SUMMARY

Health is an important input for the development of human resources and the quality of life necessary for the overall development of the community or country as a whole. In this connection, the World Health Organization has defined health as “a state of complete mental and social well-being and not merely the absence of diseases or infirmity” (WHO, 1971). Although it may not be possible to attain all such types of well-being as referred to in this definition, the WHO’s constitution says, “The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political, economic and social condition.” As such, health is a holistic concept, and one may define health in any manner relating to either one or all physical, mental and well-being of an individual, or a population, according to one’s expediency of study. From an anthropological point of view, one may look into health as a state of well-being due to the interplay between socio-cultural and biological factors - environmental and genetic factors (Kar, 2000).

In order to measure the health status of a population, one needs to take into consideration certain health parameters, which are generally considered as health indicators, although the method of measuring may vary from one study to another (Gwatkin, 2000). Park (1995) has listed a number of health indicators under different categories, viz., mortality rates, morbidity rates, disability or illness and injury rates, nutritional status, health care and delivery indicators, family planning and epidemiological policies, social and mental health indicators (e.g., include suicide, homicide, acts of violence and crimes, road traffic accidents, juvenile delinquency, alcohol and drug abuse, smoking, and the like), environmental indicators (e.g., physical
and biological environmental conditions in which diseases occur like air and water pollution, radiation, solid wastes, noise, exposure to solid substances in food and drinks, etc.), socio-economic indicators (e.g., population growth, per capita income, per capita expenditure, per capita gross national product, level of unemployment, literacy rates, family size, number of persons per room, per capita calorie availability, social security and welfare services), and health policy indicators (e.g., GNP spent on health services, water supply, sanitation, housing, community development, and so on).

It is, therefore, obvious that there are a large number of health parameters, and for that reason, it is often argued that health status is a function of many biological and socio-environmental factors. Accordingly, it is not simple to assess the health status of the population, especially in the case of individual research as it requires a technical knowledge from different fields or disciplines. “This is because health, like happiness, cannot be defined in exact measurable terms. Its presence or absence is so largely a matter of subjective judgment” (Park, 1995). Nevertheless, selection of few sensitive, specific and reliable parameters is also meaningful especially for screening or identifying the health problems of a specific population at a given point of time, which are required for immediate intervention. From the biological anthropological point of view, demographic variables (e.g., fertility, mortality and reproductive wastage), self-reported morbidity, nutritional anthropometry of adults, growth and nutritional status of children, and haematological traits including blood pressure and hemoglobin content are commonly used as health indicators of population (Khongsdier, 1996). These health parameters are in turn influenced by numerous biosocial factors. An attempt to understand the relationship of these health parameters with various socio-economic factors like educational level, occupation, income and expenditure of the household, etc., may be very helpful in understanding the health status of a population.

In the present thesis, we shall deal with the health status of the Hmar population of Aizawl District, Mizoram, with respect to certain selected health parameters such as demographic variables, anthropometric variables, growth and nutritional status, morbidity and hemoglobin level. An attempt will be made to look into the interrelationship between these health parameters and their association with age, sex, economic condition and educational level. With this end in view, we propose to undertake a study on the health
and nutritional status of the Hmars of Aizawl district in Mizoram, taking into consideration the following objectives:

1. To describe the demographic structure of the Hmar population of Aizawl district of Mizoram.
2. To understand the growth and nutritional status of children aged 2 to 10 years, using selected anthropometric measurements and indices in relation to socio-economic conditions.
3. To understand the health and nutritional status of adults in terms of anthropometric variables, hemoglobin level and morbidity pattern, and to find out the possible relationship between these health variables and certain socio-economic factors.

MATERIALS AND METHODS

Study Area and Population

The present study was carried out in Aizawl District of Mizoram during the months of September to December 2001. The state is predominantly dominated by tribal groups like Lushais, Pawis, Paites, Raltes, Pang, Kukis, Hmars, etc. In the present study, we shall deal with the Hmars of Aizawl district. The Hmars have their own dialect, which has a close affinity to the Lushais and invariably resemble Paites and Kukis. Linguistically, they belong to the Kuki-Chin family. It was the Christian missionaries who introduced the Roman script to the Hmar language in the 19th Century.

The Hmars are divided into 24 clans and each of these clans is again divided into about 180 sub clans/families. Clanship does not regulate marriage rules and an individual can select his mate from any clan including his own. Widow re-marriage is not uncommon. Being a patriarchal society, the father heads the family and lineage is traced through the male line. The general rule of inheritance is that the youngest son gets the lion share of parental property. Women are not allowed to inherit any property. Agriculture is the main occupation of the Hmars. Some are also engaged in weaving, handicraft, business and services.

The data for the present study were collected from four villages, namely, Tinghmun, Zohmun, Sakawrdai and Ratu, Darlawn Block in rural areas of Aizawl
district, Mizoram by means of simple random sampling (Census 2001). According to this sampling method, the list of 20 villages and their population in Aizawl District was first prepared based on the information from Indian Census 1991 and T.R.I. 1992. The random numbers given in Snedecor and Cochran (1967) was used for selecting the required number of sample villages. No random sampling was applied for selection of subjects/informants from each of the selected villages due to operational difficulties in the field. An attempt was made to cover 410 households, that is, about 45% of the total 914 households in all four selected villages.

Demographic Data
The nature of demographic data collected for the present study was based on those parameters suggested by the World Health Organization Working Group (WHO, 1964, 1968; Mahadevan, 1986). The entire demographic data were collected through pedigrees and schedules from all the four hundred households in the four villages, namely, Tinghmun, Zohmun, Sakawrdai and Ratu. Information on age, sex, marital status, tribe, religion, occupation, income, education, community affiliation, place of birth, place of residence, etc. was collected from the head of the household or elder member who was capable of furnishing all the relevant information as per household schedule.

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

Data on Adult Body dimensions
Some selected anthropometric measurements from the basic list of measurements, recommended by the International Biological Programme (Weiner and Lourie, 1981) were taken into consideration for the purpose of the present study. Following are the
anthropometric measurements taken on 978 adults aged 20 years and above of both sexes wearing light apparel.

Weight (Kg)
Height (cm)
Sitting Height (cm)
Biacromial Diameter (cm)
Bi-iliac Diameter (cm)
Mid Upper Arm Circumference (MUAC)
Chest girth (inhaled) (cm)
Chest girth (exhaled) (cm)

Besides the above measurements, following indices were computed for adult males and females in order to assess the nutritional status.
1. Body mass index = weight (kg)/height (m)^2
2. Cormic index or relative-sitting height = sitting height (cm)/height (cm)

**Data on Growth and Nutritional Status of Children**

The present study of physical group was based on a cross sectional sample of Hmar boys and girls aged between 2-10 years. Following are the anthropometric measurements taken on 255 boys and 252 girls:

1. Weight (Kg)
2. Height vertex (cm)
3. Sitting height vertex (cm)
4. Biacromial Diameter (cm)
5. Bi-iliac Diameter (cm)
6. Mid upper arm circumference (Left arm) (cm)

An attempt was made to follow as far as possible the standard techniques of taking the measurements as described in Weiner and Lourie (1981). For assessing the nutritional status of children, we had taken three anthropometric indices - weight-for-age, height-for-age and weight-for-height - which are considered as the indicators of nutritional status. These indices were derived as z-scores of the international standard or reference, i.e., the growth reference of the WHO/U.S. National Centre for Health Statistics (WHO, 1983, 1995). Body mass index (BMI = weight in kg/height in meter
squared) was used for assessing the nutritional status of adult males and females (WHO, 1995).

**Data on Morbidity and Hemoglobin Level**

Data on haemoglobin content of 551 adults were collected using Sahli’s Haemometer by following standard techniques (WHO, 1980). The cut-off points of 13.0 g/dl and 12.0 g/dl were taken for screening the adult men and non-pregnant women, respectively (WHO, 1968). Data on morbidity were based on "self-reported illness experience" of a subject as generally adopted in surveys, which did not involve a clinician (Strickland & Ulijaszek, 1993; Garcia & Kennedy, 1994; Strickland & Tuffrey, 1997). SRM is also more preferable from the point of view that a clinical diagnosis involves much time, cost and technical expertise, which are not always possible when carrying out community-based studies in developing countries including India.

**Socio-economic Categories**

In the present study, three important socio-economic variables were taken into consideration. These include religion, monthly income of the households and educational level. These socio-economic variables were classified arbitrarily into different groups and/or categories with a view to understanding their influence on the health traits of the study population. Our classification may be briefly described as follows:

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

- Above ($\bar{X} + 4SD/\sqrt{N}$) = High income group (HIG)
- ($\bar{X} - 4SD/\sqrt{N}$) to (Mean + 4SD/\sqrt{N}) = Middle income group (MIG)
- Below ($\bar{X} - 4SD/\sqrt{N}$) = Low income group (LIG)
Educational Level: The data on educational attainment of individuals in the present study were arbitrarily classified as follows: The category No education includes those individuals who were unable to read and write and those who had no education but could read or write their names. The individuals who attended school up to standard V were grouped into Primary level of education. The individuals with education of standard VI and above are included in the category of Secondary level of education due to inadequacy of data.

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

FINDINGS OF THE PRESENT STUDY
The findings of the present study were presented in three chapters. In chapter III, we deal with the demographic characteristics of the three religious groups. The growth and nutritional status of children are presented in Chapters IV, whereas adult body dimensions and health status was given in Chapter V.

DEMOGRAPHIC CHARACTERISTICS
The findings on important demographic characteristics of the study population are as follows:

1. According to Sundbarg’s classification of population, a population is said to be progressive when the number of persons in relation to the total population
are 40.0%, 50.00% and 10.00% in the age groups 0-14, 15-49 and 50 + years, respectively. The population is referred to as stationary if these frequencies are 33.00%, 50.00% and 17.00%, respectively; while the frequencies of 20.00%, 50.00% and 30.00%, respectively, are the characteristics of regressive population (Khongsdier, 2005). Following these classifications of population, the Hmar population is categorized as progressive type.

2. The overall sex ratio, i.e., the number of males per 100 females, is found to be 95.22 which is lower than the ideal sex ratio of 1:1, despite the absence of statistical significance ($\chi^2 = 1.56$, d.f. = 1, $p > 0.05$).

3. The mean age at marriage is significantly higher in males (25.84 ± 0.29 years) than in females (20.78 ± 0.19 years) as generally observed in other populations (Khongsdier, 2005). The mean age at marriage among the Hmar married women of the present study is higher than those reported for many populations of Assam (Sengupta and Gogoi, 1995), but it is more less similar to that reported for the War Khasi and Khynriam Khasis (Khongsdier, 2001; Mukherjee, 2002).

**Fertility and Mortality**

1. The mean live birth per mother of all ages was 4.67 ± 0.13. In comparison with the recent reports on some populations in Northeast India, the fertility rate among the Hmars of the present study seems to be fairly high.

2. The age specific fertility rate seemed to reach its peak point in the age group 25-29 years. The total fertility rate (6.10) was much higher than that reported recently for some populations in Northeast India. It is similar to those reported for the Khasi sub-groups which had the highest fertility rate in Northeast India (Mukherjee, 2002; Khongsdier, 2005c). It may be mentioned that the adoption rate of modern family planning methods is very low (about 6%) in the present population.

3. The infant mortality rate (i.e., number of deaths before 1 year of life per 100 live births) was found to be 2.83%, which was the lowest in comparison with some populations in Northeast India.
4. The prevalence of reproductive wastage (4.12%) appears to be moderate in the present population (spontaneous abortion rate = 2.86% and still-birth rate = 1.26%). In comparison with most recent data for populations from Northeast India, the prevalence of reproductive wastage among the Hmars was higher than that among the Mukloms of Arunachal Pradesh (Sarkar, 2002), similar to the Sanga and Wanang Kochs of Garo hills (Murali, 2002), but lower than many other populations (Sengupta and Kalita, 2001; Mukherjee, 2002; Khongsdier, 2005c).

5. The mean number of live births to women who married by the age of ≤ 19, 20-24 and ≥ 25 years is 4.85, 4.66 and 4.31, respectively. It is seen that the mean number of live births decreases with the increase in the mean age at marriage, despite the absence of statistical difference (F = 0.914, d.f. = 2, 437, p > 0.05).

6. It is found that the unadjusted mean of live births decreases significantly with the increasing educational level of the mothers (F = 32.27, d.f. = 2, 437, p < 0.0001). Adjusting for maternal age and household income, these differences in live births between educational groups of mother disappeared (F = 0.93, d.f. = 2, 437, p > 0.05). This indicates that the effects of education on live births are compounded by maternal age and household income. For example, it is likely that most educated mothers are in the lower age group, whereas illiterate mothers or mothers without educational background are more in the older age groups, thereby resulting in sampling variation. From this point of view, the ANCOVA test is very helpful in determining how an independent variable (e.g., maternal age in the present analysis) alone could influence the dependent factor (e.g., live birth in the present analysis).

7. It is observed that the unadjusted mean live births are 5.10 ± 0.17, 4.22 ± 0.28 and 3.97 ± 0.28 in the low, middle and high income groups, respectively, and these differences are statistically significant (F = 7.57, d.f. = 2, 437, p < 0.001). The higher mean live births in the lower income groups as compared to high income groups are statistically significant even after adjusting for maternal age and education (F = 6.15, d.f. = 2, 437, p < 0.001). This indicates that household income is very important in regulating fertility rate in the present population.
8. Results of multiple regression analysis was also carried out to have a better understanding of the relationship between live births/surviving children and socio-economic conditions. It was observed that maternal age was positively associated with live births \((b = 0.129 \pm 0.008, t = 16.42, p < 0.0001)\) and surviving children \((b = 0.104 \pm 0.008, t = 13.45, p < 0.0001)\). It was also found that maternal age at marriage was negatively associated with live births \((b = -0.120 \pm 0.025, t = 4.84, p < 0.001)\) and surviving children \((b = -0.110 \pm 0.024, t = 4.55, p < 0.001)\). In addition, household income was also negatively associated with live births \((b = -0.365 \pm 0.122, t = 2.99, p < 0.003)\) and surviving children \((b = -0.327 \pm 0.120, t = 2.74, p < 0.006)\). On the other hand, we failed to get a significant relationship between maternal education and live births as well as surviving children. Thus, it may be concluded that the role of maternal education is not clearly perceptible in the present analysis. Instead, maternal age, age at marriage and household income are very important factors for controlling live births and surviving children.

9. With respect to infant mortality, it was observed that infant mortality is negatively associated with maternal age \((b = -0.029 \pm 0.011, t = 2.62, p < 0.009)\) and negatively associated with maternal education \((b = -0.052 \pm 0.026, t = 2.00, p < 0.05)\). On the other hand, the effect of household income on infant mortality is not clearly perceptible in the present study. Thus, maternal age and maternal education seem to be very important factors in controlling infant mortality in the present population. It also indicates that household income alone may not be sufficient to bring down death rates, if maternal education is not taken into account.

**GROWTH AND NUTRITIONAL STATUS OF CHILDREN**

In the present study, we have considered the growth of children aged 2 to 10 years of age. The main purpose is to assess the nutritional status of children in relation to other demographic and socio-economic conditions of the study population. However, an attempt was also made to assess the growth status of these Hmar children in relation to their coevals at a given age in other populations including the recommended growth
references and/or standards. In this regard, we have taken into consideration only some important anthropometric variables like weight and height, which are also reported for few populations in Northeast India, such as War Khasis (Khongsdier, 1996), Khynriam Khasis (Mukherjee, 2002), Assamese Muslims (Begum and Choudhury, 1999) and Kalitas (Choudhury and Bhuyan, 1994).

It may be noted here that in India we do not have the recommended growth references and/or standards. Although the data collected by the Indian Council of Medical Research (ICMR, 1972) are old and unrepresentative of all sections of the Indian population, we used in the present study simply to understand the growth status of the Hmar children, but not as a target or standard of growth that one should assess the children's growth in the present study. As a matter of fact, we used the NCHS/WHO growth references (WHO, 1983) for assessing the nutritional status of children as internationally recommended.

**Weight**

It is observed that the Hmar boys are above the 50th percentile of the ICMR growth references from 2 to 10 years of age although they are similar at about 5 years. In comparison with the NCHS growth references, the Hmar boys are far below the 50th percentile from 2 to 10 years of age, but they are above the 3rd percentile across these ages. However, the Hmar boys are above the 50th percentile of the ICMR growth references. In comparison with their counterparts reported from some populations of Northeast India, the Hmar boys are comparable to the War Khasi boys (Khongsdier, 1996) from 3 to 5 years of age and to the Khynriam Khasi boys (Mukherjee, 2002) from 4 to 5 years of age. However, the War Khasi boys are heavier than the Hmar boys from 5 to 10 years of age. The Hmar boys are heavier than the Khynriam Khasi boys from 5 years onwards, although the Khynriam are heavier at 9 years of age. In comparison with the Assamese boys, the Hmar boys are heavier than the Kalita boys (Choudhury and Bhuyan, 1994) across ages. They are also heavier than the Assamese Muslim boys (Begum and Choudhury, 1999) from 3 to 6 and 8 to 9 years, although the latter are heavier from 9 to 10 years of age. In general, it reveals that the Hmar boys are above the 50th percentile of the ICMR growth references and heavier than the Kalita boys, although
they are lighter than the War Khasi boys from 5 to 10 years of age. They are comparable to the Assamese Muslim boys.

As for girls, it is observed that they are above the 50th percentile of the ICMR and 3rd percentile of the NCHS growth references from 2 to 10 years of age. However, they are far below the 50th percentile of the NCHS growth references. In comparison with some populations in Northeast India, the Hmar girls are heavier than the Kalita girls across ages. They are similar to the Khynriam and Assamese Muslim girls from about 3 to 5 years, and thereafter they are lighter up to about 8 years of age. They are similar to the Assamese Muslim girls from 8 to 10 years, although they are lighter than the Khynriam and War Khasi girls in this age group. They are also heavier than the War Khasi girls from about 3.5 to 5 years, and thereafter the latter surpassed the former up to about 8 years. On average, like their male counterparts, the Hmar girls are above the 50th percentile of the ICMR growth references and heavier than the Kalita girls of Assam. They are comparable to the War Khasi and Assamese Muslim girls, irrespective of certain fluctuations.

**Height**

It is observed that the Hmar boys are below the 50th percentile of the ICMR growth references across ages although they are more or less comparable from 2 to about 3.5 years of age. The Hmar boys are also far below the 50th percentile of the NCHS growth references, but they are more or less comparable to the 3rd percentile of the international growth references across ages. The Hmar boys are found to be taller than the Khynriam boys across ages, but shorter than the War Khasi, Kalita and Assamese Muslim boys. They are similar to the Assamese Muslim boys only from 3 to 4 years of age. Thus, in view of these comparisons, the Hmar boys seem to be better in growth status of height when compared with the Khynriam Khasi and ICMR growth references. However, they are shorter than War Khasi, Kalita and Assamese Muslim boys.

As for girls, they are, on average, below the 50th percentile of the ICMR growth references with respect to growth in height, and they are far below the 50th percentile of the NCHS growth references. They are taller than the Kalita and Khynriam Khasi children. They are similar to the War Khasi girls from 7 to 10 years of age and to the
Assamese Muslim girls from 3 to 5 years of age. However, they are shorter than the War Khasi and Assamese Muslim girls from 3 to 7 years and 5-10 years of age, respectively.

**Nutritional Status**

Nutritional status is defined as the physical expression of the relationship between the nutrient intakes, or bio-availability of nutrients, and the physiological requirements of an individual (Brown, 1984). This physical expression of the relationship between nutrient intakes and physiological requirements of a person can be measured by a number of methods. Of different methods, anthropometry is one that is generally used for measuring the magnitude of undernutrition at both individual and population levels. In the present study, we have taken into consideration three anthropometric indices, i.e., weight-for-age (indicator of underweight), height-for-age (indicator of stunting) and weight-for-height (indicator of wasting or thinness) for assessing the nutritional status of children. The cut-off point of – 2 Z-score was used for screening undernourished groups of children (WHO, 1983) for all the three indices.

**Prevalence of Underweight and Its Risk Factors**

The risk factors of underweight in terms of odds ratios derived from logistic regression models after adjusting certain variables. Four logistic regression models were used for presenting the risk factors of underweight. In the first model, age was taken into consideration by dividing the children into two age groups, viz., 2-5 and 6-10 years, for computing the odds ratio with 95% confidence interval (CI) from the regression models after adjusting for sex, income and mother’s education. It is found that older children aged 6-10 years had about 1.15 times greater in risk of being underweight as compared to younger children aged 2-5 years of age. However, this risk is not statistically significant (p = 0.508). The second model is concerned with the sex difference after adjusting for age, income level and mother’s education. It is seen from the table that boys had about 1.48 (95% CI: 1.01-2.30, p < 0.05) greater risk of underweight as compared with girls. This is somewhat in contrast to the general observation that underweight in Southeast Asia is higher in girls than in boys.

In the third model of logistic regression, we have taken into consideration the three income groups after adjusting for age, sex and mother’s education. It is found that children in the low and middle income groups had greater risk of underweight when
compared to those in the high income group. Children in the low income group had about 2.58 (95% CI: 1.32-5.05, \( p < 0.006 \)) times greater in risks of being underweight as compared to those in the high income group. Similarly, children in the middle income group had about 2.41 (95% CI: 1.11-5.24, \( p < 0.027 \)) times greater in risks of being underweight as compared to those in the high income group. This is clear that household income is very important factor for regulating body weight of children.

The effect of maternal education is not statistically significant in the present population. However, children of the mothers without any education had about 0.96 times the risk of underweight when compared to those with secondary level of education.

**Prevalence of Stunting and Its Risk Factors**

The risk factors of stunting in terms of odds ratios like in the case of underweight were analyzed. Adjusting for sex, household income, and maternal education, children aged 6-10 years had about 1.26 (95% CI: 0.86-1.80) greater risk of being short stature or stunting. However, this odds ratio is not statistically significant. In the next model, the odds ratio for the sex difference in the prevalence of stunting was worked out after adjusting for age, household income and maternal education. It is observed from the table that boys had about 1.64 (1.09-2.23) times greater in risks of stunting as compared to girls. Thus, like in the case of underweight, stunting is likely to be more prevalent in boys than in girls.

With respect to economic condition, it is found that children in the low and middle income groups had greater risk of stunting when compared to those in the high income group, i.e., the prevalence of stunting is similar to that of underweight with respect to economic condition. Children in the low income group had about 2.64 (95% CI: 1.52-4.56, \( p < 0.001 \)) times greater in risks of stunting as compared to those in the high income group. In comparison with those in the high income group, children in the middle income group had also about 2.18 (95% CI: 1.13-4.19, \( p < 0.022 \)) times greater in risks of stunting after adjusting for age, sex, and mother’s education. Thus, household income is likely to be an important in determining stunting in the present population. Like in the case of underweight, the effects of maternal education are not clearly perceptible in the present population.
Prevalence of Wasting and Its Risk Factors

The risk factors of wasting in terms of odds ratios are derived from logistic regression models. Unlike in the case of underweight and stunting, the effects of demographic and socio-economic factors on wasting are not statistically significant in the present population. However, it is likely that children in the low and middle income groups had greater risk of wasting when compared to those in the high income group. Thus, it cannot be totally ruled out the role of household income in regulating wasting in the present population.

ADULT NUTRITIONAL AND HEALTH STATUS

Adult Body Dimensions

In observing the means and standard deviations of anthropometric traits for adult males by age groups, with the exception of bi-iliac diameter, the mean anthropometric traits are higher significantly in the lower age groups. The same is observed for adult females. Perhaps, this may be due to secular trend other than chance factors such as sampling variation are not involved. By secular trend, we mean an increase in anthropometric measurements from one generation to another due to improvement in economic condition of a given population. With respect to bi-iliac diameter, different explanations may be given, but it is likely to be associated with the increase in fat accumulation at the bi-iliac portion of the body with the increasing age. Nevertheless, it is evident from the results presented in the Tables that individual age should be taken into consideration when carrying out statistical analyzes on the effects of socio-economic conditions on anthropometric traits, or assessing the nutritional status of the study population in relation to socio-economic conditions.

Prevalence of Under- and Over-nutrition

The individuals with BMIs of < 16.0, 16.0-16.9, 17.0-18.4, 15.5-23.0 and > 23.0 kg/m² were considered to be in the severe, mild, moderate, normal and overweight grades of nutritional status, respectively (James et al., 1988; WHO, 2000c). It is found that about 1.01%, 3.24% and 10.53% of adult males suffer from severe, mild and moderate undernutrition, respectively. Among adult females, these frequencies are 0.83, 4.55% and 10.74%, respectively. Considering the cut-off point of 18.5 for screening the individuals into normal and undernourished or chronic energy deficiency (CED) groups (Ferro-Luzzi
et al., 1992, WHO, 1995), the overall prevalence of under-nutrition is 14.78% in males and 16.12% in females. This sex difference in the prevalence of under-nutrition is not statistically significant ($\chi^2 = 0.34, p > 0.05$). These prevalent rates of CED are also lower than those reported for several populations of Northeast India, including caste groups like Brahmins, Kalitas, Jogis, Kaibartas and Hinduised groups like Ahoms, Kochs and Rajbhanjis (Khongsdier, 2001).

With respect to overweight, it has been suggested recently that the BMI of 23.0-25.0 and $> 25.0$ should be considered the cut-off points for screening overweight and obesity, respectively (WHO, 2000c). Using the cut-off point of 23.0 for screening overweight individuals, about 12.96% of males and 16.12% of females are overweight in the present population. It indicates that the prevalence of overweight is higher in females than in males, although it is not statistically significant ($\chi^2 = 1.97, p > 0.05$).

**Risks of Under-nutrition**

In order to have a better understanding of how under-nutrition is related to age, sex, cormic index and socio-economic conditions in the study population, an attempt was made to carry out the logistic regression analysis. The odds ratios (with 95% confidence interval (CI) relative to the prevalence of under-nutrition or CED) are derived from logistic regression models after adjusting for other variables under consideration. With respect to age, it is found that older individuals had greater risks of being undernourished after adjusting for cormic index, sex, education and income. The individuals aged 60+ years had about 5.06 (95% CI: 2.98-8.61) times greater in risk of being undernourished as compared with those aged $< 40$ years. On the other hand, the subjects who are aged 40-59 years had about 2.08 (95% CI: 1.37-3.17) greater in the prevalence of under-nutrition as compared with those aged $< 40$ years. Thus, it is evident from the present analysis that age is significantly associated with the nutritional status of the individuals in the present population.

As for cormic index, it is observed that the individuals with low cormic index seem to have a higher risk of being undernourished. Adjusting for age, sex, education and household income, the prevalence of under-nutrition was about 1.61 (95% CI: 1.12-2.33) times greater than those with cormic index of $> 0.53$. This indicates that cormic index is
significantly associated with the prevalence of CED in the present population. It is also found that the odds ratio for the prevalence of CED according to sex. Adjusting for age, conjic index, education and household income, females had about 1.38 (95% CI: 0.95-2.00) times greater in the prevalence of CED as compared males. This difference is, however, not statistically significant (P > 0.05).

In comparison with the high income group, the low income group had about 1.78 (95% CI: 1.04-3.05) times greater in risk of being undernourished after allowing for age, sex, conjic index and education. However, the middle income group is not significantly deviated from the high income group with respect to the risk of CED (OR= 1.04; CI: 0.55-1.97). Nevertheless, income seems to have a great influence on the nutritional status of the adult individuals in the Hmar population. Like in the case of mean BMI, the effect of education on the nutritional status of the adult males and females is not clearly perceptible.

**Morbidity by Age and Sex**

The prevalence of morbidity, that is, those individuals who had suffered from any illness and were at least one day in bed during the last one month before the survey. The overall prevalence of morbidity is 11.45%, and it is higher in males (13.36%) than in females (9.50%), and it is statistically significant ($\chi^2 = 9.18$, D.F. = 1, $p < 0.002$). The prevalence of morbidity increases with the increasing age groups in both males and females. In males, the prevalence of morbidity increases from about 12% in the age group < 40 years to 20% in the age group 60+ years. On the other hand, the prevalence of morbidity in females is higher in the age group 40-59 years (12.23%) as compared to the age groups < 40 years (7.92%). However, these age differences are not statistically significant for both males ($\chi^2 = 3.11$, D.F. = 2, $p > 0.05$) and females ($\chi^2 = 2.37$, D.F. = 2, $p > 0.05$). Thus, according to data presented in Table 5.10, it can be argued that sex is more important than age for influencing morbidity, although older individuals are likely to have a greater risk of morbidity.

The self-reported symptoms of morbidity were classified into three broad categories as generally suggested (Sadana, 2000). **Cold and Respiratory and Intestinal Disorders** include those symptoms such as cough + runny nose + headache + fever, fever + cough, cough alone, swollen glands, + cold, ear problem, breathing problem, chest
pain, sore throat, TB. On the other hand, **Intestinal Disorders** include diarrhoea, dysentery, worms, vomiting, vomiting + fever, and other self-reported problems of stomach pain. Self-reported symptoms of morbidity other than the two categories above were included in the category of **Other Problems**.

It can be observed that the prevalence of cold and respiratory disorders is more common than that of intestinal ones for both the sexes. It is slightly higher in males (5.67%) than in females (3.93%). The prevalence of intestinal disorders is more or less similar in both males (1.82%) and females (1.86%).

**Risks factors of Morbidity**

It is found that older individuals are likely to get sick when compared with the younger ones, although the odds ratios are not statistically significant. It is also found that adult males had about 1.62 (95% CI: 1.07-2.46) times greater in risk of morbidity when compared with females, i.e., after adjusting for age, nutritional status, education and household income. The undernourished individuals also have greater risks of morbidity. Adjusting for age, sex, education and household income, the prevalence of morbidity was more than 2 times (95% CI: 1.32-3.60) greater in undernourished individuals than those with normal grade of nutrition. This indicates that morbidity is significantly associated with the prevalence of CED.

Household income does not seem to have influenced morbidity pattern in the present population. However, education seems to be important factor influencing morbidity in the present population even after adjusting for age, sex, nutritional status and household income. The subjects without education had about 1.89 (95% CI: 1.13-3.16) times greater in risks of having morbidity problems when compared to those with secondary level of education.

**Hemoglobin Content by Sex and Age**

As theoretically expected, the mean hemoglobin content is significantly higher in males than in females for all of the age groups. It is also observed that the hemoglobin content tends to decrease with the increasing age groups for both males and females. The analysis of variance (ANOVA) shows that the differences in hemoglobin level between age groups are statistically significant for both males (F= 4.99, d.f. = 2, 287; p < 0.007) and females (F= 3.64, d.f. = 2, 258; p < 0.02). This indicates that age should be taken into
consideration while analyzing the relationship between hemoglobin content and other factors.

**Prevalence of Anemia by Sex and Age**

It is found that the prevalence of anemia is higher in males (38.97%) than in females (37.55%), and the differences between the sexes are statistically significant ($\chi^2 = 9.95$, d.f. = 2, $p < 0.002$). The prevalence of anemia increases with the increasing age groups for both males and females. However, the chi-square test indicates that the differences between age groups are statistically significant only in males ($\chi^2 = 12.31$, d.f. = 2, $p < 0.007$), but not in females ($\chi^2 = 3.55$, d.f. = 2, $p > 0.05$). Nevertheless, the present findings indicate that both sex and age are associated with the prevalence of anemia in the present population.

**Risk Factors of Anemia**

It is observed that the older individuals are likely to become anemic when compared with the younger ones, especially those who are aged 60 years and above. The subjects aged 60+ years had about 2.60 (95% CI: 1.36-4.95) times greater in risks of anemia when compared with those who are aged < 40 years. Although there is no significant difference between the age groups < 40 and 40-59 years, it is clear that individuals aged 60 years and above are likely to have higher prevalence of anemia. Further, the odds ratios of anemia for the sex and nutritional differences are not statistically significant, although the prevalence of anemia is higher in males as compared to females as well as in undernourished as compared to the individuals with normal grade of the nutritional status. The effect of socio-economic condition, on the other hand, on the prevalence of anemia seems to be significant in the present population. As for economic condition, the low income group had about 1.84 (95% CI: 1.10-3.07) times greater in risks of anemia when compared with those in the high income group. Also, the middle income group had 1.46 (95% CI: 0.80-2.67) times greater in risks of having anemia when compared with those in the high income group, despite the absence of statistical significance. Similarly, the subjects with no formal education were about 1.56 (95% CI: 1.01-2.41) times greater in risk of having anemia as compared to those with secondary level of education. In short, income and education seem to be very important risk factors of anemia in the present population.
CONCLUDING REMARKS

In the present study, we have taken demographic parameters, growth of children, adult body dimensions, morbidity and anemia as indicators of the health and nutritional status of the Hmar population. Our findings indicate that the Hmar population is highly progressive due to high fertility and lower mortality rates. The growth status of children aged 2-10 years of age is far below the 50th percentile of the WHO/NCHS growth references, although it is above the 50th percentile of the ICMR references. As for nutritional status of children, the Hmar population is characterized by a high prevalence of underweight (28.40% for both sexes) and a very high prevalence of stunting (48.72% for both sexes) but with low prevalence of wasting (3.16%), according to the classificatory criteria proposed by Gorstein et al., (1994), which takes into consideration all the three anthropometric indices. With respect to the nutritional status of adults, the Hmar population seems to be better than those reported for many populations in Northeast India. There is also an indication of overweight perhaps due to improved standards of living as generally suggested in developing countries (Nube, 1998; Khongsdier, 2002). The better nutritional status in the adults of the present population is also consistent with the results on lower morbidity and anemia. The present findings have many implications which may be summarized briefly as follows:

1. The present findings seem to have certain implications for the application of the demographic transition theory. It is well known that the second stage of demographic transition theory predicts that improvement in standard of living and health facilities results in population growth due to high fertility and low mortality. The poor performance of family planning welfare programmes and/or low practice of family planning methods of contraception enhances the fertility rate or population growth. It is observed that only about 5 % of the Hmars married women adopted family planning methods. Therefore, fertility rate is still high in the population, thereby suggesting a need for greater political will to implement family planning programmes.

2. It is observed that the fertility rate in the present population is negatively associated with the maternal age, age at marriage and income levels of households. The effect of age at marriage on fertility is by and large universal
since the reproductive period is shorter in the case of those with higher age at marriage. On the other hand, the significant effect of the household income on fertility rate in this population is likely to be related to the fact that people belonging to the higher economic groups are more conscious of the socio-economic welfare of their children. It is likely that they have higher aspiration for better education and higher economic status, thereby reducing the birth rate in order to provide their children with the best facilities (Mukherjee, 2002). What is interesting in the present study is that the effect of maternal education disappeared after adjusting for maternal and household income. This insignificant effect of education on fertility rate in the Hmars of the present study is inconsistent with the general observation in other populations (Caldwell et al., 1999), and it is difficult to give any clear-cut explanation. It, however, suggests that maternal education is not the only factor that can regulate fertility rates in the Hmar population. For example, our analysis indicates that most educated mothers are in the lower age groups, whereas the proportion of illiterate mothers or mothers without educational background is higher in the older age groups, thereby resulting in sampling variation. In addition, it is likely that other social and cultural factors also might have played a significant role in either directly regulating fertility rate or indirectly controlling the effect of education on fertility rate. This, however, does not mean to say that education is not important in the Hmar population. It is observed that maternal age and maternal education are very important factors in controlling infant mortality. Further studies are needed to have a better understanding of this problem in the Hmar population.

3. The high prevalence of underweight and stunting in Hmar children is contradicted by the low prevalence of wasting. This has an implication for the relevance of the international growth references/standards to the study population. It has been suggested that the use of international growth references is relevant only to the children below 5 years of age in South Asian populations (Khongsdier and Mukherjee, 2003). In the present study, we also observed the higher prevalence of underweight and stunting in the higher age group (6-10 years) than in the lower age group (below 6 years) for both boys and girls. The low prevalence of wasting
as indicated by weight-for-height is consistent with the observation made by Seckler (1982) in Indian and Nepali populations. This is due to the fact that weight-for-height is independent of age, whereas indices of underweight and stunting are dependent of age. In short, the role of genetic factors and errors in the estimation of age cannot be totally ruled out in the present study. Weight-for-height is, therefore, a better indicator of nutritional status.

4. The present findings also indicate the co-existence of under- and over-nutrition (as indicated by BMI) in the Hmar population. Recent reviews has revealed that although under-nutrition remains a major health problem in many developing countries, over-nutrition is also emerging with the improvement in socio-economic condition and/or increasing urbanization (Popkin, 2002, Khongsdier, 2005c). Consequently, the double burden of under- and over-nutrition exerts considerable impact on the economy and health system in many developing countries. In general, many countries in Asia are in this situation due to "changing dietary pattern towards energy-dense and high fat diets, together with a more sedentary lifestyle arising from increasing urbanization" (Florentino, 2002). The increasing urbanization, changes in standards of living, dietary patterns and occupational work patterns are the key factors to risks of the epidemic of obesity and associated morbidity and mortality. Therefore, the spread of overweight and obesity in the Hmar population needs to be monitored and prevented, but it should not be done at the expense of the efforts to alleviate under-nutrition.

5. On average, the present findings indicate that the health and nutritional status is better in females than in males for both children and adults. This is contrary to the general observation in South Asian populations, which reveal that the health and nutritional status of females is worst as compared with males. There are two major implications with respect to these findings. The first implication is concerned with the hypothesis of the “biological fragility” of males as compared to females (Kraemer, 2000). Our study may have certain implications with respect to the observation that boys are more vulnerable than girls to adverse conditions, such as infections and/or nutritional deprivation (Tanner, 1962; Stinson, 1985; Worthman, 1996). The second implication is related to the role of
cultural diversity in regulating health and nutritional inequalities. It is often argued that discrimination against females is very high in South Asian populations because of the patrilineal system of societies. However, our recent analysis on the nutritional status of the adolescents in both patrilineal and matrilineal societies did not confirm such an observation (Khongsdier et al., 2005). It is observed that the nutritional status is better in females than in males in both matrilineal and patrilineal societies. It is, therefore, suggested that the regional variation in biological and cultural characteristics should be taken into consideration to understand this problem. For example, discrimination against females may not exist everywhere in India, but varies from one society to another depending upon different socio-cultural conditions. As for the present study, we failed to observe such sex discrimination, although sex preference may arise in the case of the question on lineage continuity and old age security.

6. Another important implication of the present findings is that of socio-economic inequality in health and nutritional status. On average, our findings confirm the general observation that the health and nutritional status is better in the higher socio-economic classes than in the lower socio-economic ones. From the anthropological point of view, the question arises whether or not being in a poor socio-economic condition is also indicative of being the victims of natural selection? Natural selection is a blind natural force that preserves the beneficial variations and eliminates the injurious ones. The process of preserving the beneficial variations is also known as the survival of the fittest in the struggle for existence. According to Malthusian and Darwinian points of view, the struggle for existence, or competition for survival, is due to the increase in population beyond the means of subsistence. The short supply of resources, therefore, increases competition in different forms including social stratification in which “members of the privileged class may own even up to or over 10,000% of what a poor person owns” (Cohen, 1998). The high prevalence of malnutrition and infections is a clear evidence of poor access to adequate nutrition and health amenities among the lower socio-economic classes. From this point of view, one may argue that social stratification mediates natural selection in human populations in the
form of malnutrition and infections, which ultimately lead to higher morbidity and mortality in the lower strata of social stratification. However, this argument is based simply on differential survival or *survival of the fittest* due to limited resources mediated by social stratification. There is no evidence that the operation of natural selection in the lower socio-economic strata of the society is genetic in nature (Khongsdier, 2006). Therefore, equality of economic opportunity in a society, for example, enables a man to choose any occupation, which is most suited for him by his abilities and willingness to strive for his survival and well-being.