake of free school meals, where applicable, was not universal). In Leicestershire, the uptake of school dinners by primary schoolchildren is 59.1% with a good uptake in the inner city area. Leicester inner city area has a population of which 25% is non-indigenous and in which the numbers qualifying for free meals is higher than the surrounding areas, although, the mix of White/Indian uptake is unknown (Leese, pers.comm.). Variation in the amount of muscle between the different ethnic groups is likely to be due to genetic influences, whilst subcutaneous fat is affected by the current or recent past dietary environment, assuming adequate dietary intake of protein. Subcutaneous fat values in the Indian population suggest that the current or recent past dietary environment has been adequate in that, in general, the Indian child had higher levels of subcutaneous fat, in the two sites measured, than the European. Ulijascek et al (1979) found a similar result for the subscapular site, in a sample of Indian and European children in London.

Midarm circumference gives a measure of the total muscle mass (Standard, Wills and Waterlow 1959) as midarm muscle circumference reflects in a general way, total body protein - although a direct linear relationship cannot be used. It can be assumed that exercise is not a major independent factor in determining muscle bulk in children. In adults and adolescents, training programs increase muscle bulk, but exercise patterns in young children are unlikely to do so (Malina and Johnston 1969).

Johnston and Beller (1976) found significant differences in upper arm muscle circumference among three different ethnic groups, and differences in triceps skinfold values between sexes only, not between ethnic groups and Dugdale et al (1970) also found a correlation between bony growth and muscle growth with subcutaneous fat varying independently. In this study there are differences in the arm muscle areas between the Indian and European ethnic groups at all ages studied, suggesting genetic differences in lean body mass composition but less differences in arm fat areas. Zavaleta and Malina(1980) considered estimated muscle mass of the arm between two ethnic groups and concluded that the differences were due in part to the smaller body size of one of their ethnic groups and also to dietary factors. It is also documented that the length of the limbs is greater relative to the trunk, and that the limbs have smaller girths and transverse diameters, in inhabitants of warmer climates, (Roberts 1960) and Crognier (1981) indicated that people in hot areas of the world are smaller and leaner. But, although the Indian children in this study are smaller, even after correcting for body height, the Indians in this study still have less muscle area than the Europeans.

Nutrition for Indians in Great Britain

There may be some dietary problems for the immigrant to the country. The migrants' diet faces considerable upheaval and change when they come to Great Britain. Some of the migrants from India have come from a subsistence farming economy with poor nutrition for most of their lives. Others, while of a more affluent background, will still find a considerable change to their diet in this country, as certain foodstuffs are no longer available and they have to adjust to an intake of alternatives, whether they wish to or not (Ruck 1979). The small local corner shops, now being run by Indians in the centre of Indian housing areas, help to supply some of their requirements, by stocking some of their native vegetables, pulses, etc.. Some studies of the dietary patterns of Asians in this country suggest that the adaptation to local alternatives is limited, e.g. Wharton, Smalley, Millns, Bissenden and Scott (1980) found that their Hindu mothers in Birmingham did not like the temporate vegetables and depended largely upon imported ones, although this can be at a considerable cost to the purchaser.A study of Asian, African, Chinese and Scottish children in Glasgow (Goel et al 1976) found that most of the Asian and Chinese children had retained their national dietary habits even after many years of stay in the United Kingdom.

Secondly, school children are exposed to the British system of school dinners. In the last eighteen months, in Leicestershire schools, considerable attempts have been made to supply the correct dietary requirements to each religious group, (Leese pers.comm.). But exposure to Western food has considerable influence on the children, and many are receiving more Westernised food, by demand as well as by the restricted choice and availability of their own Indian food (Pearson et al 1977). The supply of traditional Indian meals in secondary schools in Leicestershire is a non-starter by choice of the children, but in primary schools there is enthusiasm still for such traditional food both by the parents and children, so much so, that 59.1% of primary children in the city of Leicester, have a school dinner each day (Leese 1985 pers.comm.). The change in diet, from parent to child, imposed by the influence of the new country of habitation may have considerable implications for the growth of the children. The Asian diet is higher in fibre and lower in sugar content than the Western diet but some vitamins and iron may be deficient in quantity. The early immigrants to this country sometimes showed cases of rickets, (Arthurton 1972), anaemia (Butler 1970), multiple vitamin deficiency (Britt and Harper 1976) and even fairly recently, Wenlock and Buss (1977), found deficiencies in the diet of some

Asian families. But a dietary inbalance of a different sort was found by Abraham (1983) who reported dietary intakes of fat among Asians in the United Kingdom, to be higher than the intake in their counterparts in India. With recent campaigns, e.g. Anti-rickets campaign (D.H.S.S. 1980), and a greater awareness of the problem, Asian children are more healthy now and more adaptable to a mix of traditional diet at home and more Western orientated meals in school (Spalding pers.comm). However, the change in nutrition inflicted upon the Indian family by migration to the United Kingdom will have had some impact upon the family even if it is not easily quantifiable.

Other evidence suggests that nutrition may still have a considerable part to play in the changing growth pattern of Indian children. Nutritional problems are very common in infants and young children of Asian immigrants (Jivani 1978) often as the result of inadequate weaning (Evans et al 1976). Harris et al (1983) in a nutritional survey of Bangladeshi children found some deficiencies in their diet with food proportions often inappropiate and weaning considerably delayed, i.e. they found 3 children out of 177 at the age of 2 still receiving only breast milk - according to their mothers. Among the children in the Leicestershire Growth Study, (details are known for 96% of the Indian and 98% of the European subjects), 12% of the indigenous population and 67% of the Indian population were still receiving milk, either by breast and/or bottle after 18 months, although this is unlikely to have been to the exclusion of any other food. This does not appear to be only applicable to the Asians in this country, e.g. a recent study by Bhalla et al (1986) found three mothers in Chandigarh, India who failed to introduce semisolids into the diets of their infants until the age of 8 months, in spite of advice. Other researchers, e.g. Aykroyd and Hossain (1967) found in a survey of Pakistani families in Yorkshire, that there had been an almost immediate adoption of artificial feeding methods for babies, on arrival in the United Kingdom but a retention of the Pakistani diet by the adult community in general. For older children, deficiencies in certain nutrients were recorded in a dietary survey of immigrant schoolgirls in Leicester (Pearson et al 1977). But as those working in multiracial areas become more experienced at giving advice, (both to the mothers, e.g. at antenatal clinics, and to children in schools), that complements the diets of the various religious and cultural customs, so such feeding problems should hopefully become less common. Although, even if the problems and their cause are identified, it has proved very difficult to change the feeding habits which have their roots deeply seated in religion and tradition. Even in those Asians who are the most settled in the community it was found that the quality of their diet was much lower than the national average for riboflavin, vitamin A and vitamin D.(Wenlock and Buss 1977). There are often pressures on migrant people not to change their food intake from the pattern of their country of origin, coupled with the fact that the women, who have learnt to cook with very limited facilities and food available, e.g. those from the rural areas of India and Pakistan, may find it very difficult to provide a varied diet in this country because of their limited experience. But this could change with subsequent generations of Asians born and educated in this country, although the Asian families tend to be more hierarchial than white British families, so that the younger members who are more exposed to the host culture are the ones who have the least power.(Ruck 1979).

Health

There are a number of diseases and illnesses to which the Asians are susceptible and which may have some effect upon growth (see Chapter 2) but school children between the ages of five to fifteen years, in the developing regions do not normally show significant serious illness from malnutrition and will have achieved a substantial immunity against at least some of the prevalent infections and parasites, e.g. malaria (Jelliffe 1966). They have passed the dangerous years, which may have marked them, of early childhood, are now growing more slowly, and able to compete for and digest the full range of the adult diet. It is interesting that a recent study by Cameron, Jones, Moodie, Mitchell, Bowie, Mann and Hansen (1986) suggests that a growth insult caused by malnutrition may not cause a reduction in final size, i.e. may not mark them. Cameron et al found that boys who experienced a single acute insult of Kwashiorkor, between 5 months and 4.33 years, ended up heavier and taller than their non-affected sibs (who obviously were from similar geographic and socioeconomic circumstances) and female sufferers did not differ from control subjects at adulthood. But it must be remembered that those diagnosed as suffering from malnutrition, were then given supplements in their diet, as were, in some cases, their nonaffected sibs. The children in this study have all come from a developing region, but for many, it was their parents who emigrated from such an area, rather than themselves. Since the data from children of three years of age and over only, have been analysed, even if they are new arrivals to this country, they have passed through the time of potential greatest insult to growth.

Genetic Factors

But if environmental conditions for growth are adequate and similar for both the indigenous population and the Indian children in Leicestershire, will the differences that currently exist between the two populations be maintained in future generations? It has been proved that physical growth in man is the result of his environmental and genetic status. Genetic endowment is the inherent potential of physical growth, whereas the environmental influences accelerate or retard these processes. Normal growth standard is an elusive goal as the growth of an individual child or children in the community is a dynamic process which improves with changes brought about by improvement in sanitation, control of infections, availability of food and a rise in the general standard of living. It is evident that given appropiate nutritional and health support in a good environment, Indian children are capable of achieving better standards of growth than their counterparts in not so good a milieu, e.g. differences in growth between children from high and low socioeconomic backgrounds (Banik et al 1972).

Having accepted that changes in environment over a period of time appear to be responsible for the increased birth weight in Asian children born in this country (Clarson et al 1982), there may, even so, be genetic differences between the Indian population and the indigenous population and within the Indian subgroups since the religious groups also impose marriage patterns. Furthermore, the genetic characteristics of each population are dictated by the history of development of that area. It is known that the Muslims were the invaders into North West India. Where they conquered the local inhabitants in Gujarat and Punjab they established their own courts and communities and did not mix with the indigenous population. Thus any genetic differences were maintained. At Partition there was considerable movement of Muslims from North India into Pakistan and Hindus from Pakistan into North India which will have mixed the genetic stock in those 2 countries, but the specific Muslim sects and the Hindu exogamous caste system will tend to retain the genetic characteristics within each level (although there are also group structures within the Hindu caste system that are endogamous in terms of marriage). Society in India is also very much a rural one with extended families living in small village communities. Such forms of habitation will tend to produce local marriage arrangements and restriction of the genetic mix. The religious revival in the 1400's specifically in Punjab amongst the Hindu and Muslim inhabitants gave rise to the Sikh religion in that area, suggesting that initially the Sikhs, who were converted Hindus (or Muslims), were members of the same gene pool then as the rest of the population. But, practitioners of the Sikh religion, like the other two religions, will also tend maintain their own identity, retain a marriage structure within the religion and not interbreed with the other religious populations and a continuation of this practice will have helped to develop a distinct gene pool.

So religious factors may involve genetic differences as the different religions either developed among similar peoples of India e.g. conversion of Hindus to Sikhism (Gupta 1971), or were imported along with the invasion of peoples from neighbouring states e.g. Moslems (Bhatt 1972).

The majority of the children in the Leicestershire schools from the Indian subcontinent are those who were born in this country to parents who were born in the home country, and their growth and development are influenced by their parents size. Since adult stature is less affected by short term environmental factors than childrens' stature and is also dependent of the rate of maturation, a comparison of the heights and weights of adult females from the Indian subcontinent resident in Great Britain with those of the adult European female, from a number of studies, using data from antenatal clinics was made. Unfortunately, this study contained no parental data, but 3 of the following are of Leicestershire adult Asian females:-

Group	Weight(kg)(S)	Height(cm)(S)
(Davies et al 1982) - Leicester		
Asian (70)	52.0 (11.2)	153.5 (7.81)

White Caucasian (70)	59.9 (8.6)	160.1 (5.2)
(Hutchins 1982) - Leicester		
Indian (Hindus from Gujarat)		*152.2 (4.8)
European		166.5 (6.7)
(Chetcuti et al 1985) -Leicester		
Hindu (50)	+51.7 (9.3)	*154.3 (8.24)
Moslem (50)	+51.7 (8.3)	*155.0 (5.62)
Sikh (50)	+55.6 (5.3)	*156.3 (5.4)
White mothers (50)	61.8 (11.8)	162.1 (7.23)
(Brooke and Wood 1980)		
Asian (80)		156.1
(MacFadyen et al 1984) - Harrow		
Hindu (664)	*55.3 (5.6)	*155.8 (5.6)
Muslim (132)	*58.0 (8.3)	*158.0 (5.6)
European(486)	63.3 (9.1)	162.7 (6.4)
(Wharton et al 1980) - Birmingham		
Asian		!154.6 (5.8)
European		!158.5 (6.0)
(Wharton et al 1984) - Birmingham		
Hindu (11)	55.9 (5.5)	157.1 (5.1)
Sikh (15)	54.7 (9.0)	154.5 (6.8)

* - P<0.001, + - P<0.004 ! - p<0.05

As can be seen from the above figures, in all cases the Asian females are smaller and lighter than the White mothers although there is considerable variation within both the Asian and European groups, in the different areas of the country. Although differences in adult stature among populations do not necessarily imply that similar differences exist throughout childhood, as the rate of maturation within different populations may vary. Since the Indian mothers are smaller, uterine space may be smaller and this uterine constraint, coupled with the genetic factors, may dictate the smaller size and weight of the Asian baby compared with babies born to White mothers in the same area of the country (Alvear and Brooke 1978: Grundy et al 1978: Brooke and Wood 1980: Davies et al 1982: Wharton 1982: Chetcuti et al 1985). It is known that smaller mothers have smaller babies (Tanner and Thompson 1970). But it is also documented that babies cross centile lines on reference growth charts for height and weight during the first two years of life as the uterine restraints are removed, and the growth pattern imposed by them is adjusted with extrauterine life and 'catch-up' occurs (Davies 1980). Brooke and Wood (1980) found this for Asian children in London. Further evidence that the genetic influence upon growth can be masked prenatally by environmental constraints can be seen in the greater concordance of certain anthropometric parameters in monozygotic twins with increasing age after birth compared with the concordance in dizygotic twins, which at birth was found to be greater than that for monozygotic twins, but decreased with increasing age (Wilson 1976). Since it is the growth that is achieved during childhood that dictates the final adult height, future generations of Indian immigrants living in this country may be larger.

But, even when birth weight was adjusted for maternal height and parity, the Asian babies in Birmingham were found to be lighter and smaller than European babies born to mothers of similar height, parity and gestational age (Wharton et al 1980). McFadyen et al (1984) in their study found significant differences between the Hindus and the Europeans, with the Hindu newborn 190g lighter, after birthweight was adjusted for gestational age, maternal height, fetal sex and parity although their Muslim and European newborn were almost identical. Their East African Hindu were also lighter than their Indian Hindu. Alvear and Brooke (1978) also found Asian newborn infants from the Indian subcontinent were significantly smaller in several dimensions compared with the North European, even when adjustment was made for socio-economic status and other factors that influence birth size and weight. They suggested that these racial differences in growth may be genetic in origin or they may reflect intergenerational effects of the environmental factors e.g. malnutrition.

Bhargava et al (1980) suggested that the birthweight of Indian children was an important factor in influencing the later growth in childhood although the contribution of maternal undernutrition to low birth weight is still debated, i.e. Frisancho, Klayman and Matos (1977) claimed that variations in birth weight and recumbent length in their newborn Peruvian, urban babies were more affected by maternal nutritional status than by maternal stature and Sibert et al (1978) claimed that the nutrition of the mother has an important effect on the nutrition of her baby and that malnutrition is an important reason why Indian babies are lighter than European ones, although such a statement is not necessarily applicable for Indian mothers resident in Great Britain. It has also been suggested that undernutrition is only one factor in the aetiology of low birth weight in Asian babies born in Great Britain (Wharton 1982). Goel et al (1981) found that in all their immigrant groups, the children born in Scotland were on average taller and more advanced in bone age than those born in their country of origin, the implications being that environmental conditions in Scotland are more favourable for growth than those in the country of origin. In which case, generations of improved nutrition and the growth of immigrant children could be materially altered.

But Davies et al (1982) in a study of Leicester newborn, concluded that the smaller size of the Asian babies at birth was unlikely to be due to undernutrition of the mothers in pregnancy and that the shorter stature of the mother was unlikely to have been caused by malnutrition. They, therefore concluded that Asian babies and their mothers are small for genetic reasons. In support of this, with respect to fetal growth, a study by Meire and Farrant (1981) using ultrasound, suggested that the Indian fetus has a different body build to the European and that this feature is probably genetically determined rather than being due to some unusual form of growth retardation. This body build difference was found to be particularly marked in Gujaratis, who have been shown to have smaller fetuses than any other Indian subgroup (Jayant 1964). Further, with respect to maternal nutrition and diet during pregnancy, a study by Abraham, Campbell-Brown, Haines, North, Hainsworth and McFadyen (1985), in Harrow, found that the average weight gain and energy intake was similar in their pregnant Asian women and their European sample. There were some differences, in that the European diet contained more protein and zinc, but less fibre and fat, than the Asian diet. However, they found no evidence of adverse consequences because of this, to either the mother of fetus. Their Asian sample were mainly from Gujarat, both Hindus and Muslims, and included meat eaters and vegetarians.

But birth weight and birth length do not always provide reliable information about the subsequent growth pattern of the child, nor of the ultimate adult height. Normal healthy infants show shifts in their growth pattern across the centile lines on a standard growth chart, during the first 2 years of life (Smith, Truog, Rogers 1976) and the correlation of birth length with ultimate height has been found to be only 0.25 (Tanner, Healy, Lockhart 1956). However, skeletal dimensions, unlike the soft tissue components that contribute to weight or skinfold thickness, are less responsive to immediate environmental conditions and therefore are more likely to be expressed in response to their genetic inheritance, e.g. the correlation of a white child's height with that of his parents is 0.7-0.8 after the age of two (Tanner et al 1970), such a good correlation is an indication of the genetic influence on height given an adequate environment for growth and after shifts in the growth pattern within the first 2 years of life have established the child upon his genetic path. Whether this is as valid for Indians is debatable. Mueller (1976) in a review of 24 studies of parent-child correlation found that samples of European ancestry had higher parent-child correlations and that there was considerable variability between the samples. He attributed the lower parent-child correlations that occurred to malnutrition and environmental changes between parent and offspring generations. Tanner et al (1970) also speculated that such correlations might be lower amongst the European lower classes because the children from those groups could be experiencing better conditions than their parents did. Rona and Chinn (1986) found that the variation in a child's height explained by parents' heights for their Asian children in Great Britain was fairly low, i.e. 2.0% for Punjabis, 5.9% for other Asians (those not allocated to the Urdu, Gujarati or Punjabi groups) compared with their Caucasian group of 11.0% .

So a study of skeletal dimensions might help to indicate genetic variability rather than short term environmental changes and, given an adequate environment, any significant differences in height between the two populations, Indian and European, are more likely to be responses to different genetic inheritances. However it must not be forgotten that the parents' and child's growth are affected by their environment and for the Asian immigrants, the two generations have lived in two different environments. Rona and Chinn (1986) who classified their Asian groups by language spoken at home, found that there was a large variation in height between their different Asian immigrant children groups and that all groups had mean heights below the 50th centile of their English population. The Leicestershire Asians in this study also showed a large variation in height but where differences occurred only the mean heights of the Muslim and Hindu children fell predominantly below the European data, and the Sikh mean heights matched those of the European children. The Punjabi children of Rona and Chinn will probably be a mix of Hindu and Sikh whilst their Gujarati speaking children are likely to be predominantly Hindu, but may include some Muslim adherents which will help to account for the differences between the two Asian samples.

It is also documented that there are differences in body proportions, between different ethnic groups, when measuring sitting height and leg length (Eveleth 1978) and Eveleth and Tanner (1976) quoted smaller sitting heights for Indian children compared with European although a resemblance between the 2 for relative sitting height. This study confirmed ethnic differences between the Indians and Europeans and found that the Indian children had smaller sitting heights. However, it also found that the Sikh sitting heights resembled more closely the European than did the Hindu and Muslim, although they were still slightly smaller.

Another skeletal dimension that can be considered is that of head circumference. The head circumferences of the Leicestershire Indian children were much smaller than the reference standards for all three religious groups. There is the possibility that the measurement technique may have been slightly different, the measurer certainly was, as there are some differences between the indigenous population and the reference data. But, a comparison of the Leicestershire Indian and European children measured, using the same technique for both populations, also produced significant differences. Such distinct differences in the skeletal dimension of head circumference, a dimension that does not appear to be affected by adverse environmental factors or increased by favourable factors (Nelhaus 1968), although more recently, Ounsted et al (1985) have claimed evidence of a positive secular trend in their European children, suggests a definite distinctive growth pattern difference between the two ethnic groups even though Nelhaus (1968) found no variation based upon racial, national or geographic factors. However Alvear and Brooke (1978) also reported smaller head circumferences in their Asian population compared with the European, as did Chetcuti et al (1985), in both cases with significant differences ($p<0.001$). Kantero and Tiisala (1971) found a variation between different ethnic groups and Purohit, Purohit, Saxena and Mehta (1977) found that the head circumference of Indian children in

Jaipur, aged 0-6 months, was smaller than that of British children, reported by Falkner (1958), although the crown rump lengths of the 2 populations were comparable. Beals (1972) reported an inverse relationship between temperature and cephalic index, and the findings of this study, whilst not measuring cephalic index directly, suggest that the Indian sample, originating from a hotter environment, have a smaller head circumference than the European children.

But body composition changes in bone and muscle may evolve in the longer term, given long term environmental changes. The Sikhs, who come mainly from Punjab in India, the state with the highest proportion of agricultural produce in India (Government of Punjab 1976), and by religious definition, have an unrestricted diet, may be considered to have had the greatest opportunity, over the last five hundred years, of achieving their growth potential, and thus may represent the genetic growth pattern of the Indian child from the Punjab area of India. This suggests that the differences that currently exist between the children from North India and the European children who both live in Leicestershire, may be reduced in time, and that the Indian children have the potential to increase some of their anthropometric dimensions, in subsequent generations as the adverse environmental factors that have affected previous generations are reduced or removed altogether. The fact that the growth of the well-off Indian child in India ressembles that of Western children, that the Indian children now resident in Leicestershire are taller and heavier than their counterparts in India and finally, that one group from the Leicestershire Indian population, who appear to have less cultural restrictions, ressemble more closely the indigenous population in all aspects of growth studied, than the other 2 groups, suggests that the differences that occur appear to have been influenced by adverse environmental factors in the country of origin. So, in time, the phenotype of the Indian child living in Great Britain, could be closer to that of the European child, than is currently the case.

CHAPTER 7

CONCLUSIONS

CONCLUSIONS

Growth is the product of environment and hereditary factors, the genetics establishes the possibilities - the genotype, and the environment creates the probabilities - the phenotype. In this case there are both environmental and genetic forces at work. It is possible that the majority of the Indian immigrant population have as yet not achieved their genetic potential, and given an ideal environment, or at least one favourable to growth, they will proceed some way towards achieving such growth potential.

Currently, there are differences between the Indian and the European children aged 3 - 10 years in Leicestershire in their body composition. The Indians have smaller bone and muscle areas in their upper arm, and, in the light of the reduced weight of the Indian children it is possible that this difference in lean body mass will appertain throughout the rest of the body. The Indians' skeletal dimensions, i.e. stature, sitting height and head circumference are all smaller than those of the Europeans. The subcutaneous fat values however show less differences between the two populations studied, compared with the other anthropometric parameters measured in this study. Also, conversely, the Indian children have higher values of subcutaneous fat on the triceps and subscapular sites than the European children. Such differences, in a measurement that shows a fairly quick response to change in dietary intake or to change in other environmental conditions, such as ambient temperature, may reflect a transitional state, as the Indian adapts to his new environment.

Historically, the genetic composition of the peoples of North West India, from which area most of the Leicestershire immigrants originate, was mixed, with Punjab and Gujarat states having slightly different patterns of infiltration of different races and, therefore, development. Of the Indian children measured as part of the Leicestershire Growth Study, the Sikhs came predominently from Punjab, whilst the majority of the Hindus and Muslims were from Gujarat. Further, it is documented that the Muslims were initially the invaders, and as such, maintained their insularity in the conquered land.

How much of the differences in growth are due to the historical development of the two areas is not known but some of the present differences may be attributed to current factors within the 2 states, i.e. Punjab is the more affluent, producing an environment more favourable to growth. It is documented that the Punjabis are taller and heavier than the residents of other Indian States. In addition, religious factors appear to influence growth, as the Sikhs are taller and heavier than the Hindus and Muslims, both in India and maintained in this country. Religious factors impose patterns of restrictive mating, affecting the genotype plus dietary regulation, affecting the phenotype.

But the migration to Great Britain has added other environmental factors and changed the conditions under which growth progressed in India. Change of habitation has had some impact upon growth as the Indian immigrant children measured in Leicestershire, regardless of religion, are taller and heavier than their counterparts in India. In addition to change of country of residence, the duration of residence in this country is also having some impact upon the growth of the Indian child, i.e. those who were born in this country and have, therefore, spent all their life in this country, show an increased size in some of the anthropometric parameters studied, compared with those who came to this country as children.

Finally, it appears that the growth of the Indian child is influenced both by length of stay in this country and if the Indian child or his parents have spent an intermediate period of residence in East Africa. The East African children also show increased values in some of the anthropometric parameters measured compared with those children who have come to Leicestershire direct from India.

Thus, the implications are, that given time, and an adequate environment, the Indian child resident in

Leicestershire will show a positive secular trend in growth. There is already such a trend in increased birthweight in Asian newborn. Such an environment is present in Great Britain, even in the inner city areas, where most of the Indians choose to live, since the white children living in the same areas under some of the same conditions, are showing a growth pattern comparable to, or even greater than, the reference growth standards. Whether a total match between the 2 ethnic groups will ultimately be achieved is debatable, because of a number of factors, e.g. dietary restrictions in 2 of the 3 religious Indian groups, but affluent Indians in India, match British standard growth data, . It is in the Sikh group, which has no dietary restrictions, that the Indian child ressembles most closely that of the European. But dietary regime in itself is not the total influence upon growth, rather it is the outlook and approach to life that goes with the different religious groups and the self imposed customs and regulations of the different religious communities linked with socioeconomic factors. The Indian child's growth may still differ from that of the European because the Indians tend to maintain their ethnic isolation in their new habitat, with their own choice of housing area, patronage of their own socio-cultural activities and institutions and arranged marriages within their own cultural group.

Thus, currently, the Indian child in this country, if a Hindu or a Muslim, is smaller, lighter, has a smaller head circumference, smaller arm circumference, and smaller sitting height than the indigenous child. The Sikh child resembles the White child in all of the above parameters except head circumference, and for that dimension, the Sikh has a smaller head circumference but not as small as those of the other 2 religious groups.

CHAPTER 8

RECOMMENDATIONS

RECOMMENDATIONS

Since there are some distinct differences in certain anthropometric parameters between the Indian and European ethnic groups, differences which occur regardless of religion observed by the Indian, it is recommended that some of the growth charts are modified for use by paediatricians and medical workers working with the Leicestershire Indian children. Head circumference is such an important growth parameter, especially in the first 5 years of life, and with all the Indian children differing from the reference standard of Tanner (1978) a new chart should be created. For this purpose, as this study has analysed data only from children of 3 years of age and over, because of a shortage of subjects in the lower age groups, a further study should be made using 0-5 year old Indian children. A model for the new chart for head circumference for Indian children aged from 3-10 years inclusive, using Growth Study information from the Indian children in Leicestershire, is presented in Figures 28 and 29. The graphs show the 10th, 50th (mean) and 90th centiles for the Indian children and Tanner's (1978) 50th centile for comparison. The 10th and 90th centiles were chosen as representative of the outer centiles because of limited subject numbers. Values for the 10th and 90th centiles were calculated from the formula:-

$$x + 2.282\ (S.D.)$$

after the standard deviation values for each age group had been adjusted using Healy's (1962) correction factor $b^2/12$, where b is the growth increment in the year over which measurements are analysed. This correction adjusts for the extra variance due to children in a given age group having different dates of birth, i.e. being of varying ages within the age band.

For weight, differences from the reference charts occur mainly in the Hindu and Muslim population. Therefore, a chart describing the weight of the Hindu and Muslim children in relation to the British reference data used is presented, based upon the format of the current reference charts, see Figures 30 and 31. These data have been compiled from Hindus and Muslims. The choice of these 2 religious subgroups only, was made because in most cases the Sikh children were not significantly lighter than the indigenous population. As well, at present, Sikhs can be relatively easily identified by their naming system, and for males, by their hair styles. The charts shown in Figures 30 and 31 include the median weight and the 10th and 90th centiles, at each year age band, using data derived from the Leicestershire Growth Study, and Tanner et al's (1966) median for comparison. The 10th and 90th centile values at each age were obtained by ranking the data, because of its skew characteristic, as recommended by Tanner (1952). Unfortunately it requires more children to establish centiles for a given degree of accuracy than it does to establish the standard deviation (Tanner 1952) which means that the degree of accuracy for the 10th and 90th centiles for weight will not be comparable to those for head circumference.

Finally, with such variation in the environmental conditions over the last few years, the growth of the Indian child must be in a continuous state of change. There is evidence of a positive secular trend in birthweight and trends towards increased height and weight for Indians in this country compared with their counterparts in India. In addition, the increased growth shown in the Indian child living in Leicestershire today, contributes towards a larger adult ultimately. This in turn reflects upon subsequent generations of Indian children born in Great Britain. Since growth is a dynamic occurrence and with so many positive factors available to influence the growth of Indian children in this country, considerable change could occur, with indications that children of Indian origin, could be physically larger in the future. It is therefore recommended that, as a contribution to the study of growth of the Indian children in Great Britain, a follow up study is made upon the children who were measured as part of the Leicestershire Growth Study. It is also imperative that this minority subsection of the United Kingdom population, contributing in large numbers in certain areas of the country, is monitored frequently, and the changing growth values and rates of growth, recorded, because of this potential.

HEAD CIRCUMFERENCE, INDIAN BOYS

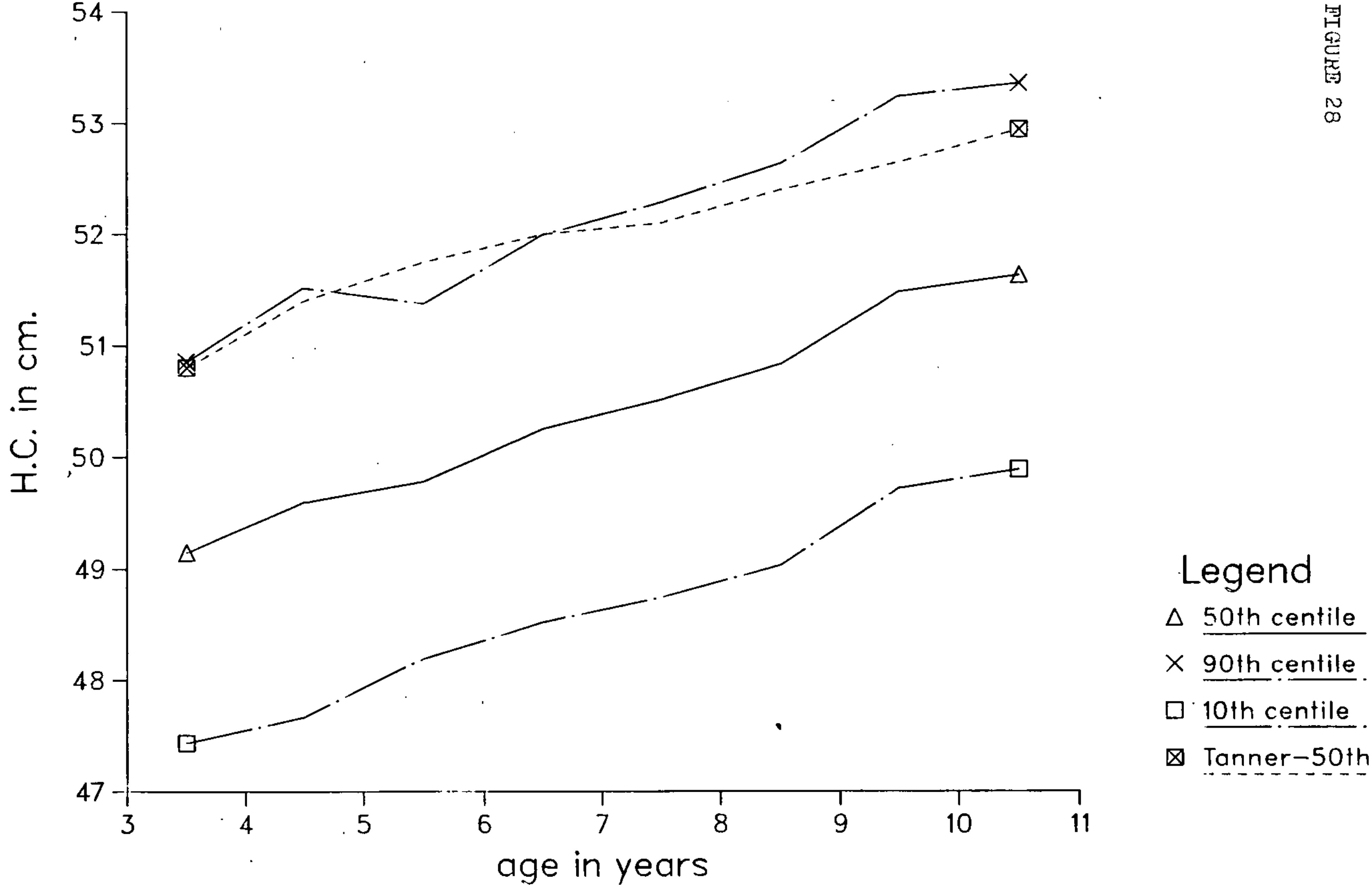


FIGURE 28

HEAD CIRCUMFERENCE, INDIAN GIRLS

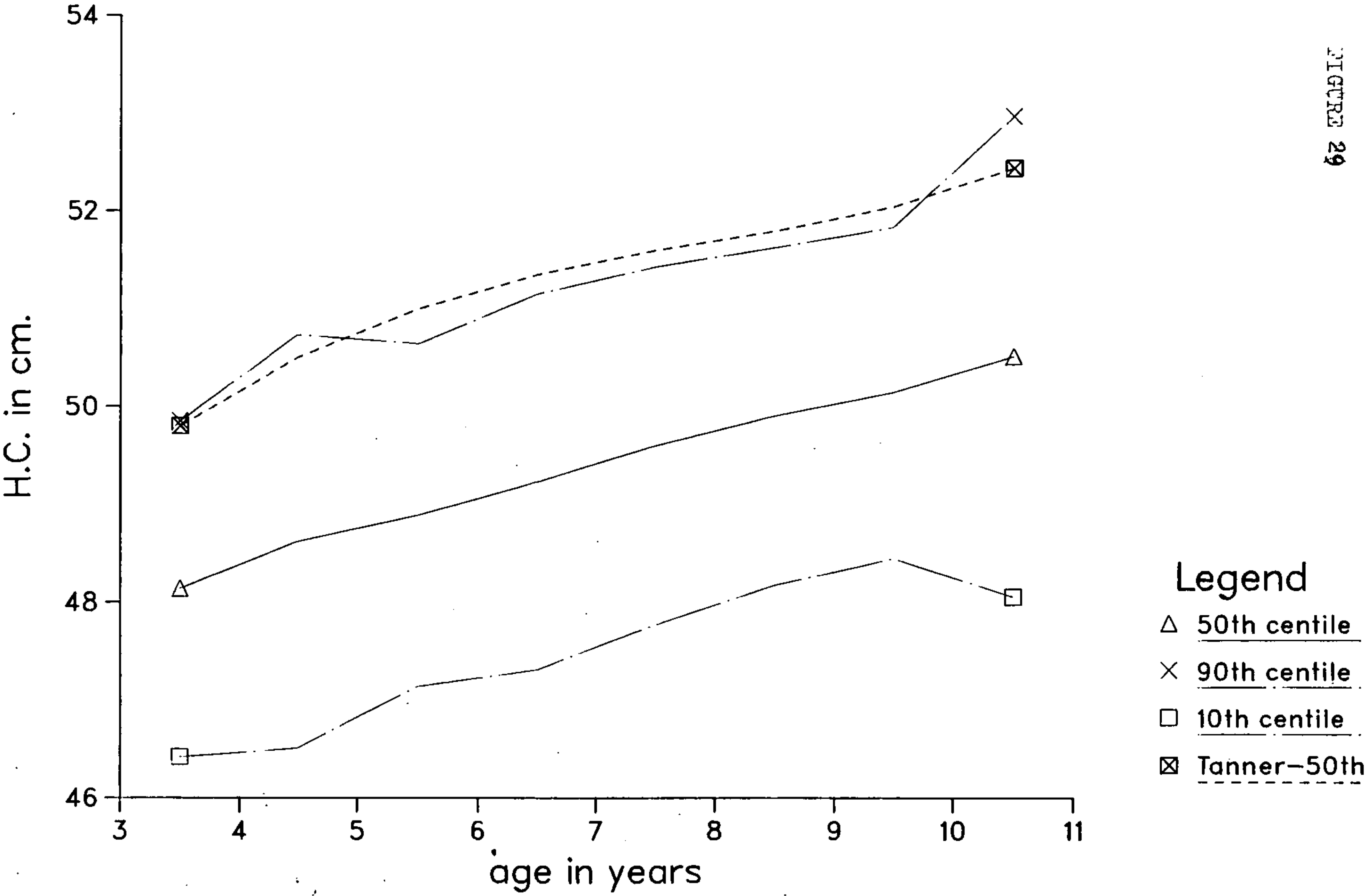


FIGURE 29

WEIGHT, INDIAN MUSLIM AND HINDU BOYS

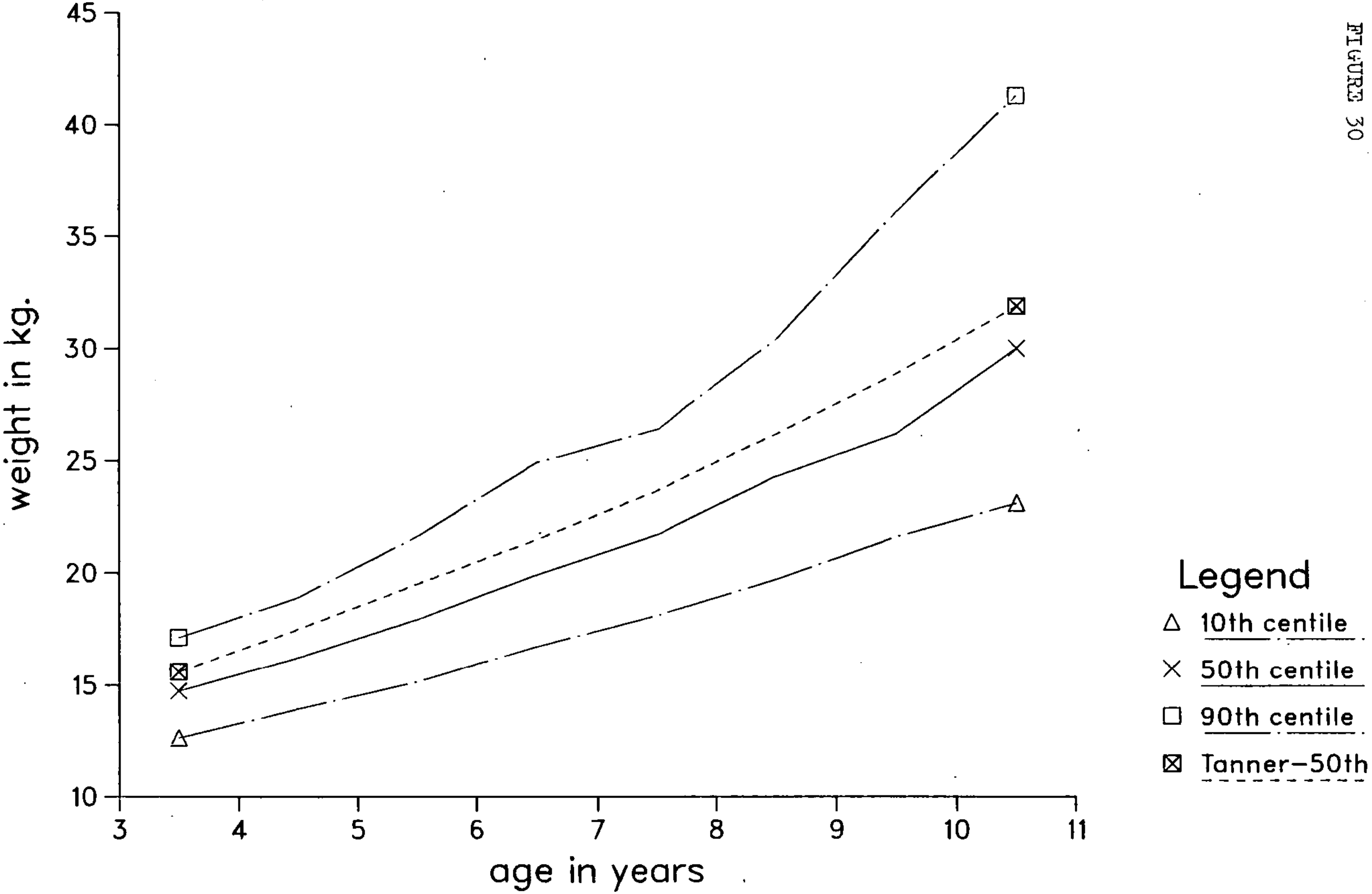


FIGURE 30

WEIGHT, INDIAN MUSLIM AND HINDU GIRLS

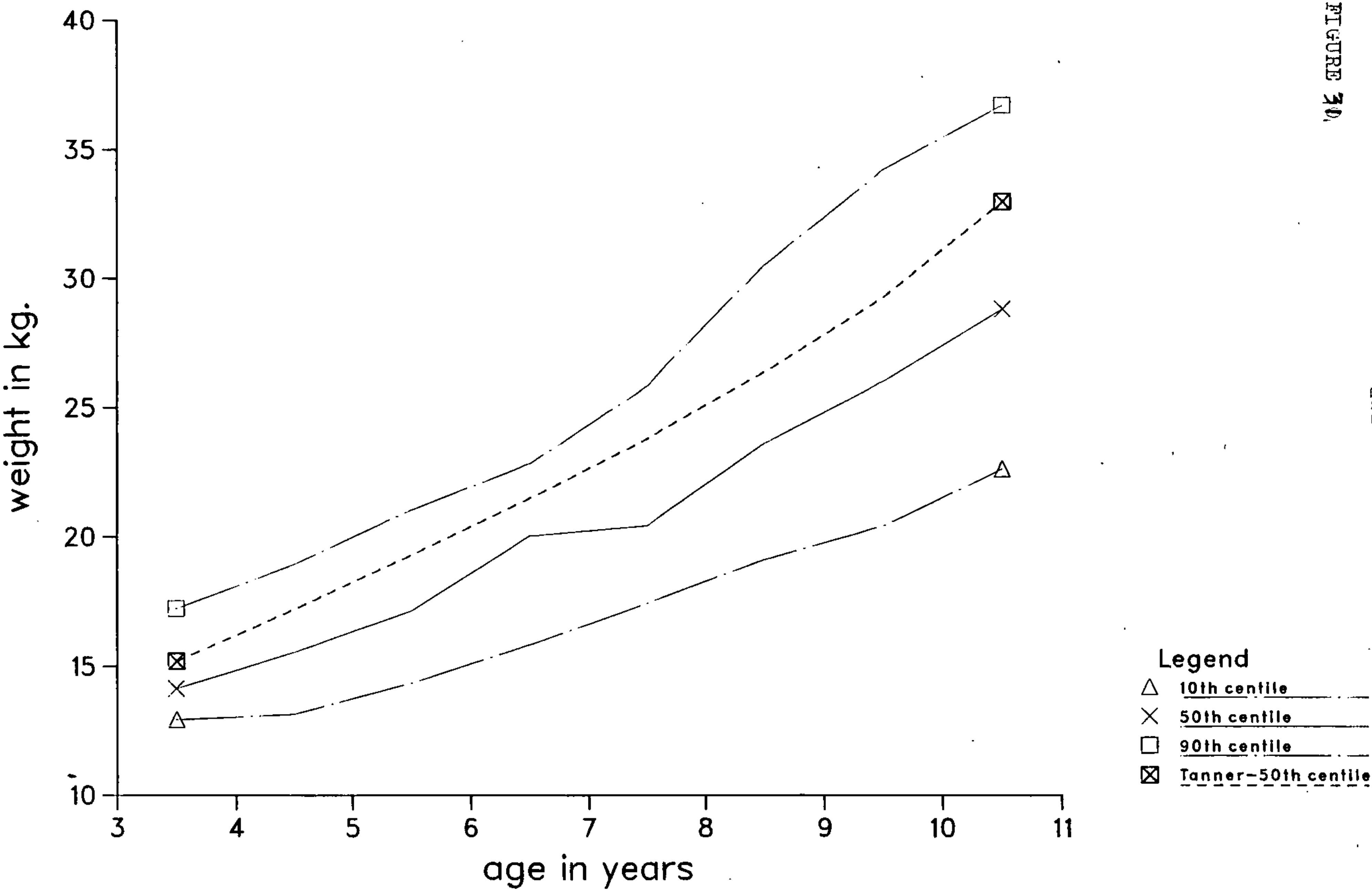


FIGURE 30.

CHAPTER 9

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CHAPTER 10

APPENDICES

APPENDIX A

ETHNICITY

An ethnic group can be operationally defined as a collectivity of people who

(a) share the same patterns of normative behaviour.

(b) form a part of a larger population interacting with people from other collectivities within the framework of a social system.

The term 'ethnicity' refers to the degree of conformity by members of the collectivity to these shared norms in the course of social interactions (Cohen 1974). Patterns of normative behaviour refer to symbolic formations and activities found in such contexts as kinship and marriage, friendship ritual and other types of ceremonial. These patterns are often referred to as customs or culture. These are collective representations even though they manifest themselves in individual behaviour. Ethnicity is essentially a form of interaction between culture groups operating with common social contexts - this is why the phenomena of ethnicity are so dramatically evident in the cities in both developing and developed countries (although it is not confined to the cities)(Cohen 1974).

So ethnic group means any group which is defined or set off by race, religion or National origin or some combination of these categories. But these three concepts do not mean the same thing - race - technically refers to the differential concentrations of gene frequencies responsible for traits, which so far as are known are confined to physical manifestations such as skin colour or hair form. It has no intrinsic connection with cultural patterns and institutions. Religion and National origins - are both cultural phenomena but they are distinctly different institutions, which do not necessarily vary concommitently.

But all these categories have a common social-psychological link - all of them serve to create, through historical circumstances, a sense of group belonging or peoplehood, i.e. an ethnic group (Gordon 1978).

The ethnic group bears a special relationship to the social structure of the modern complex society which distinguishes it from all small groups and from most other large groups. Within the ethnic group there develops a network of organisations and informal social relationships which permits and encourages the members of the ethnic group to remain within the confines of the group for all their primary relationships and some of their secondary relationships throughout all the stages of their life cycle. (Gordon 1978) so reducing or inhibiting links with Western culture and diet in Asian immigrants.

The ethnic minority, especially where these groups are recent immigrants or are racially different from the host society are concentrated geographically at a variety of scales. e.g. at National scale, ethnic groups are not equally distributed in all areas - Asians and particularly Pakistani Muslims are especially concentrated in Birmingham and the northern industrial textile towns, Gujarati Hindus are concentrated in Leicester, Punjabi Sikhs in Leamington Spa, Pakistani Muslims in Bristol. Within individual cities, ethnic minorities also concentrated in particular areas, inner city or the twilight zones. There is strength in voluntary clustering among the Asian population in Great Britain, especially where the intention is to return to their country of origin at a later stage - 'myth of the return' - held to explain the low level of participation by Asians in British society generally and their apparent reluctance to apply for council housing in particular. The apparent exercise of unfettered choice at one level may have constraints which operate at another level e.g. a study of Asian entrepreneurial activity in Bradford, Leicester and Ealing where the apparent success of small scale shopkeeping by Asian entrepreneurs has had the effect of shielding the Asian community from the rest of the population with whom they cannot compete on terms of economic equality (Jackson 1983).

APPENDIX B

Leicestershire Area Health Authority
Princess House
20 Princess Road West
Leicester

November 1978

Dear Parent

Leicestershire Growth and Nutrition Study

Your child attends a school which has agreed to take part in this survey which is being carried out by the Area Health Authority, together with the Department of Child Health, Leicester University and the Department of Human Sciences, Loughborough University. We hope that all the children in the school will join in but, of course, we will not allow your child to do so without your consent.

The population of Leicestershire today is very different from the one studied to make the growth charts which doctors use to assess children. These charts were based on boys and girls who were born about 25 years ago and who did not live in this part of England. We are therefore measuring a large number of normal healthy Leicestershire children and would like to include your child in the study.

If you agree, we should like to take the following measurements:- Height; Weight; Height when sitting; Head size; Distance round the upper arm; Skinfold thickness on the arm and on the back.

If you agree, would you please sign the consent form and give as many answers as you can to the questions on the attached sheet. These questions are important because children's growth is affected by both their family history and their diet. However, if you do not know the answer to a question, just leave the space blank.

Your child's name will not be used in any report of the study and under no circumstances will personal details of any child be given to any other authority or individual.

Yours sincerely

Dr B S M Marshall
Specialist in Community Medicine
(Child Health), Leicestershire
Area Health Authority.

LEICESTERSHIRE GROWTH AND NUTRITION SURVEY

Name of child: ______________________________________

I consent to my child being measured as part of the Leicestershire Growth and Nutrition Study.

Signature ______________________________

(Parent/Guardian)

SEX: .... DATE OF BIRTH: ....

BIRTHPLACE OF CHILD AND ANCESTORS:

	Nearest City	State	Country
CHILD			
FATHER			
MOTHER			
MOTHER'S FATHER			
MOTHER'S MOTHER			
FATHER'S FATHER			
FATHER'S MOTHER			

NB. Please put the name of the closest City, State or Country in the spaces. If you do not know any of these places, leave the spaces blank.

1. Is the child now being (a) breast fed
   (b) bottle fed
   (c) fed on solid food

2. For how long was the child breast fed?

3. For how long was the child bottle fed?

4. For how long has the child been taking solid food?

You may not remember exactly for how long your child was taking different foods but please answer as accurately as you can.

5. If your child is now taking solid food, does this include meat, poultry or fish?

Leicestershire Area Health Authority,
Princess House,
20 Princess Road West,
LEICESTER.

Dear Parent,

Leicestershire Growth and Nutrition Study

At the moment, if your child's growth needs to be assessed, the doctor has to use growth charts based on children who were born 25 years ago and who did not live in this part of England.

The aim of this study is to produce new growth charts that will be suitable for all children who now live in Leicestershire. To do this we need to measure a large number of normal healthyLeicestershire children of all ages. If you agree we would like to include your child in the study.

We shall take the following measurements:- height, weight, height when sitting, head size, distance around upper arm, skinfold thickness on the arm and on the back. Also, because children's growth is affected by their family history and their diet, there are short questions about this to be answered.

Your child's name will not be used in any report of the study and under no circumstances will personal details of any child be given to any other authority or individual.

The study is being carried out by the Area Health Authority and the Department of Human Sciences, Loughborough University.

Yours sincerely,

Dr. B.S.M. Marshall
Specialist in Community Medicine
(Child Health)

LEICESTERSHIRE GROWTH AND NUTRITION STUDY

Name of child ______________________________

I agree to my child being measured as part of the Leicestershire Growth and Nutrition Study.

Signature ________________________
(Parent/Guardian)

Sex of child: __________________ Date of birth of child: ______________

1. Birthplace of child and relations ancestors

	Nearest City	State	Country
Child was born in			
Father was born in			
Mother was born in			
Mother's father was born in			
Mother's mother was born in			
Father's father was born in			
Father's mother was born in			

NB Please put the name of the closest city, State or Country in the spaces. If you do not know any of these places, leave the spaces blank.

Please tick the correct answers in the next 3 questions.

2. As a baby, was your child

(a) breast fed (b) bottle fed (c) both?

3. For how long was your child

(i) breast fed? (a) less than 3 months (b) 3-6 months (c) 6 months - 1 year (d) 1-2 years (e) over 2 years

(ii) bottle fed? (a) (b) (c) (d) (e)

4. Do your child's meals now include

(a) meat (b) poultry (c) fish (d) eggs?

5. For how long has your child been taking solid food?

APPENDIX C

CODING FOR THE QUESTIONNAIRE

PARENTS' ETHNIC BACKGROUND

0 Unknown

1 Pakistan or Bangladesh

2 Pakistan or Bangladesh and Africa

3 India

4 India and Africa

5 India and Pakistan or Bangladesh

6 Africa

7 Other Asian Countries

8 European

9 West Indies

BIRTH PLACE

(a) Of Child and Parents

0 Child born in Great Britain, parents one or both unknown,

1 Child born in Great Britain, with one parent born here,

2 Child born in Great Britain, with both parents born here,

3 Child born in Great Britain, but neither parent born here,

4 Child not born in Great Britain, neither parent born here,

5 Child not born in Great Britain, one parent not born here,

6 Child not born in Great Britain, both parents born here,

7 Child not born in Great Britain, parents details unknown

8 No information.

(b) Of Grandparents

0 Mixed birth places of Great Britain, not here and unknown,

1 All born in Great Britain,

2 Non born in Great Britain,

3 Half born in Great Britain, one side of the family only,

4 Half born in Great Britain, from both sides of the family,

5 One born in Great Britain, three not,

6 Three born in Great Britain, one not,

7 Unknown,

8 Some born in Great Britain, rest unknown,

9 Some not born in Great Britain, rest unknown.

DIET

(a) Pre-weaning

0 Unknown,

1 Breast fed for 6 months or less,

2 Breast fed for 6-12 months,

3 Breast fed for over 12 months,

4 Bottle fed for 6 months or less

5 Bottle fed for 6-12 months,

6 Bottle fed for over 12 months,

7 Mixed breast and bottle feeding for 6 months or less,

8 Mixed breast and bottle feeding for 6-12 months,

9 Mixed breast and bottle feeding for over 12 months.

(b) Post-weaning

1 Vegan,

2 Vegetarian,

3 Non-vegetarian, eating all meat, poultry, fish and eggs,

4 Non-vegetarian, with 1 protein source missing from diet,

5 Non-vegetarian, with 2 or 3 protein sources missing,

6 Unknown,

7 No solid food yet.

APPENDIX D

For the people from India, Pakistan, Bangladesh and East Africa only, names were used to indicate religious adherence, and coded on the protocols as follows:-

Muslim	-	from Bangladesh	0
Muslim	-	from Pakistan	9
Muslim	-	from India or East Africa	3
Hindu	-	from India or East Africa	1
Sikh	-	from India or East Africa	2

APPENDIX E

SCHOOLS AND DAY NURSERIES VISITED IN THE LEICESTERSHIRE GROWTH STUDY

SCHOOLS

(a) Loughborough

(i)	Cobden Infants	24-25/2/1982
		16/9/1982
		18/1/1984
(ii)	Cobden Juniors	11-12/4/1984
(iii)	Mountfields Junior	21,30/6/1983
(iv)	Rendell Primary	24-25/11/1981
		14/1/1982
		23/9/1982
		13-14/1/1983
		20/3/1984
(v)	Rosebery Junior	11-14/6/1984
(vi)	Shelthorpe Primary	15-15/10/1982

(b) Leicester

(i)	Abbey Primary	8/3/1982
		15-16/3/1882
		25-30/3/1982
(ii)	Belgrave Primary	4-5/6/1984
(iii)	Blaby Stokes Primary	12-15/12/1983
(iv)	Catharine Juniors	17-18/9/1984
(v)	Catharine Infants	29-31/10/1984
(vi)	Evington Valley Infants	8-11/2/1983
(vii)	Glenfield Primary	21-23/11/1983
(viii)	Glenhills Primary	14-16/11/1983
(ix)	Greenlane Infants	9-10/3/1983
(x)	Herrick Infants and Juniors	18-21/6/1984
(xi)	Highfields Infants	12/11/1984
(xii)	Latimer Primary	7-8/11/1983
(xiii)	Mellor Infants	24-25/9/1984
(xiv)	Shaftesbury Juniors	26/11/1984
(xv)	St.Patrick's Primary	1-2/10/1984
(xvi)	Uplands Infants	29-31/11/1982

		1-2/12/1982
(xvii)	Wyvern Infants	15/6/1984
		12/9/1984

DAY NURSERIES

(i)	Regent Street, Loughborough	25/6/1981
		13/10/1981
		24/5/1982
		23/11/1982
		6/6/1983
		3/4/1984
(ii)	High Street, Coalville	13/8/1981
		13/1/1982
		10/6/1982
		16/11/1982
		9/4/1984
		3/5/1984

APPENDIX F

LEICESTERSHIRE GROWTH AND NUTRITION SURVEY

MEASUREMENTS PROTOCOL

DATE OF BIRTH: ______________ DATE OF EXAMINATION: ______________

AGE: ______________

STUDY CODE ______________

SUBJECT NO. ______________

SEX ______________

BACKGROUND (coded from questionnaire) ______________

DATE OF BIRTH (DECIMAL) ______________

EXAMINATION DATE (DECIMAL) ______________

MEASUREMENTS:

STATURE or crown-heel length ______________

WEIGHT ______________

HEAD CIRCUMFERENCE ______________

UPPER ARM CIRCUMFERENCE ______________

TRICEPS SKINFOLD ______________

SUBSCAPULAR SKINFOLD ______________

SITTING HEIGHT or crown-rump length ______________

DIET

RELIGION

APPENDIX G

COMMENTS ON THE CALCULATION OF UPPER ARM AREAS

There are some comments that must be recorded about the use of the derived AFA and consequently derived AMA, i.e. there are variations between ages, races and sex, in compressibility of the skinfold and no allowance has been made for this. Other variable factors that might have affected circumference measurements are the state of dehydration and the amount of vasodilation of the upper limb (McMorris and Elkins 1954).

Additionally, the skinfold value recorded is that of a double fold of subcutaneous fat and skin tissue under pressure and individuals go through a series of changes in the thickness and distribution of subcutaneous fat as a function of age and sex. Skinfolds are also always an under estimation of the actual thickness, but inconsistently so, depending upon the site and sex (Himes 1980).

Subcutaneous fat is also not uniformly distributed over the arm, the triceps skinfold is greater than the biceps and the fat area model assumes that the underlying tissues are circular in cross-section, which is not true as the muscle component in the upper arm resembles a clover leaf in shape (Frisancho 1981) and bases the depth of fat upon that of the triceps value only in this study.

The assumption has been made that the upper arm is cylindrical in cross-section although in reality it is usually elliptical and that there is no variation in the size of the humerus. Research on the radiographic composition of the arm in White children showed virtually the same ratio of muscle to bone in both sexes in both pre-and post-pubertal age groups (Malina and Johnston 1969) but whether this is also true for the Indian children in this study is not known.

Finally, all the measurements in this study were taken on the left upper arm. The incidence of handedness is reported to be 1-34% (Annett 1972) in adults. It is possible that the children in this study, because of their young ages, will not show dimorphism in their upper arm dimensions but it is known that Muslim practices dictate the specific use of each hand for certain tasks, and whether this will have any impact upon variability of upper arm circumference, arm musle areas, and arm fat areas over and above any variability that may exist in the other religious groups where definitive taboos and distinction of role for the two limbs is not known.

APPENDIX H

SPECIMEN ANALYSIS OF VARIANCE TABLES

	HEIGHT	WEIGHT
GENERATION B, CHILD FROM INDIA	C58	C28
GENERATION A, CHILD FROM EAST AFRICA	C35	C35
GENERATION A, CHILD FROM INDIA	C48	C48
GENERATION A, CHILD FROM EAST AFRICA	C55	C55

One way analysis of variance, using Z scores, derived from the Leicestershire Hindi child population sampled, divided by generation and country of origin.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF	F-RATIO
FACTOR	3	6.525	2.175	2.32
ERROR	1125	1054.334	0.937	
TOTAL	1128	1060.858		

LEVEL	N	MEAN	ST. DEV.
C58	335	-0.343	0.944
C35	693	-0.181	0.954
C48	27	-0.164	0.738
C55	74	-0.313	1.2[illegible]6

POOLED ST. DEV. = 0.968

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF	F-RATIO
FACTOR	3	12.151	4.050	4.18
ERROR	1158	1122.953	0.970	
TOTAL	1161	1135.104		

LEVEL	N	MEAN	ST. DEV.
C28	342	-0.411	0.934
C35	715	-0.206	1.011
C48	28	-0.393	0.7[illegible]1
C55	77	-0.442	1.0[illegible]4

POOLED ST. DEV. = 0.985