A STUDY ON HEALTH STATUS OF THE KHASIS IN DOMIASIAT AREA OF WEST KHASI HILLS DISTRICT, MEGHALAYA.

(ABSTRACT)

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ABSTRACT

Health is an important input for the development of human resources and the quality of life, necessary for the overall development of a community or country as a whole. According to the World Health Organization, "health is a state of complete physical, mental and social well being and not merely the absence of diseases or infirmity". 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. In other words, there are different parameters or indicators of health. From the biological anthropological point of view, demographic variables (e.g., fertility, mortality and reproductive wastage), physical growth and nutritional status of the children, body dimensions and nutritional status of adults, self-reported morbidity, anemia and hypertension may be considered as important indicators of health. An attempt to understand the relationship of these indicators with various cultural, social and economic factors may be very helpful in understanding the health status of a population.

This thesis is concerned with the health status of the Khasis in Domiasiat area of the West Khasi Hills district in Meghalaya. The main purpose of the thesis is to understand the health status of the people living in Domiasiat area, which has become a burning issue due to the proposed uranium mining. To best of our knowledge, there has not yet been any comprehensive study relating to the health status of the people in this area. Secondly, this thesis is not directly concerned with the effects of radiation on the health status of the people. It is basically an exploratory type of study that may help for future studies concerning the health status of the Domiasiat area. However, an attempt was also made to collect data from the neighboring area, i.e., Rangblang village, which is located about 25 km from Domiasiat. The basic design of study is therefore to carry out a comparative analysis of data between the two areas of study. Such a comparative analysis

is useful to have a better understanding of the health status of the people in Domiasiat area.

CHAPTERIZATION

The thesis has been divided into seven chapters. The first chapter gives a general introduction relating to the scope and importance of the study. The objectives and statement of problem are also given in this chapter along with a brief description of the study population and study area. The 2nd Chapter deals with the review of literature. Chapter III describes the materials and methods of data collection. The methods of data analyses are also presented in this chapter. Chapter IV gives the findings on demographic characteristics of both Domiasiat and Rangblang areas. In Chapter V, we described our findings on the growth and nutritional status of children and the effects of socioeconomic characteristics on the nutritional status as indicated by anthropometric indices. Chapter VI gives the findings on the health and nutritional of adults in terms of anthropometric variables, hemoglobin level, blood pressure, and self-reported morbidity. Chapter VII discusses the findings of the study in the light of other studies. It also discusses the social and biological implications of the findings. Chapter VIII gives the summary and conclusions.

OBJECTIVES

1. To describe the demographic structure of the Khasi population in Domiasiat and Rangblang areas.
2. To understand the growth status of children aged 2 to 6 years, and to assess the nutritional status of both children and adults in terms of selected anthropometric measurements and indices.
3. To understand the morbidity pattern of the study population and to find out the possible relationship between morbidity and body dimensions.
4. To understand the relationship between health parameters (such as fertility, mortality, physical growth of children, adult body dimensions, morbidity, hemoglobin level and blood pressure) and other biosocial factors (such as age, sex, family size, education and household income, and anthropometric variables).

MATERIALS AND METHODS

Chapter III of the thesis deals with the materials and methods adopted for the present study. They may be briefly presented as follows:

Study Area and Population

The present study was conducted in Domiasiat area of the West Khasi Hills district of Meghalaya during the months of January-June 2005 and January- June 2006. It is located between 25° 47' and 25° 57' north latitude and between 91° 10' and 91° 57' east longitude. It is situated to the south-western part of the West Khasi Hills district about 60 km from Nongstoin. The Domiasiat area as well as the whole West Khasi Hills district is dominated by the Khynriam Khasis, one of the Khasi sub-groups, who speak the Monkhmer language of the Austro-Asiatic group and have been following the matrilineal system of society. Thus in the present study, the term "Khasis" refers to the "Khynriam Khasis" inhabiting mainly in the West Khasi Hills district of Meghalaya, particularly those living in Domiasiat area.

The sampling design for this study was based on the geographical distribution of villages, which are located within 10 Km radius from the uranium mining site. Therefore, in this thesis, the term "Domiasiat area" refers to the area within 10 km radius from the uranium mining site. According to our survey, there were altogether 10 villages with total households of 443 and about 2826 souls. These villages include Phlangdiloin (106 households), Umjarain (63 households), Domiasiat (8 households), Mawkhlaitngap (33 households), Wahkajee (76 households), Nongjynrin (10 households), Nongtynger (56 households), Nongtynniaw (75 households), Mawthabah (10 households) and Mawlaikhap (6 households). We made a complete enumeration of households for demographic information. For other measurements, only those individuals who were willing to cooperate to this study were included in our samples.

As already mentioned, data were also collected from 239 households of Rangblang village, which is located about 25 km from Domiasiat. Rangblang is the biggest village in the northern part of Domiasiat area. It is considered to be more advanced than Domiasiat area in terms of socioeconomic conditions. The basic purpose is to make a comparative analysis of data between the two areas of study for better understanding of the health status of the people in Domiasiat area, i.e., even if Rangblang sample is not necessarily considered as a control group.

Demographic Data

The entire demographic data were collected through schedules. 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 using household schedule.

The fertility schedule was completed by filling-in the information on the number of conceptions, number of live births, number of reproductive wastage (abortion and still births), sex, present age, age at death, birth order, etc. from all ever married women. 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 because 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.

Measures of Fertility and Mortality

Age Specific Fertility Rate: The total marital fertility rate is estimated by generalized Poisson regression using SPSS. The dependent variable is the number of births over the three years preceding the survey; we include five-year age groups (as dummy variables) on the right hand side of the model and control for the length of exposure (three years for each woman) using a term called **the offset**. Fertility rates are obtained as exponents of the regression coefficients for each of the five age groups, and the total fertility rate is equal to the sum of the rates multiplied by five.

Mortality: For analysing data on mortality, three parameters are taken into consideration. These are: infant mortality (i.e., those who died before one year of life); child mortality (i.e., death between1-4 years); juvenile mortality (deaths between 5-14 years of age) and reproductive wastage (abortions and still-births). In the present study, abortion refers to any foetus or embryo which is expelled from its mother's womb on or before the twenty eight weeks of pregnancy because of its failure to develop or otherwise. It refers to both spontaneous and induced abortions. Still-birth is defined as any child expelled from its mother after the twenty eight weeks of pregnancy but did not breath or show any other signs of life.

Anthropometric Data

A cross-sectional method of anthropometric study was adopted for assessing the growth and nutritional status of children (2-6 years) and adults (18-60 years). Anthropometric measurements such as weight (Kg), height (cm), sitting height (cm), mid upper arm (MUAC), hip and waist circumferences (cm), skinfold thickness at biceps, triceps and sub-scapular (mm) were taken, following standard techniques.

Anthropometric measurements were used to estimate the body composition, using the prediction equations of Durnin and Womersley and Siri based on age, weight, height, and skinfold thickness. Anthropometric indices and ratios, such as body mass index (BMI), cormic index, conicity index, waist-hip ratio, etc. were also calculated, following standard methods. The nutritional status was assessed, using the cut-off points for body mass index as recommended by the WHO.

Hemoglobin Level and Blood pressure

Data on hemoglobin content of adults were also collected using Sahli's Hemometer, and following standard techniques. Mercury sphygmomanometer was used to measure blood pressure of the individuals included in the present study. All measurements were taken on left hand when subjects were being seated position. Each participant was asked to relax and take rest for 10 minutes before taking the measurement. Systolic blood pressure was recorded as the first Korotkov sound (phase 1). Diastolic blood pressure was taken as the disappearance of the Korotkov sounds (Phase V). Measurements were recorded for three times, and the average of the three was taken as recorded measurement.

Data on Morbidity

Data on morbidity were collected on the basis of "self reported illness" of the information taking into consideration the timeframe of two-week, three-week and four-week recalls of illness prior to the survey. Schedules were prepared for getting data on informant's perception of illness rather than the Western medical definition of a specific disease. The self-reported symptoms of illness were grouped into different categories as followed by many studies. For the present analysis, self reported symptoms of morbidity are broadly classified into three groups: (i) **Cold and respiratory** include those symptoms such as cough, runny nose, fever, breathing problem, chest pain, sore throat, etc. (ii) **Intestinal disorders** include diarrhea, dysentery, worms, vomiting, and other self-reported problems of stomach pain. (iii) Self-reported symptoms of morbidity like headache, diabetes, hypertensions and other than the two categories above were included in the category of **other health problems**.

Socio-economic Categories

In the present study, certain socio-economic variables were classified arbitrarily into different groups and/or categories with a view to understanding their influence on body composition and nutritional status. Our classification may be briefly described as follows:

Income groups: Data on household income were collected directly from the heads of the households 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 per capita monthly income of the households was classified as follows:

Above 75th percentile (>Rs.667) = High income group (HIG)

50th to 75th percentile (Rs.400-667) = Middle income group (MIG)

Below 50th percentile (<Rs. 400) = Low income group (LIG)

Educational Level: Data on educational attainment of individuals in the present study were arbitrarily classified into four broad educational levels, namely, illiterate, primary, secondary and above secondary. In the present study, the number of illiterates (i.e., those individuals who were not able to read or write) was included in the category of illiterates. **Primary level** of education includes lower primary and upper primary, i.e., up to standard VIII. In the **secondary level** of education, we included those individuals who attended standard VIII to X. **Higher Secondary** or above secondary **level** included other individuals who attended standard XI and other higher levels of education. This educational classification is highly arbitrary. However, we assumed that if education is really important in regulating nutritional and health indicators like in the western countries, its effects can be observed even if the individuals were dichotomized only into two categories, say, lower and higher levels of education.

Family Size: The family size was classified into three categories. The individuals who lived in a household with less than 4 family members were considered as having a *Small Family Size*. The *Average/Medium Family Size* includes those individuals who lived in a household with 4-8 family members. The individuals who lived in a household with more than 8 family members were grouped in the category of *Large Family Size*.

Statistical analyses

The basic design of the study is to analyse and present comparative data between Domiasiat and Rangblang. In addition, the main focus of analysis was to understand how nutritional and health status is related to biosocial variables, such as age, sex, anthropometric variables, self-reported morbidity, blood pressure, household income, education and family size in both the areas of study.

All data were managed and analysed using SPSS/PC Software. The analysis was first carried out to present the basic descriptive statistics of demographic and anthropometric variables, blood pressure, hemoglobin, and morbidity prevalence in relation to socio-economic characteristics of the study samples for both Domiasiat and Rangblang. 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 characteristics of the population. Logistic regression analysis was used for analyzing the effects of biosocial variables on dependent variables that are dichotomous. Receiver operating characteristic (ROC) was adopted for determining the necessary cut-off points by using MEDCALC 12 Windows Software. Curve fitting and graphical presentations were carried out by using ORIGINLAB 8.5 Software for Windows.

FINDINGS OF THE PRESENT STUDY

As already mentioned, the findings of the present study were presented in chapters IV, V and VI. Since our design of study is to compare the two areas of study, the chapter segregates the total sample size into Domiasiat and Rangblang areas in order to examine the differences and the causes of such differences. I shall briefly present them as follows:

Demographic Characteristics

Age, sex and Marital Status

1. According to Sundbarg's classification of population, a population is *progressive* when the proportions of persons relative 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 proportions are 33.00%, 50.00% and 17.00%, respectively; whereas the frequencies of 20.00%, 50.00% and 30.00%, respectively, are the characteristics of *regressive* population. Following these classifications of population, both Domiasiat and Rangblang populations are *progressive type*, which may be characterized by high fertility rates.

2. The population pyramids for Domiasiat population and Rangblang also show that the base is quite broad, indicating that the fertility rate is fairly high in both the areas.

3. The overall sex ratio, i.e., the number of males per 100 females, is found to be more or less according to the ideal sex ratio of 1:1 in Domiasiat population (101.28). On the other hand, the sex ratio in Rangblang population (97.14) is lower than the ideal sex ratio of 1:1, although it is not statistically significant (χ^2 = 0.32, df = 1, $p > 0.05$). In short, the difference in sex ratio between Domiasiat and Rangblang areas is not statistically significant (χ^2 = 0.43, df = 1, $p > 0.05$).

4. There are no differences between Domiasiat and Rangblang in mean age at marriage. However, it is found that the mean age at marriage is significantly

higher in males than in females in both Domiasiat and Rangblang. This indicates females get married earlier than their male counterparts in both Domiasiat and Rangblang areas.

Fertility

1. The mean numbers of live-births per married woman is slightly higher in Rangblang (4.37 ± 0.22) than in Domiasiat (4.05 ± 0.14) mothers, although it is not significant. It is found that the mean number of live-births increases with the advance in age of mothers in both rural and urban areas. The coefficient of correlation is also positively significant for Domiasiat and Rangblang areas.
2. Like in the case of live-births, the number of surviving children per married woman was slightly higher in Rangblang than in Domiasiat.
3. The completed family size (i.e., mean live-births to mothers who are aged 45 years and above, married only once and continuously lived in wedlock till attainment of 45 years) are significantly higher in Rangblang (7.58±0.47) than in Domiasiat (6.99±0.34) areas ($t = 2.81$, $p < 0.05$). However, the difference in mean surviving children between these two areas is not statistically significant. Nevertheless, the present findings indicate that the completed family size in these two areas is fairly high in terms of both live-births and surviving children.
4. The age specific marital fertility rate (ASMFR) reaches its peak when women are aged 30-34 years. The total fertility rates are 6.45 and 7.85 live-births per woman in Domiasiat and Rangblang, respectively. The TMFR among women in Rangblang setting is 1.22 times higher as compared to Domiasiat area. Adjusting for this residence difference, the TMFR is 7.09 live-births per woman. Like in the case of completed family size, the TMFR derived from Poison regression model is fairly high among the Rangblang and Domiasiat women of the present study.

Fertility and Socio-demographic Correlates

1. **Age at marriage:** The mean number of live-births decreases with the increase in mean age at marriage as theoretically expected. Using the one-way analysis of variance (ANOVA), the differences in live-births (unadjusted) are highly significant in both Domiasiat and Rangblang areas. We also adjusted for mother's

age, maternal education, and household income by using the analysis of co-variance (ANCOVA). It is found that the differences in live-births by age at marriage is till significant for both (Domiasiat: $F = 29.55$, $p < 0.001$) and Rangblang ($F = 21.25$, $p < 0.001$). This indicates that age at marriage is very important in regulating fertility rate in the present population.

2. **Maternal education:** It is found that the differences in live-births between educational groups are not statistically significant for both Domiasiat and Rangblang areas. Thus, it suggests that maternal education, in general, did not play a significant role in influencing fertility in both the areas of study. However, the linearity test suggests that live-births are likely to decline with increasing educational levels, especially among the Rangblang mothers.
3. **Household income:** There are significant differences in live-births between income groups for both Domiasiat and Rangblang mothers. Further, it is found that 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 for both Domiasiat ($F = 12.49$, $p < 0.001$) and Rangblang ($F = 8.71$, $p < 0.001$) mothers. This indicates that household income is very important in regulating fertility rate among both Domiasiat and Rangblang mothers.
4. **Socio-economic differences:** We have shown that TMFR is lower in Domiasiat than in Rangblang. It is also observed that age at marriage and household income are significantly associated with fertility in both the areas. Is lower fertility among Domiasiat women because of the different distribution of women with respect to age at marriage and household income, for example? It is found that the answer is negative. Thus, it is likely that other factors, which were not considered in the present study, are important in bringing about the differences in TMFR between Domiasiat and Rangblang mothers. Whether or not it was because of other environmental factors like uranium ore deposits is altogether beyond the scope of the present study. We hope future studies will shed more light on what we pointed out here.

Infant mortality and Reproductive Wastage

1. The rate of reproductive wastage (i.e., number of abortions and still births per 100 pregnancies) is found to be more or less similar between Domiasiat (7.58%) and Rangblang (7.92%). The abortion rates (i.e., number of spontaneous abortions per 100 pregnancies) are 5.73% and 7.11% in Domiasiat and Rangblang areas, respectively. The differences are not significant. The still-birth rate (i.e., number of still births per 100 pregnancies) is significantly greater in Domiasiat (1.85%) than in Rangblang (0.81%) areas ($\chi^2 = 5.30$, df = 1, $p < 0.02$).
2. The infant mortality rates (i.e. number of deaths before 1 year of life per 100 live births) are 6.17% and 6.46% in Domiasiat and Rangblang, respectively, whereas the child mortality rates are 2.11% and 2.74%, respectively. The differences between Domiasiat and Rangblang are not statistically significant for both infant mortality and child mortality. Similarly, the juvenile mortality rate (per 100 live-births) is more or less similar in both Rangblang (1.32%) and Domiasiat area (1.76%) areas. Therefore, it is obvious that the infant, child and juvenile mortality rates are similar in both the areas.

Mortality and Socio-demographic Variables: The results of the present study suggested that both the areas are similar in mortality rates, except in respect of still-births. Two questions are arising out of these results: First, what are the socio-demographic factors that influence the different types of mortality in both Domiasiat and Rangblang areas? Second, what are the factors that could have brought about the differences between Domiasiat and Rangblang? These questions are also related to one of the objectives of this study. In order to address these questions, we have carried out simple regression analyses, and the findings are as follows:

1. It is that abortion, total reproductive wastage and child mortality are significantly correlated with maternal age and education. Infant mortality is significantly correlated not only with maternal age and education, but also with household income. On the other hand, still-birth was not correlated with any of the socio-demographic variables included in the present study. Thus, the differences in still-births between Domiasiat and Rangblang areas are not because of socio-

demographic variables considered in the present study. Instead, it is likely that other factors are playing a very important role in bringing about the differences between the two areas of study.

2. On the basis of the above results, a regression analysis was carried out by including only those variables that were correlated with different types of mortality. It is found that abortion is significantly associated with maternal age, i.e., the effect of maternal education disappeared when it is included with maternal age. Thus, we may suggest that the effect of maternal age on abortion is more important than education in both Domiasiat and Rangblang areas. The same is true with respect to reproductive wastage (i.e., the total of both abortions and still-births) and child mortality. As regards infant mortality, it is found that the effect of household income is less important compared to maternal age and education. Thus, we may suggest that infant mortality is more associated with maternal age and education compared to household income.

GROWTH AND NUTRITIONAL STATUS OF CHILDREN

In the present study, we have considered the growth of children aged 2 to 6 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. Only selected anthropometric variables like weight, height, sitting height, hip circumference, waist circumference and mid upper arm circumference (MUAC) were taken into consideration. In this presentation, I shall present our findings on weight and height only. The comparison is delimited to Domiasiat and Rangblang in relation to the WHO growth references (WHO, 2006), because or basic design of study is to make a comparative analysis of these two areas only. Our findings may be briefly given as follows:

Weight

It is found that there were no clear sex differences in body weight of children in both the areas, except at age 6 in Rangblang, which indicates that boys are significantly heavier than girls. However, the graphical comparison depicts that Domiasiat boys are heavier than Rangblang boys especially from about 2.5 to 4.5 years of age. It is also seen that both Domiasiat and Rangblang boys are by and large above the 5^{th} percentile of the

WHO growth reference. Similarly, the body weight of both Domiasiat and Rangblang girls is above the 10^{th} percentile of the WHO reference. However, the curve for Rangblang girls is below the 10^{th} percentile after 5 years of age. They are also lighter than the Domiasiat girls from about 2.5 to 3.5 years of age.

The annual increments or growth rates in body weight were fitted by differentiating the first derivatives of the fourth degree polynomial curve, i.e., the distance curve fitted according to the following polynomial model: $y = a + b_1(age) + b_2(age)^2 + b_3(age)^3 + b_4(age)^4$, where a is the constant and b stands for the coefficient of regression.

It is found that the velocity is highly fluctuating in both the sexes. It declines from 2 to 3 years for Rangblang boys and 2 to about 5 years for Domiasiat boys. The velocity curve tends to be U-shaped in the case of Domiasiat boys, indicating the absence of a peak in growth rate between 2 and 6 years of age. However, it is likely to form a peak after or at 6 years of age. The Rangblang boys, on the other hand, are much lower in growth rate than the Domiasiat boys from 5 years onward, although they have higher growth rates from 3.5 to 5 years of age. Indeed, the deceleration rates from 2 to 5 years of age are lower in Rangblang than in Domiasiat boys.

Unlike the case of boys, Rangblang girls showed a maximum of gain from 2 to 3.5 years of age. Thereafter, the velocity curve tends to decline up to about 5.5 years of age, thereby forming a bell-shaped curve. Among Domiasiat girls, there was a decline in growth rate from 2 to about 3.5 years, and thereafter, the velocity increases with a peak at 5 years. It is further seen that the growth rate declines at greater rate than their Rangblang counterparts after 5 years of age.

Height

As expected, height increases with the increase in age for both boys and girls. However, the differences between boys and girls are not statistically significant across age groups, although it does look as boys were taller than girls at many age groups. The distance curves show that Domiasiat boys are taller than Rangblang boys across age groups. They are also above the 5^{th} percentile of the WHO growth reference from 2 to about 4.5 years of age. Thereafter, they are below the 5^{th} percentile up to below 6 years of age. The Rangblang boys are below the 5th percentile of the WHO growth reference across ages.

Unlike the case of boys, both Domiasiat and Rangblang girls are by and large below the 5th percentile of the WHO growth reference. The Domiasiat girls are similar to the 5th percentile of the WHO reference from 3.5 to about 4 years, and they are shorter than the Rangblang girls from 4 to 4.5 to about 5.5 years of age. The point to be noted here is that the prevalence of stunting is high when the growth curve is below the 5th percentile of the growth reference.

As regards velocity, it is observed that the growth rate is more fluctuating in Domiasiat boys than in Rangblang boys. It is higher in Domiasiat boys from 2.5 to about 4 years of age, and thereafter it is greater in Rangblang boys up to about 5.5 years of age when the former surpassed the latter. Similarly, the growth rate is more fluctuating in Domiasiat girls than in Rangblang girls. The fitted curves for Domiasiat girls depicted a negative growth before 2.5 years of life. It is only from 2.5 to below 4 years that the growth rate is greater in Domiasiat girls. The Domiasiat girls are also greater in growth rate from 5.5 years onward. The maximum increase in height occurs between 5 and 6 years for boys (Domiasiat = 8.55 cm; Rangblang = 6.75 cm) and 3 and 4 years for girls (Domiasiat = 8.54 cm; Rangblang = 6.53 cm). The total gain in height from 2 to 6 years of age is greater in Domiasiat girls than in Rangblang girls (Domiasiat = 23.29 cm; Rangblang = 21.18 cm). However, the boys are similar in total gain (Domiasiat = 24.14 cm; Rangblang = 24.15 cm).

Nutritional Status

In the present study, we have taken three important anthropometric indices, i.e., weight-for-age, height-for-age, and weight-for-height for assessing the nutritional status of the children. We have also made an attempt to correlate these indices with certain socioeconomic variables such as household income, maternal education and family size. The findings of the study may be presented briefly as follows:

Weight-for-age

The overall prevalence of underweight (moderate and severe) in boys is higher in Rangblang (24.24%) than in Domiasiat (17.55%). The odds ratio (OR) indicates that the risk of being underweight is about 1.50 times higher in Rangblang compared to Domiasiat boys. However, the difference is not statistically significant. This is also consistent with the Gaussian fitted curves relative to the WHO growth reference. The fitted curves are more or less similar for both Domiasiat and Rangblang boys, although the peak of the curve for the latter is slightly higher than the former. In general, the curves for both Domiasiat and Rangblang boys tended to shift to the left of the WHO growth reference, i.e., lower than -1 z-score of the reference.

The situation is opposite in the case girls. It is found that the overall prevalence of underweight is higher in Domiasiat (20.96%) than in Rangblang (12.61%) areas. The unadjusted risk of being underweight in Domiasiat girls is about 1.83 times as compared to Rangblang girls, despite the absence of statistical difference. The fitted curves also depict that the distribution of girls below -2 z-score is greater in Domiasiat than in Rangblang area. However, the fitted curves for the overall distribution of z-score in the two areas seemed to be better than those observed for boys.

It is also observed that the overall prevalence of underweight in Domiasiat is higher in girls (20.96%) than in boys (17.55%). On the contrary, Rangblang boys (24.24%) are more likely to be underweight than their female counterparts (12.61%), and it is statistically significant (χ^2 = 5.57, df = 1, $p < 0.01$). Thus, we may conclude that there are no statistical differences between Domiasiat and Rangblang children in the prevalence of underweight. However, the sex differences are significant in Rangblang.

Height-for-age

The prevalence of stunting as indicated by height-for-age was higher in Rangblang boys (46.97%) than in Domiasiat boys (42.55%). However, the chi-square test suggests that the differences are not sufficient enough to accept that Rangblang boys have a greater prevalence of stunting compared to Domiasiat boys (χ^2 = 0.62, df = 1, $p > 0.05$). But it is clear that there is high prevalence of stunting in both the areas with a peak shifted towards -2 z-score of the WHO reference - which is the critical limit for defining the undernourished children.

The same is true with the case of girls. Although, the prevalence of severe stunting is higher among the Domiasiat girls, the overall prevalence was much greater in

Rangblang girls (52.10) than in Domiasiat girls (41.92%), although it is not significant. It is also be seen from that the distribution of girls with -2 and – 3 z-scores of height-for-age is greater in Rangblang than Domiasiat. Similar to boys, both Domiasiat and Rangblang girls seemed to have a mean of -2 z-score compared with the WHO growth reference.

The percentage points of difference between Domiasiat and Rangblang in respect of stunting seems to be greater in girls than in boys (i.e., 1.50 times in girls and 1.20 times in boys), but the chi-square test suggests that the differences are not real ($\chi^2 = 2.90$, df = 1, $p > 0.05$). Therefore, we may conclude that although the prevalence of stunting is greater in Rangblang than in Domiasiat, there is not enough statistical evidence to accept the hypothesis. However, both the groups experienced a high prevalence of stunting.

Weight-for-height

It is observed that both Domiasiat and Rangblang boys are similar in the prevalence of wasting, i.e. 6.38% and 6.82%, respectively. Both Domiasiat and Rangblang boys are by and large within the norm of the WHO growth reference, and there is a tendency for the curves to shift the right. However, there was a significant difference between Domiasiat and Rangblang girls in the overall prevalence of wasting ($\chi^2 = 4.52$, df = 1, $p < 0.01$). It is found that the Domiasiat girls had about 9 times greater in risk of being wasting compared to the Rangblang girls (Odds ratio = 9.14, CI = 1.17-71.25). Although both Domiasiat and Rangblang girls are by and large similar in the distribution of weight-for-height z-score from 0 to -2 z-score, the proportion of those girls with below – 2 z-score is greater among the Domiasiat. It is also seen that the proportion of girls with above 3 z-score is greater in Domiasiat than in Rangblang girls. This suggests the existence of the double burden of malnutrition. In addition, Rangblang boys are significantly greater in the prevalence of wasting (6.82) compared to their female counterparts ($\chi^2 = 3.94$, df = 1, $p < 0.05$). Thus, we may conclude that although the prevalence of wasting is moderately lower than that of underweight and stunting, the differences between the sexes and areas of study seemed to be statistically important.

Summary on nutritional status

The present findings suggest that the prevalence of stunting is very high in both Domiasiat and Rangblang children, ranging between 40 to 52%. The prevalence of underweight ranges between 13 and 24%, whereas the prevalence of wasting is moderately low. Pooling the data for both sexes and areas of study, the cumulative prevalence of stunting (i.e., number of stunted children with less than or equal to -2 z-score as indicated by height-for-age) was about 50%, whereas the prevalence of underweight as indicated by weight-for-age z-score was about 20%. On the other hand, the prevalence of wasting as indicated by weight-for-height was about 5%. Therefore, stunting is the major nutritional problem in both the areas.

There are not enough statistical evidences to support the hypothesis of the differences in nutritional status between Domiasiat and Rangblang areas. However, the sex differences seemed to be statistically important especially in Rangblang area of study. The Rangblang boys are more likely to have a greater risk of underweight and wasting compared to their female counterparts.

NUTRITIONAL STATUS AND BIOSOCIAL FACTORS

Odds ratios derived from the logistic regression analysis were used to test the effects of biosocial factors on the nutritional status of children. The nutritional status of children is dichotomized into two categories for all the three anthropometric indices, namely, weight-for-age, height-for-age and weight-for-height. For example, the nutritional status according to weight-for-age is classified into underweight and non-underweight groups. The findings are described as follows:

Risk Factors of Underweight

As shown in the previous analyses, it is found that residence (Domiasiat and Rangblang), sex and family size are not associated with underweight. However, household income and maternal education seemed to be important in regulating the weight status of children. It is found that that children in the low and middle income groups had respectively about 3.08 and 2.77 times greater in risk of being underweight as compared to children in the high income group. It is also found that the chi-square test for linear trend was significant (χ^2 for trend = 6.08, df = 1, $p < 0.01$). It suggests that underweight is not only associated with household income, but also decreases with increasing income level. As normally expected, it may be interpreted that low economic condition acts as a significant risk of being underweight among children.

It is also found that underweight is associated with maternal education. The odds ratios were significant for the illiterate (CI: 1.07-22.89, $p < 0.04$) and primary (CI: 1.39-25.54, $p < 0.02$) groups compared to children whose mothers with educational level of greater than secondary. The chi-square test for linear trend was also highly significant (χ^2 for trend = 5.28, df = 1, $p < 0.02$). Therefore, it suggests that maternal education also plays a very important role in regulating the weight status of children, and it is likely to decrease with the increasing educational level of the mothers.

It may also be mentioned that the effect of maternal education is still significant even when it is included with household income (Model-2). Therefore, we may conclude that both household income and maternal education are important in controlling underweight among children of Domiasiat and Rangblang areas.

Risk Factors of Stunting

It is found that children in the low income groups had about 3.41 (CI: 1.97-5.88, $p < 0.001$) times greater in risk of being stunted as compared to children in the high income group. Similarly, the risk for children in the middle income group was about 2.79 (CI: 1.58-4.94, $p < 0.001$) times greater than those belonging to the high income group. The chi-square test for linear trend was also highly significant (χ^2 for trend = 17.13, df = 1, $p < 0.001$). Therefore, like underweight, it suggests that stunting in children of the present study is not only associated with household income, but also decreases with increasing income level.

With respect to maternal education, children of illiterate mothers had about 2.15 times greater in risk of being stunted compared to their counterparts whose mothers are educated up to secondary and above, although it was not statistically significant. Similarly, the risk of being stunted was significantly greater among children of mothers with primary level of education compared to those with above secondary level of education (OR =2.07, CI: 1.03-4.16, $p < 0.04$). Thus, the role of maternal education in regulating stunting cannot be totally ruled out among children of the present study. It is also found that the chi-square test for linear trend was highly significant 9.71 (df = 1, $p < 0.001$). However, when both household income and maternal education were included in

Model 2 of the logistic regression analysis, the effect of maternal education disappeared. Therefore, we may interpret that both household income and maternal education are significantly associated with stunting, but it is likely that household income is relatively more important.

Risk Factors of Wasting

Unlike in the case of underweight and stunting, the effects of demographic and socioeconomic 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. Similarly, the role of maternal education cannot be totally ruled out in regulating wasting in the present population.

NUTRITIONAL AND HEALTH STATUS OF ADULTS

Socioeconomic characteristics

The findings on the important socioeconomic characteristics show that both Domiasiat and Rangblang areas are more or less similar in socioeconomic characteristics.

Anthropometric traits

1. It is found that both Domiasiat and Rangblang males are similar in stature, but the former are significantly lighter than the latter. The Rangblang males had also greater skinfold thickness compared to the Domiasiat males. This is clearly reflected in other fat mass indicators such as body mass index (BMI), fat-mass index (FMI) and conicity index. Therefore, it is likely that the nutritional status is better in Rangblang males than in Domiasiat males.
2. Like in the case of males, Rangblang females are significantly heavier than Domiasiat females. They are also significantly greater in skinfold thicknesses, BMI and FMI. Thus, the present findings clearly indicate that there are considerable differences between Domiasiat and Rangblang areas with respect to body dimensions and composition that are related to nutritional status. Therefore, our design of study to segregate the Domiasiat and Rangblang data seems to be well-fit as far as the present study is concerned.

BMI Cut-Offs

The nutritional status of participants in this study was assessed by using BMI, taking into consideration the cut-off points recommended for the Asia pacific region (WHO, 2000). It may be mentioned that the WHO (1995) has recommended the BMI cut-offs of 25.0 kg/m^2 and 30.0 kg/m^2 for defining overweight and obesity, respectively. But there is considerable evidence that these cut-off values are not applicable across ethnic groups, especially among Asian populations. Accordingly, the new BMI cut-off points of 23·0 kg/m^2 and 25·0 kg/m^2 have been recommended for Asian populations and other populations, respectively. In order to test the validity of these recommended cut-off points, we used the Receiver Operating Characteristic (ROC) curve analysis. The findings are as follows:

Using the reference values of percentage body fat (PBF) >25% for men and >30% for women, it is found that the BMI cut-off points of $\geq$ 22 and $\geq$23 kg/m^2 would be most appropriate for detecting overweight or obesity among males and females, respectively. The area under the ROC curve (AUC) was slightly greater in males (AUC = 0.96, CI: 0.93-0.98, $p < 0.0001$) than in females (AUC = 0.94, CI: 0.91-0.96, $p < 0.0001$).

If the BMI cut-off point is increased up to $\geq$ 25 kg/m^2 against the reference PBF >25%, the rate of sensitivity or true positive rate in males decreased substantially from 92.68% to 34.20%, while the rate of specificity or false positive rate increased to 100%. Similarly, the positive predicted value in females increased from 86% for the BMI criterion of 23.01 kg/ m^2 to 99% for the BMI criterion of 25 kg/ m^2, and the negative predicted value decreased from about 87% to 99%. Therefore, the cut-off points recommended for the Asia-pacific regions (WHO, 2000) would be more appropriate than those recommended by the WHO (1995).

Nutritional status according to BMI

1. The prevalence of underweight is significantly higher in Domiasiat than in Rangblang ($\chi^2 = 6.59$, df = 1, $p < 0.01$). Similarly, the prevalence of underweight is significantly higher in Domiasiat females (19.75%) than in Rangblang females (11.68%). It is also found that the prevalence of underweight is greater in females than in males in both Domiasiat ($\chi^2 = 4.62$, df = 1, $p < 0.05$) and Rangblang (χ^2 =

2.44, df = 1, $p > 0.01$) areas. Thus, it is obvious that were differences between the sexes and the two areas of study with respect to the prevalence of underweight.

2. With respect to the prevalence of overweight and/or obesity, it is observed that are three aspects of differences: (i) It is found that the prevalence of overweight/obesity in Domiasiat females, for example, was 5.23% according to the international cut-off points, but it was about 17.44% according to the cut-off points recommended for the Asia-pacific regions, (ii) unlike the prevalence of underweight, the prevalence of overweight is higher in Rangblang than in Domiasiat area, irrespective of cut-off points and sexes. The graphical presentation indicates that percentage distribution of persons with BMI of ≥ 23 kg/m^2 is greater in Rangblang, especially in females, and (iii) women had a greater prevalence of overweight than men in both Domiasiat and Rangblang areas, despite the absence of statistical significance. The percentage distribution of persons with BMI of ≥ 23 kg/m^2 is greater in females, especially in Rangblang.

Blood Pressure

1. It is found that the mean diastolic blood pressure is similar in both the sexes and areas of study. On the contrary, systolic blood pressure seems to be greater in males than in females, and the sex difference is statistically significant in Rangblang ($t = 2.85$, $p < 0.05$).
2. The differences between Domiasiat and Rangblang are not clearly perceptible in the prevalence of hypertension. It is also found that the differences between the sexes are not statistically significant. Therefore, we may conclude that the prevalence of hypertension does not seem to be related to sex or place of residence.

Hemoglobin

1. The hemoglobin content is significantly greater in Rangblang than in Domiasiat. It holds true for both males and females. Unlike blood pressure, the differences between the sexes and areas of study are clearly perceptible in respect of hemoglobin content.
2. The prevalence of anemia is significantly greater in Domiasiat males than in

Rangblang males. However, the difference between these two areas of study is not significant in females. With respect to the sex differences, females had greater prevalence of anemia in both Domiasiat and Rangblang areas. Therefore, the differences between the two areas of study are not clearly perceptible in females, but significant in males. On the other hand, females had greater prevalence of anemia than males in both Domiasiat and Rangblang areas.

Self-Reported Morbidity

The prevalence of different types of morbidity is significantly higher in Domiasiat than in Rangblang areas. It is true for both males and females. However, the sex differences in respect of the overall morbidity are not statistically significant for both the areas of study. Therefore, the present findings indicate that the prevalence of self-reported morbidity was higher in Domiasiat than in Rangblang, whereas the differences between the sexes were not statistically significant.

Underweight and Biosocial Correlates

Using logistic regression analysis, it is found that underweight is significantly correlated with place of residence, sex, age, household income, education, morbidity and waist-hip ratio. When only these variables are included in the conditional stepwise regression models, it is found that place of residence, age, sex and waist-hip ratio are relatively more important factors than household income, education and morbidity.

Overweight and Biosocial Correlates

It is found that overweight is significantly correlated only with place of residence, family size and waist-hip ratio. It is likely that the participants in Rangblang would have a greater risk of being overweight compared to those in Domiasiat. Similarly, increased family size and waist-hip ratio are likely to be the risk factors of overweight among the participants of the present study.

Hypertension and Biosocial Correlates

It is found that hemoglobin level and fat-mass index are the two important factors that are significantly associated with hypertension among the participants in the present study.

Hemoglobin Content and Biosocial Correlates

It is found that anemia is correlated with age, sex, household income, education, systolic and diastolic blood pressure, BMI, and fat-free mass index. However, anemia is more related to sex, household income and systolic blood pressure compared to other correlated factors.

Morbidity and Biosocial Correlates

It is found that place of residence, age, hemoglobin level, BMI and fat-mass index are significantly correlated with morbidity. However, morbidity it is more related to place of residence, hemoglobin level and fat-mass index compared to age and BMI.

OVERALL HEALTH STATUS

On the basis of the concept of HDI, we have also measured the population or overall health index in the present study by taking into consideration the average of infant mortality, reproductive wastage, proportions of children with underweight, stunting and wasting, and proportions of adults with underweight, overweight, self-reported morbidity, anemia and hypertension. Assuming that the ideal population health index as 1 and the least population health as 0, we calculated the overall health index (OHI) as follows:

OHI $= 1/7(H_{FD}) + 1/7(H_{IC}) + 1/7(H_{CM}) + 1/7(H_{AM}) + 1/7(H_{SM}) + 1/7(H_{HB}) + 1/7(H_{HP})$

Where,

H_{FD} = 2/3(Still-birth index) + 1/3(Miscarriage index)

H_{IC} = 2/3(Infant mortality index) +1/3(Child mortality index)

H_{CM} = 3/6(Wasting index) +2/6(Underweight index) +1/6(Stunting index)

H_{AM} = 2/3(Adult underweight index) +1/3(Adult overweight index)

H_{SM} = Self-reported morbidity index

H_{HB} = Anemic index

H_{HP} = Hypertension index

The OHI is about 2.8 percentage points greater in Rangblang (0.8623 or 86.23%) compared to Domiasiat (0.8343 or 83.43%). It is seen that both Domiasiat and Rangblang are similar in health indices due to infant mortality, child mortality, and wasting of children. Domiasiat participants are also better than their Rangblang counterparts in health indices due to underweight and stunting of children, overweight of adults and hypertension. The greater OHI in Rangblang is mainly because of the lower prevalence of underweight, anemia and self-reported morbidity of adults.

Therefore, the health status of the Khasi living in Domiasiat area is by and large similar to those in Rangblang with respect to several health parameters considered in the present study. However, Domiasiat participants had poor health indices than their Rangblang counterparts due to underweight, anemia and self-reported morbidity.

CONCLUDING REMARKS

This study has examined the demographic, anthropometric and physiological characteristics, which are generally considered as health indicators at the population level. It has considered evidence from Domiasiat and Rangblang areas of the West Khasi Hills district in Meghalaya, which are predominantly dominated by the Khynriam Khasis. Domiasiat has always been in the news because of the proposed uranium mining by the government of India. The burning issue is that uranium mining may cause health hazards of the people in the area. Unfortunately, to best of our knowledge, there has not yet been any comprehensive study relating to the health status of the people in this area. Therefore, this study has been conducted with a view to generating some baseline data that may be helpful to the future studies on the health status of the people in Domiasiat area. The study has got nothing to do with the direct effects of natural radiation due to uranium ore deposits in the area or preliminary mining works. However, an attempt has been made to collect data from the neighboring area, namely, Rangblang, which is located about 25 km from the Domiasiat area. The null hypothesis is that there is no difference between Domiasiat and Rangblang with respect to selected health indicators because both of them are by and large in the same ecological area. The overall findings of the study seem to accept this null hypothesis. However, there are certain components of health indicators that may have certain anthropological and policy implications.

The findings of the present study seem to confirm the earlier reports on the high fertility and infant mortality rates among the Khasis. It is clearly evident that the national family planning program has gained little momentum among the Khasis of Meghalaya. Interestingly, the role of education is not as significant as it should be among the Khasis of the present study. From the anthropological point of view, this should be examined in more detail on the role of culture in regulating fertility and mortality differentials among the Khasis. The policy implication, on the other hand, is the need to intensify the implementation of the national family planning program and other child welfare schemes with more political will.

One of the interesting findings on the demographic aspects of the Khasis living in Domiasiat and Rangblang areas is lower fertility in the former than in the latter. The same is true with respect to higher prevalence of still-births in Domiasiat compared to Rangblang. These differences between Domiasiat and Rangblang did not seem to be accounted for by the socioeconomic factors considered in the present study. There is a possibility that other cultural factors, or environmental factors including uranium ore deposits, may play certain role in bringing about the live-birth and still-birth differences between Domiasiat and Rangblang areas. We hope future studies will shed more light on what we have pointed out here.

The findings indicate that Domiasiat and Rangblang boys are by and large above the 5^{th} and 10^{th} percentile of the WHO growth reference in weight and height, respectively. However, Domiasiat boys are heavier and taller than Rangblang boys and from about 2.5 to 4 years of age. The growth rates in weight and height are highly fluctuating, indicating the wide variation in nutritional status. Although it is unlikely that the growth curves for children of Meghalaya would fall exactly on the 50^{th} percentile of the WHO reference population, it may be expected that the curves should at least lie between 50^{th} and 25^{th} percentiles. When the growth curves fall away from the 25^{th} percentile of the WHO growth reference, it is likely that the prevalence of underweight and stunting would be high in the population.

This study shows that there are no statistical evidences for the differences between Domiasiat and Rangblang in nutritional status of children. Similarly, there are no statistical differences between the sexes, but Rangblang boys are more likely to be underweight and wasted than boys. The major nutritional problem is the high prevalence of stunting in both the areas. The point to be noted here is that stunting is a long-term response to nutritional and socioeconomic deprivation. Although the role of genetics in stature cannot be ruled out, it is well established that that under-five children belonging to the higher socioeconomic strata in developing countries have shown similar growth patterns to their coevals in developed or high-income countries. Many studies from India have also supported this theory. Therefore, it is likely that the high prevalence of stunting in Domiasiat and Rangblang areas is mainly the consequences of a long-term nutritional and socioeconomic deprivation. This study has clearly supported the view that socioeconomic factors like household income and education play a significant role in controlling the nutritional status of children in both the areas of study. From the policy point of view, efforts to intensity nutritional programs like the Integrated Child Development Scheme (I.C.D.S) is immediately needed in both the areas of study. Secondly, this study has indicated the Rangblang boys have greater risk of underweight and wasting compared to their female counterparts. Whether it is associated with the matrilineal system of the society, or the biological sex differences in susceptibility to nutritional deprivation are the moot questions to be answered clearly by the future studies. On the basis of the present findings, it is likely that sex preference has little to do with the sex differences in Rangblang, because both Domiasiat and Rangblang follow the same system of society.

With respect to the nutritional status of adults, it is observed underweight is significantly higher in Domiasiat than in Rangblang, whereas overweight in greater in the latter than in the former. Females are likely to have a greater risk of being underweight and overweight. The major implication here is the emerging trend of the double burden of malnutrition, especially in Rangblang. Secondly, this study also indicates that the use of BMI cut-off points is very important for defining obesity or overweight among adults. If we follow the cut-off points recommended for the Asia-pacific regions, the prevalence of overweight increases significantly for both the sexes. The point to be noted here is that, although the present study supports the use of BMI-cutoffs for the Asia-pacific regions, caution should also be taken while interpreting the prevalence of overweight/obesity, lest it is overestimated.

With respect to other health indicators, this study has indicated that hypertension does not seem to be related to sex or place of residence. However, anemia and self-reported morbidity are significantly higher in Domiasiat than in Rangblang. While anemia is more related to economic condition, self-reported morbidity is more related to nutritional status. The absence of significant relationship with other socioeconomic factors considered in the present study is interesting. It is possible that other factors not considered in this study may play a very important role. There is a need to conduct more in-depth studies to understand the causes of high morbidity in Domiasiat, especially respiratory infections that may be related to other environmental factors.

A STUDY ON HEALTH STATUS OF THE KHASIS IN DOMIASIAT AREA OF WEST KHASI HILLS DISTRICT, MEGHALAYA.

BY

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MAY, 2011

DECLARATION

I, **Jennifer Baiamonlang Khyriem**, hereby declare that the subject matter of this thesis entitled " **A Study on Health Status of the Khasis in Domiasiat area of West Khasi Hills District , Meghalaya"** is the record of the work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anyone else, and that the thesis has not been submitted by me for any research degree in any other University/ Institute.

This is being submitted to the North-Eastern Hill University for the degree of Doctor of Philosophy in Anthropology.

15/5/11

(Jennifer. B. Khyriem)

16/5/11

(Prof. R. Khongsdier)

DEPARTMENT OF ANTHROPOLOGY
N E H U, SHILLONG

CONTENTS

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"To dream is easy but to achieve its yet another dream."

With reference to the above lines this thesis arose in part out of years of research that has been done through cooperation and handwork of the people around me .Their contribution in assorted ways to my research work and the process involved in the making of the thesis deserved special mention. It is a pleasure to convey my gratitude to them all in my humble acknowledgment.

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Dated :Rynjah,Shillong. (Jennifer Baiamonlang. Khyriem)

the: 15th May 2011.

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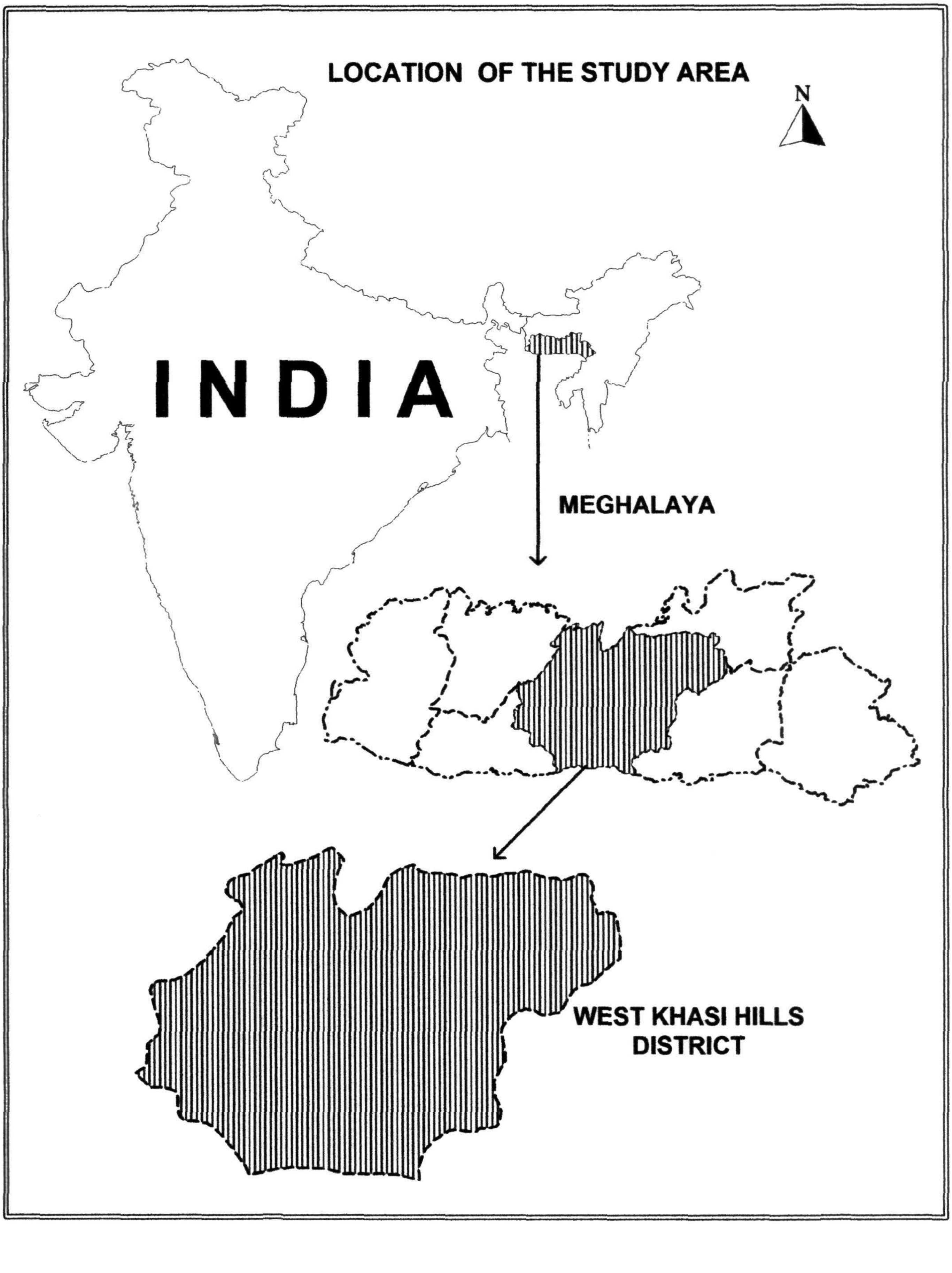

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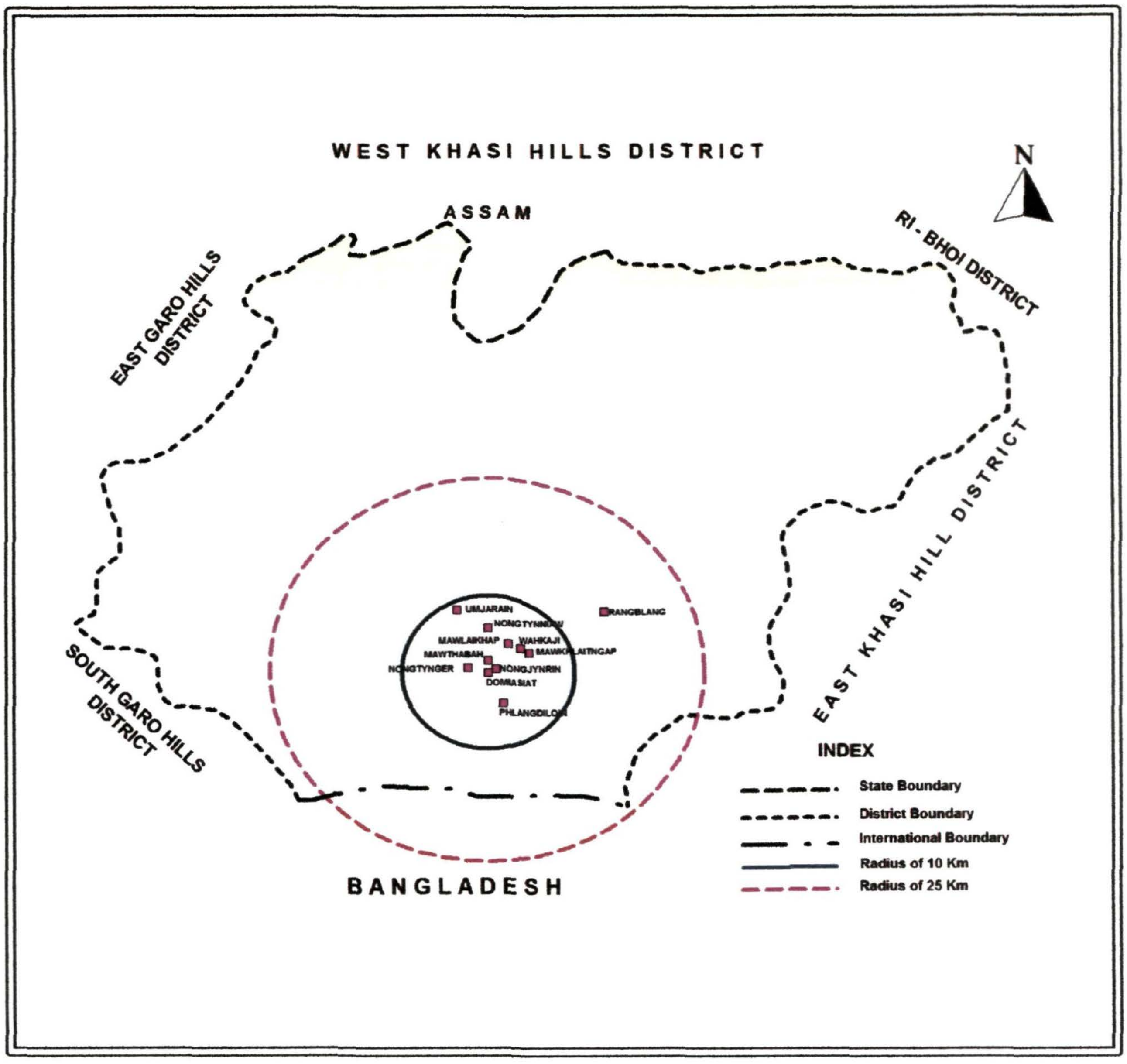
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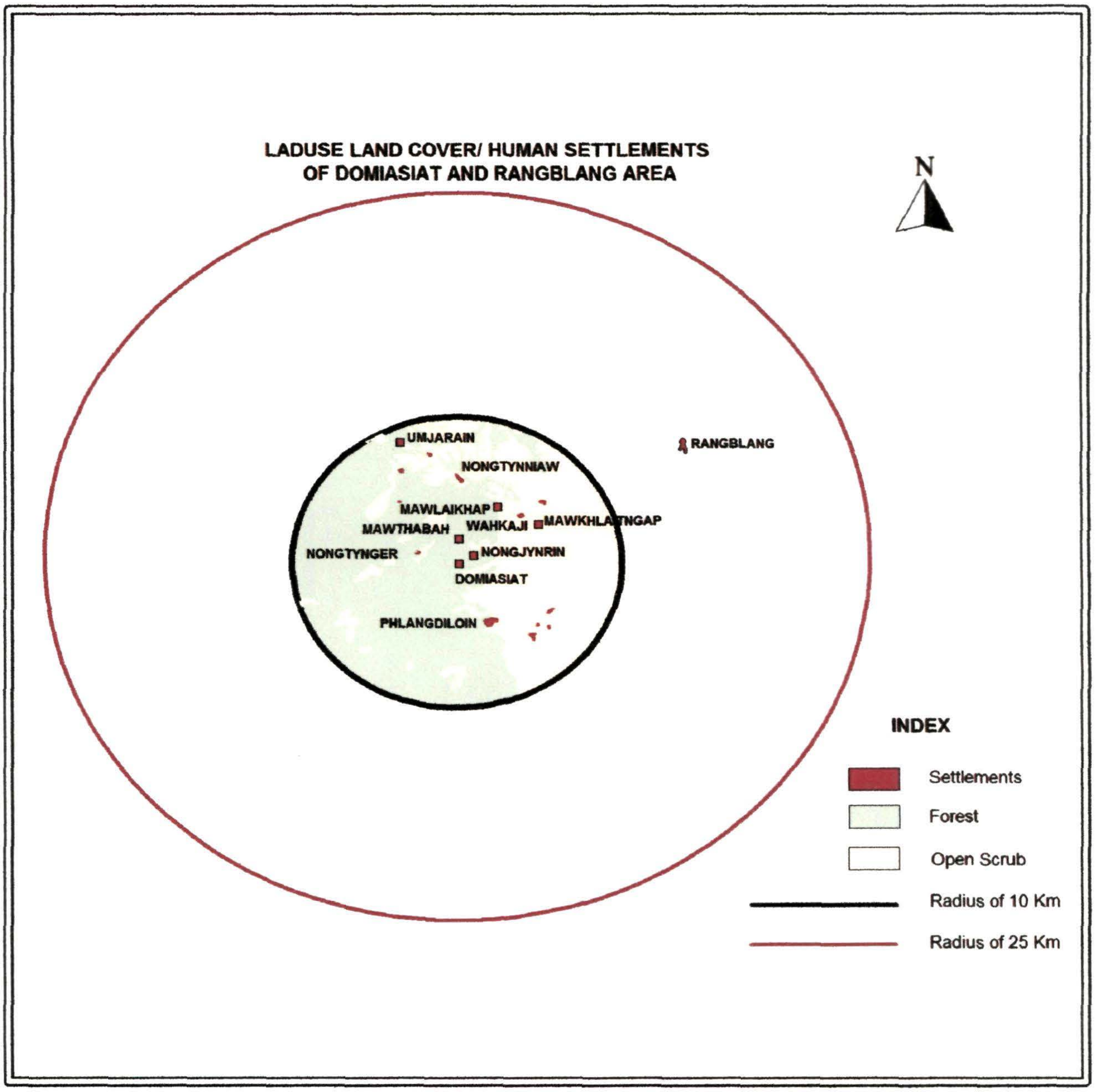
LADUSE LAND COVER/ HUMAN SETTLEMENTS
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UMJARAIN
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Radius of 10 Km
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CHAPTER 1

INTRODUCTION

Health is an important input for the development of human resources and the quality of life, necessary for the overall development of a community as a whole. To have a healthy mind and body is a common desire among all people all over the world. In fact, health is a human right, which is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease and 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. To make an individual healthy in mind and body is to build human development and a healthy nation necessary for peace and security (WHO, 1998).

In physical anthropology, the study of human biological variations and processes of human evolution is one of its central themes. In the early part of the 20th century, physical anthropology was primarily concerned with the taxonomic classification of human population with a view to understanding the human evolutionary history. It is under this theme of study that the sub-discipline has undergone different stages of changes and development. The advent of the science of genetics, in particular, has brought about a considerable impact on the anthropological perspective of human evolution. During the 1950s, one of the major breakthroughs is the recognition that the changes in the genetic composition of population from generation to generation are but an evolution. The population as such is the "unit of evolution". As a unit of evolution, a population has a heredity, which consists of an array of genes of the different genotypes, or individuals of such a population. "It occupies a definite position in space and time. It derives what it needs for energy, growth, body repair, reproduction, protection against the elements of enemies, from its physical environment, and so affects it and is affected by it. If the population is successful in meeting its needs it survives or expands; if not, it diminishes and become extinct" (Roberts, 1991). Anthropologists' concern for health and physical fitness is a part of traditional anthropology. The theory of human evolution is based on Darwinian concept of "Survival of the fittest". A group of people may be genetically well endowed and physically more fit or capable to live in a particular environment. For its survival, the population must maintain such a balance through time. Physical fitness is a must in maintaining a satisfactory level of health. This realization has now dominated the views of many modern physical anthropologists, or biological anthropologists. Anthropological studies have also revealed that every known human society has its own concept regarding health and disease and also methods of coping with them. The impact of other disciplines such as demography, zoology, molecular genetics, physiology, auxology, nutrition, ecology, etc. has considerably expanded the horizons of physical anthropology as a holistic discipline of human biology. The areas of interest are nowadays manifold ranging from functional aspects of anthropometry to mapping of human DNA. The concepts and approaches that have emerged in the fields of modern physical anthropology are more holistic in nature with more emphasis on biological and social problems of the world today – overpopulation, environmental destruction, poverty, nutritional and health problems. Medical science is directly involved with the study of health condition, disease and its treatment. But for proper implementation of public health programme communities' acceptance and participation is very essential. Many physical anthropologists today are interested to understand the relationship between human biology, especially to those aspects relating to health and nutrition, and various socio-cultural factors (Strickland and Tuffrey, 1997). In fact, it is now believed that the human biological processes are largely influenced by various social, economic and cultural aspects of the society. It may be noted that there is always a "delicate balance" between a population and its environment. Thus, Physical anthropological knowledge can be used as an evaluative tool for knowing people's health problem and health status .

Research on health status of a population is very important, because it is likely to provide a framework for a better understanding of both the cultural and biological variation of human populations. Thus, from the anthropological point of view, one may consider health as a state of well-being due to the interplay between socio-cultural and biological factors - environmental and genetic factors (Kar, 2000). Further, such a study is very vital for the integration and development of anthropology as a discipline, which is primarily concerned with both socio-cultural and biological aspects of human populations. So, it is important for physical anthropologists to undertake such studies with a view to understanding of not only the processes of human evolution, but also the health and nutritional aspect of human populations.

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.), *socioeconomic 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 the health services, water supply, sanitation, housing, community development, and so on). Health, besides others depends on body constitution, determined by genes, life style and self discipline adopted by the community of individuals, the food habits and the totality of environment in which they live. Environmental changes are having tremendous impact on human species' biology and thus providing tremendous scope for planned anthropological studies. The impact of environmental stresses for instance high altitude or migration on human health has opened fresh vistas for anthropologists to explore.

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 the 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 of 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 judgement" (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 hematological tests such as blood pressure and hemoglobin content are commonly used as health indicators of population (Khongsdier,1996). These health variables/traits are in turn influenced by numerous bio-social factors (Eveleth and Tanner, 1990; Vijayalakshmi and Devanaki, 1976; Ayeini and Oduntan, 1978; Bharti, 1981; Barua,1982; Visaria, 1988; Gwatkin, 2000). An attempt to understand the relationship of these health traits with various socio-economic factors like educational level, occupation, income and expenditure of the household, family size, religion, etc., is very helpful in understanding better the health status of a population.

This thesis is concerned with certain aspects of the health status of the Khasi population in Domiasiat area of the West Khasi Hills district, Meghalaya in Northeast India. Domiasiat is a proposed uranium mining site, which has become a burning question, especially on the issues relating to the ill-health condition of the people in the area. However, no scientific study has so far been carried out relating to the health status of the people in this area. Thus, the urgent need to carry out a study on the health status of the people in Domiasiat area with a view to understand the effects of socio-cultural and environmental factors (including radiation) on the health of human populations living in the area in general was felt. This study is a small attempt to deal with the health status of the people with a view to understanding how certain selected socio-economic variables interact or associated with demographic and biological measures of health and nutrition. It also aims at providing preliminary information from anthropological view point on the effects of the environment if any especially exploratory mining that had taken place in the area on the health of the people. It may, however be noted that the present study is not concerned with the direct effects of radiation on the health condition of the people of Domiasiat area due to many operational difficulties and subjective constrains. However an effort has been made to report on the health conditions of the people of the area although the present study is delimited particularly to understand and address the following objectives. Therefore, we undertook a study on the general health status of the Khasis in Domiasiat and Rangblang areas of West Khasi Hills District of Meghalaya with the following objectives:

OBJECTIVES

1. To describe the demographic structure of the Khasi population in Domiasiat and Rangblang areas.
2. To understand the growth status of children aged 2 to 6 years, and to assess the nutritional status of both children and adults in terms of selected

anthropometric measurements and indices.

3. To understand the morbidity pattern of the study population and to find out the possible relationship between morbidity and body dimensions.
4. To understand the relationship between health parameters (such as fertility, mortality, physical growth of children, adult body dimensions, morbidity, hemoglobin level and blood pressure) and other biosocial factors (such as age, sex, family size, education and household income, and anthropometric variables).

LAND AND PEOPLE

Area of study: Called the 'Scotland of the East', by the colonial rulers long ago, Meghalaya is a hilly region of unsurpassed scenic beauty, waterfalls and mountains, lakes and valleys. Meghalaya is essentially a small tribal state which came into existence on 21st January, 1972. Initially, it was a part of Assam and it was composed of only two districts namely, the United Khasi and Jaintia Hills district and the Garo Hills district. At present, there are seven districts, namely, East Garo Hills, East Khasi Hills, Jaintia Hills, Ri-Bhoi, South Garo Hills, West Garo Hills and West Khasi Hills. Meghalaya lies between 25°47" and 26° 10"N latitude and 89° 45" and 92° 45"E longitude, covering an area of 22,429km^2 with a total population of 2,306,069 individuals out of which 1,167,840 are males and 1,138,229 are females (Census, 2001).

West Khasi Hills, presently the largest district of Meghalaya, was carved out of the erstwhile Khasi Hills District on the 28th October, 1976. In the same year, on 10th November, the Mairang Civil Subdivision was inaugurated, whereas the Mawkyrwat

Block was converted into an Administrative unit. With the upgradation of Mawkyrwat into a full-fledged Sub-Division on June 26th 1982, the District now comprises three Sub-Divisions (including the Sadar Sub-Division), one Administrative Unit, *viz.*, Mawshynrut which came into being on the 9th February, 1996 and 6 (six) C & R D Blocks, *viz.*, Nongstoin, Mairang, Mawkyrwat, Mawshynrut, Ranikor including Mawthadraishan Block, which was created on 20th March, 2001. The District comprises eight Syiemships, *viz.*, Nongstoin, Nongkhlaw, Maharam, Myriaw, Rambrai, Mawiang, Langrin and Nobosohphoh, together with the three Sirdarships of Jyrngam, Riangsih and Nonglang.

The present study was conducted in Domiasiat area of the West Khasi Hills district of Meghalaya. It is located between 25° 47' and 25° 57' N latitude and between 91° 10' and 91° 57' E longitude. It is situated to the south-western part of the West Khasi Hills district. Domiasiat and its adjoining villages are situated at an altitude of 987m above sea level. It is located at a distance of 150 km from Shillong and 60 km from Nongstoin, the district capital. Domiasiat area as well as the whole of West Khasi Hills district is dominated by the Khasis, who speak the Mon-Khmer language of the Austro-Asiatic group and have been following the matrilineal system of society. Thus in the present study, the term "Khasis" refers to the people inhabiting West Khasi Hills district of Meghalaya and also those living in Domiasiat area. The villages that had been taken into consideration for the present study are located about 10 km radius from the uranium mining site. These villages include Domiasiat, Mawthabah, Nongbahjynrin Wahkajee, Mawkhlaitngap, Mawlaikhap, Nongtynger, Umjarain, Phlangdiloin and Nongtynniaw. Rangblang which is situated approximately 25 km from the mining areas is considered as the non-mining area. The main occupation of the people in this area is agriculture and charcoal making. It is also believed that this area is more backward and illiteracy rate is still very high when compared with other parts of West Khasi Hills.

Topography: Meghalaya maybe broadly divided into five geological formations, namely Archean Gneisses Complex, Shillong group of Rocks, Lower Gondwana Rocks, Cretaceous Tertiary sediments and Sylhet Traps (Bhakta, 1991). Shillong Group of Rocks is exposed in the central parts of the Khasi hills comprising mostly Quartzite. Rocks of this type rest uncomfortably over the gneissic rocks with basal thick bed of conglomerate in the western part. The mildly folded sediments have suffered low grade metamorphism and are dissected by numerous faults. These rocks are intruded by ultra basic and acidic sills and dykes. The granite intrusive along the axial region of the Shillong group of rocks around Mylliem is termed as Mylliem granite.Several granite bases such as Kyllang Plateau are intrusive into the gneissic complex in different parts of the region.

Minerals: Meghalaya is endowed with a number of economically important minerals, the major ones being limestone, coal, uranium, siliminite and clay, especially West Khasi hills district but most of the minerals are under investigation.

Climatic Condition: The climate of Khasi Hills shows considerable variations due to altitudinal differences in the areas. Shillong which is situated at about 1500m above sea level has a pleasant climate, neither extremely hot nor cold.The temperature rises above 24°C-34°C in the summer and falling below 4°C in winter. The average temperature and annual rainfall vary from one region to another.Cherrapunjee and Mawsynram areas receive the heaviest rainfall in the world (1270 cm).

Flora and Fauna: The district is blessed with a rich heritage of flora. The vegetation of Khasi Hills may be broadly classified into two major types, viz., the Tropical and Warm Temperate types. The forest of Meghalaya is the rich source of timber. The important timber yielding species included Khasi pines (*Pinus khasiana*) in the higher altitude areas and Teak (*Tectana grandis*), Sal(*Shore robustra*),Titachap (*Michaelia champa*ca), Gamari (*Gmelina or borea*), and Makri Sal (*Schima khasiana/wallichii*) in the lower reaches. Pitcher plants (*Nepenthes khasiana*) and varieties of orchids are also found in many pockets. However, with the passage of time, owing to the deforestation process most of the species have been depleted. Different types of bamboo also grow in abundance. Also Broomstick cultivation is widely practiced in these areas.

Some of the important crops grown by the people of the area are paddy, maize, millet, potato(*Solanum tuberasum*), bayleaf (*Betula acuminate*), Black pepper (*Piper nigrum*), rice (*Oryza sativa*), mustard (*Brassica juncea*), radish (*Raphanus sativus*). Among the vegetables chilly especially raja mircha (*Capsicum chinense cv)*, beans etc. Horticultural crops like oranges (*Citrus sinenses*), lemon (*Citrus limonium*), Pummelo (*Citrus spp*), jackfruit (*Arthocarpus integrifolia*), papaya (*Carica papaya*), mango (*Magnifera indica*), guava (*Psidium guyava*), Arecanut (*Areca catechu*) and other varieties of citrus fruits are grown too. Tezpatta (*cinnamomum tarnata*) is also grown in this area.

The area is not so rich in wildlife owing to large scale deforestation for making charcoal and hunting practices that are still being practice .The fauna of the district includes elephants, apes, monkeys, deer, sambar, tigers, wild boars, bears, leopards and many others. Currently, elephant depredation is the common occurrence due to the fact that their original habitat has been disturbed by the haphazard cutting of trees. Indiscriminate burning of forest and plantation impedes the regeneration process. Different types of birds are also found although the numbers are dwindling with deforestation still being practice even with the ban on cutting trees. However, leeches are found in large numbers during rainy seasons and the summer months.

The People: In West Khasi Hills, the total population is 296,049 of which 150,419 are males and 1, 45,630 are females. The sex ratio of the district is 968 females per 1000 males which is lower than the ratio of the state (984 females per 1000 males) and a lower literacy rate of 65.10% when compared to that of the state (i.e.,76.98%).

The present study was carried out in Domiasiat and its surrounding areas of West Khasi Hills District of Meghalaya, which is predominantly inhabited by the Khyriam Khasis who speak the Mon-Khmer language of the Austro-Asiatic group. So far as the Austric language is concerned, it is believed to be spoken by the earliest inhabitants of the country, particularly the Australians and their descendants (Ghosh and Khongsdier, 1997). The people of the district have their distinct dialects of about 23 in number. Majority of these dialectical groups, understand Khasi, which is common or link language of the people. They follow the matrilineal pattern of society as in the case of other Khasi sub-groups. At present, besides the Khasis, other peoples like the Kols, Mundas, Nicobarese of Nicobar Islands, etc. are the Austric speakers in India. Das (1987) has reported that the Wanchoo of Arunachal Pradesh also use some Austric words in their language.

The people of this district belong to the scheduled tribe community. The Khynriam Khasis are the predominant inhabitants of West Khasi Hills District. However, they are known by different names according to geographical areas:

(1)*Ki Nongphlang* are those people living in the central up land also called *Khatsawphra*, Mawiang, Maram, etc. (2) *Ki War* are those living in the southern slopes towards the border with Bangladesh. (3) *Ki Mailang* are those in the Langrin Syiemship (South-west). (4) *Ki Rimen* are those living in the Northern side. (5) *Ki Muliang* are those in Langpih area and Jyrngam Sirdarship. (6) *Ki Nongtrai* are those living in areas between the Nongphlang and Lyngngams. (7) *Ki Lyngngam* are those living in the western part and in close proximity with east and south Garo Hills. (8) The Garos are found in Langrin Syiemship, Nongstoin Syiemship, Maharam Syiemship, Mawiang Syiemship, Jyrngam Sirdarship and Nonglang Sirdarship. There are a small number of Hajongs in the Maharam, Langrin and Mawiang Syiemships, as well as about 20 families of the Banai Community in Nongjri village of Ranikor Block, Nongstoin Syiemship.

Physical Characteristics and Affinities: From Anthropological point of view, the Khasis (or Khynriams, Pnars, Bhois, Wars and Lyngngams) belong to the Indo-Mongoloid of the Mongoloid racial stock (Das, 1981). Das (1987) has decided that "the Khasis have brown skin colour. Their head hair is dark brown with a reddish tinge in colour, straight or flat wavy in form and coarse to medium in texture, rich in quantity and with a single whorl in the occipital region. They have scanty beard and moustache. The forehead is medium to low in height, medium in breadth with none or slight slope. The colour of the eye is brown to dark brown. The eye slit is mostly oblique and palpebral fissure is medium. Straight eyes with broad fissure are also frequently met with. Eye fold is present in most cases. Among the Khasi the supra-orbital ridges are slightly prominent. The nose shows slight to medium depression at the root and the nasal profile is straight with a horizontal septum. The malar region is very prominent. They are short in stature. Their head is mesocephalic, hypsicephalic and acrocephalic. Face is euryprospic and nose is platyrrhine but the frequency of mesorrhine nose is also high". Regarding the four sub-groups of the Khasis, Das (1978) says that these four divisions (i.e., Khynriams, Pnars, Bhois and Wars) do not deviate much from the average Khasi in relation to stature and trunk height. He, however, points out that the "Pnars and the Bhois show most often deviation in higher magnitude and that these two populations are standing porpoise to one another in relation to the average Khasi." It may be mentioned that the people have so far treated the Khynriams, Pnars, Bhois, Wars and Lyngngams as one and the same ethnic group. Marwein (1987) says that the Khasis are known sometimes by different names at different places. The names are either confined to a particular Syiemship or state or a particular geographical region. All these sub-groups claim to have descended from the same origin, i.e., *U Hynniew Trep U Hynniew Skum* (The Seven Huts). Recently the Government of Meghalaya has published one volume of Meghalaya (DIPR, 1991) which clearly stated that these Khasis groups are of the same ethnic origin, sharing common traditions and customs, although there may be some variations, owing to different geographical conditions and admixture with other communities.

Economic life: Agriculture' is the primary occupation of the Khasis. They produce rice, millets, pumpkin, chilly, mustard, maize, yams, sweet potatoes, potato, etc in the hills to a great extent and export them to different places. They also produce maize and rice in some areas much. Besides, the Khasis grow various fruits like orange, pineapple , betel-nut, cassia leaf, cinnamon, ginger, long ground, turmeric and various vegetables. Basically the community is a land owing community. The lands are classified under two main divisions: public lands or *ka raij* and private lands belonging to the individual proprietress.

Rearing of domestic animals like pigs, cows, chickens, goats are also practiced by the people. Some of the people also practice bee-keeping which is mostly for home consumption. Horses are also being kept by some people living in interior places which helps them in transportation, especially during the weekly market days. The majority of small business like tea stalls , grocery , selling fish , keeping small shop outlets are mostly run by women .

Another traditional occupation prevalent among the Khasis of these areas is charcoal making. The burning of charcoal (*thang rnga*) for domestic use is very common. Charcoal of these areas is being transported to Byrnihat which is an industrial area where the demand is very high. Hence, it has led to wide scale deforestation making most areas to look completely barren, unfertile and a loss of many plant and animal species. Lack of proper roads and infertility of the land have further pushed many people to this occupation. Except for a few women who are having small children, both men and women are engaged in different kinds of work to support the family. A number of people are also engaged as daily labourers either within their village or its surrounding areas or work in far away areas like the coal mines of Garo Hills and Jaintia Hills District. Other people are also engaged in trade, business and other services. In Rangblang, one of the villages under my study grinding of dry chilly is a thriving cottage business among the people for supply to Iewduh (Bara bazaar) in Shillong.

Food Habits: The food habits of the Khasis of the area is very simple as it depends on the availability of the resources. They prefer boiled food than fry food or spices, although, nowadays oil is used more often in some families. The staple food of the Khasis is rice. They are non-vegetarian and eat almost all kinds of meat which they get from the market and meat of wild animals which they hunt from the forest except cats, dogs, snakes, lizards unlike some other tribal communities of North-East India. If there is no curry with the rice they simply burnt a dry fish together with salt or sometimes rice with only warm water mixed along with salt. They domesticate cows and pigs and eat their flesh. Meat and fish are bought from their weekly market hence consumption is mostly once or twice in a week. Chicken are eaten only sometimes during marriages or some other occasions. Most people also eat tadpoles(dohlun) , grasshoppers and silkworms if available .However, dry fish is liked by all and is found in different varieties in almost each and every house who can afford to buy which is kept dried in their '*Tynger*' or the wooden structure hanging from the roof down towards the hearth. On this they dry almost everything from firewoods to maize, beans which would be sown for the next season. '*Tungtap*' is one type of dry fish taken as chutney. In the weekly market, the red grounded rice cake or the '*pu-saw*' or '*pu-tharo*' which is white in colour or '*pu-khlein*' which is red grounded rice cooked in oil is taken as snack along with tea. Red tea is mostly taken by the people. The nutritious value of milk is not known to the Khasis, so milk-tea or drinking of milk is not practiced by the villagers, which however is changing nowadays with time.

Smoking and drinking is restricted to men only in the olden days, however, some women are also seen drinking in the present days in some places although taking of raw tobacco or '*duma*' is allowed for women. Chewing of areca nut '*kwai*' with betel leaves '*tympew*' is very common in a Khasi family even if a family is poor. It is immediately served to visitors before anything else and it is almost every man's habit to chew it.

Marriage and Divorce: Marriage is the oldest and universal form of social institution in the history of mankind. According to Malinowski "Marriage is a contract for the production and maintenance of children." Radcliff-Brown (1950) in his introduction to African Systems of Kinship and Marriage described that "Marriage is a social arrangement by which a child is given a legitimate position in the society, determined by parenthood in the social sense". Marriage as an institution has different implications in different cultures. Its purpose, function and forms may differ from one society to another society. But it is present as an institution in traditional as well as in modern society.

Among the Khasis, marriage is an extraordinary serious matter. According to Shadwell's view in Gordon's (1906) book "The Khasis", marriage among the Khasis "is purely a civil contract." However, it is to be noted that originally marriage is not done in random but it is done in a very serious manner by the elders of the family -a prearranged marriage. The sole aim of marriage is procreation of children. If no issues are born, then the marriage is considered as faulty and not pleasing to the gods. The Khasis are strictly clan exogamous unlike the other neighbouring tribes like the Hmars, Vaiphei, Zuo (Bareh, 2001; Zehol, 1998; Kumar, 1999) but not strictly endogamous at community level. They consider it a great crime to marry within one's clan as they belong to the same ancestress or *ĭawbei*. Incest or *ka sang* means cohabiting with a member of a man's or woman's own clan was punishable with exile or fine (Gordon, 1906). It is sacrilege and an alien thinking for a man and woman becoming one flesh-one blood after marriage as in the Christian concept as for them it is synonymous to saying that they are of the same *kur* which is a taboo or *sang*. People who befall into this, are excommunicated from the clan, their rights of inheritance are removed, exiled and after their death their bones are not kept in the family cairn. It is believed by the the evils resultant from incestuous connection is very great; the following are some of them: being struck by lightning, being killed by a tiger, dying in child birth etc (Gordon,1906). Marriage with the maternal uncle's daughter or with a paternal aunt's daughter is prohibited during their lifetime but the prohibition is removed after their death. Such marriages are not favoured.

A Khasi can have only one wife by formal alliances, but he can keep another woman as his partner by an informal alliance. In this case the first wife is called *ka tnga trai* (real wife), while the second wife is called *ka tnga tuh* (stolen wife). The children of *ka tnga tuh* (stolen wife) have no right to the self-acquired property of their father as long as he lives with *ka tnga trai.* Divorce among the Khasis is quite a common phenomenon. There are numerous reasons why divorce is practiced. Lack of understanding between the couple , ill-treatment of the husband , adultery (*ka klim*) and failure to bring forth issues which is one of the chief reasons of divorce. This fact, however, should not lead us to think that marriage is a trivial matter. The Khasis hold marriage to be sacred as they generally believe that it is the scheme of God for man. Thus, a Khasi would undoubtly expect every couple to live in peace and harmony. If God really willed it, he will fructify this sacred union. Therefore, a marriage that does not bring such happy consequences is looked upon as unfavourable to God. Marriage among the Khasis is strictly clan exogamy.

Position of women: One of the few parts in the world where people rejoice when a girl is born, is a unique societal structure of the Khasis- the matrilineal group. A Khasi woman comparatively enjoys more freedom and autonomy than women in other parts of the country. Anthropologists describe it as a matrilineal society. Socially Khasi women are considered equal to Khasi men. Depending on the seriousness of any matter a Khasi women can take decision regarding family matters on their own or in consultation with husband or other relatives. A family without a girl child is considered incomplete as there is no more continuity of lineage of the clan. In the earlier times, adoption of a girl child was practiced preferably from the clan or relatives and orphans who could carry on with the title of the particular clan. Nowadays too, some families still practice adoption , although now people are more cautious. However, it should not be mistaken that boys are ill-treated as its generally thought by people of other communities because birth of a boy child is equally welcome in the family as that of the girl child. A man is considered a "protector" and a "provider" of the family wheras a woman is the "caretaker". In case if divorce happens between the spouses, the children stays with the mother. Traditionally, women are prohibited to participate in political matters of the village council or "durbar" . Even if women enjoy social freedom yet, few women participate in politics. Nowadays, slowly some women are taking part in the state politics but when it comes to the "dorbar" they still are not yet ready to change the age old traditional system .

Religion: According to the Khasis, religion is a relationship between God and man. Originally, the native Khasi religion was neither Hindu nor Muslim. It was, according to tradition, a religion based on the belief in one formless living god (*U Blei*) who was omnipotent, omnipresent, and omniscient. They considered it a sacrilege to symbolize God or to picture God in any shape or form. The religion taught that through service to others, one serves God. One of the commandments says, "*Tipbriew –tipblei*" (know man-know God). At the same time they believed in gods and goddesses of rivers, streams, jungles, etc. Their religion was based on conciliating good, evil and ancestor spirits through animal sacrifices to these gods and goddesses. Reverence for the tree spirit, protecting and keeping of sacred groves "Law Kyntang" is seen in many areas near the vicinity of the villages. These groves are taboo and it is an offence to cut trees therein for any purpose other than performing funeral obsequies. The Khasis do not worship the dead . The giving of food (ai bam) to the spirit of the departed ancestors is to win their favour and blessings . The spirits being in the house of God are in a position to intercede for the living before God and secure his help and protection for them .(Minattur ,1955). In the olden times, the Khasis used to erect memorial stones or megaliths in memory of the ancestors or in commemoration of some big events in the past and present. These megaliths are seen scattered in some pockets of Meghalaya .The indigenous Khasi religion is still practiced by many in the region. However, these days majority of the people are Christians belonging to different denominations. A small number of them are Muslims through marriage alliances with the other communities.

CHAPTER II

REVIEW OF LITERATURE

Health is a function, not only of medical care but for the overall integrated development of socio-cultural, economic, education, social and political. Each of these aspects has a deep influence on health which in turn influences all these aspects. Hence, it is not possible to raise the health status and quality of life of people unless such efforts are integrated with the wider effort to bring about the overall transformation of a society. Good health and good society go together (Basu, 1992). The health status of Indian population is directly related to the ecology, human settlements and amenities available. The natural life support systems of land, water and air have been weakening over time as a result of the pressure of population and certain demands made by economic growth (Bhasin and Bhasin, 1994). In the present chapter, we shall make a review of related literature with special reference to those works carried out in Indian populations. The review of literature is far from being complete and exhaustive, but its main purpose is to get an insight into certain aspects which is affecting the nutritional and health status of the population.

DEMOGRAPHY

In the beginning, demography was concerned only with the enumeration of population. Gradually it began to study population from empirical, statistical and mathematical view points. Today it studies the size, the composition and distribution of population.

Demographic study of population is an integral part of anthropological research. Demographic variables such as fertility and mortality are very important to understand the genetic and social structure of human population (Basu, 1969; Khongsdier, 2005a). The growth of population depends upon fertility, mortality and migration. The environment, both the physical and cultural setting, influences elements of population growth, yet there have been few studies in which the effect of the environment on population is considered. Such consideration should be part of any study, plan, or policy on population. In addition to growth, environmental factors are often responsible for the distribution and density of population. These factors cause some areas to remain unsettled while others are overpopulated. In the overpopulated areas, environmental degradation results when the capacity of the land to support the human and animal population is exceeded. On one hand, demographic variables are largely influenced by various socioeconomic factors and on the other hand they can affect the genetic composition of human population. The relationship between population growth, resource depletion and environmental degradation has been a matter of debate for decades. Demographic parameters are, therefore, very vital for understanding not only the genetic structure, but also the socio-economic condition of a population in a particular area or environment. In the present study, we are not concerned with the genetic structure of the population, but we shall look into certain socio-economic factors that may influence fertility and mortality of the population.

Fertility and Mortality

Fertility and mortality are fundamental determinants of population growth in order to understand the changes in the genetic structure of a population and also essential in the understanding of human society. Fertility is a complex process responsible for maintenance of the society, while mortality determines the survival index. Fertility pattern influences the demographic profile and development status of the community. By fertility is meant the actual bearing of children (Park, 2005). Biological as well as socio-cultural factors are responsible for the differential fertility and mortality among human populations (Elizabeth *et al.*, 2000; Emma *et al.*, 2007; Mostafizur Rahman *et al.*, 2008). The biological factors consist of heredity, general health conditions, age, location, sex drive, fecundability, diseases, sterility, etc. Similarly, some of the socio-cultural factors are age at marriage, absence of spouse, widowhood or widow-remarriage, polygamy and postpartum sexual abstinence during certain seasons or ceremonies and permanent celibacy by some members of the population, etc. which also affect the population growth (Reddy, 2005). Research studies repeatedly emphasize that biological and socio-cultural variables like age at menarche, age at marriage, type of marriage, economic levels, education and birth control methods have significant influence on the fertility and mortality of a population (Meerambica *et al.*, 1999; Das and Goswami 2004; Hammami 2005; Al- Kandari 2007; Bosch *et al.*, 2008; Koc, 2008). Along the lines of Subbarao and Raney (1995), Dreze and Murthi (2001) empirically found that female education is the most important determinant of fertility. Studies (Brookins and Brookins, 2002, Dreze and Sen, 2002; Dreze and Murthi, 2001) found the role played by female education in fertility reduction. It is also widely accepted that fertility and mortality are influenced by a large number of biosocial factors like maternal age, parity, education, religion, economic conditions and so on (Caldwell, 1979, 1982; Nag, 1981; Kost and Amin, 1992; Bicego and Boerma, 1993; Feeny and Feng, 1993; and others), in addition to conception control practices and attitudes (Elamin and Bhuyan,1999). For example, demographic transition from high to low levels of fertility and mortality is considered to be associated with the economic development of a population, or rising in the income of a household. However, recent studies have also suggested that the effect of economic condition is rather slow in comparison with other social variables like education, particularly female education (Murthi *et al.*, 1995). For example, Kerala recorded the lowest fertility rate in India during the 1980s, though the per capita income in the state was lower than that in many other states. In addition, the fertility decline that is the source of the changed age structure may act directly to induce greater female labour supply (Bailey, 2006) and increase attention to primary education and health (Joshi and Schultz, 2006). The studies in Bangladesh by the World Bank (Cleland *et al.*, 1994) have also indicated that the lower fertility in that country with low per capita income is mainly because of the efficient implementation of family planning programmes. Low income group couples shows high fertility and mortality than middle and high income group couples. The per capita annual income has considerable impact on mortality status both at prenatal and postnatal life. Mortality decreased with better income level. (Reddy and Sudha, 2010). Similarly, the effect of education on fertility rate varies from one population to another depending upon other socio-cultural factors. It was found that the acceptance of contraception increased as the age increased (Pushpa *et al.,* 2011).Studies shows the certain positive effects of maternal grandmothers with respect to survival of offspring (Lahdenpera *et al.*, 2004; Leonetti *et al.*, 2005, 2007; Mace and Sear, 2005).Also, the rates of infant and child mortality have been found to be considerably higher in rural areas than in urban areas (Pandey, 2009).

Age at marriage

Age at marriage is an indirect factor which affects the rate of fertility (Reddy and Sudha, 2010). The negative effect of age at marriage on fertility has been reported in many studies (Mahadevan, 1979; Patnaik, 1981; Choudhury, 1984; Bharati and Dastidar, 1990; Freeny and Feng, 1993; Sengupta and Gogoi, 1995; Verma *et al.*, 1999; Khongsdier, 2005c; Adhikari, 2010 and others.). Factors such as type and place of residence, religion and ethnicity have been found to be important in explaining variation in the timing of marriage (United Nations, 1990, Choe *et al.*, 2004). Age at marriage determines the reproductive life span of women and has a direct bearing on fertility as it delays exposure to the risk of conception (Durch, 1980; Yadav and Badari, 1997). Early marriage is almost always associated with early childbearing, especially in settings such as South Asia, where marriage is virtually universal and where strong social sanctions exist against childbearing outside of marriage (Caldwell, 2005). Early marriage and childbearing have numerous negative social and health consequences; they have been identified as an abuse of girls' human rights (UNICEF, 2001) as well as a cause of morbidity and mortality during pregnancy, labor, and delivery (Zabin and Kiragu, 1998) and of infant and child morbidity and mortality (Casterline and Trussell, 1980; Zabin and Kiragu, 1998; Ikamari, 2005). They also contribute substantially to rapid population growth (Bongaarts, 1994). Gangadharan and Maitra (2001) find parental education to be associated with higher levels of education and later ages at marriage among daughters in Pakistan. Women with higher levels of education are able to invest more time and resources per child because they tend to have delayed and lower fertility (Hobcraft, 2000). High levels of maternal education are associated with a slower transition to marriage among daughters in rural

Bangladesh, but that the size and significance of the association diminish when the full set of covariates are included (Bates.et.al,2007).Women who marry early will have, on average; a longer period of exposure to the risk of pregnancy, often leading to higher completed fertility. Zathar (1988) has observed that the "Initial rises in mean age at marriage of women to around 18 in Pakistan may lead to higher marital fertility owing to the higher fecundity and other factors which seem to lead to very spacing between consecutive births". It is generally observed that women who marry late have significantly lower fertility as compared to those who marry at younger age (Kono, 1986; Mahadevan and Sumangala, 1987; Arora, 1990; Kinfu, 2000). Therefore variation in age at marriage helps explain differences in fertility across populations and also helps explain trends in fertility within a given population over time (United Nations, 1990; Ezeh and Dodoo, 2001). Delay in age at marriage directly affects completed fertility by reducing the number of years available for childbearing. Later marriage permits women to complete their education, build labor force skills, and develop career interests. These career interests may, in turn, motivate women to limit family size and/or widen the birth spacing (Amin, 1995; Jensen and Thornton, 2003). Anderson (1998) has shown that higher age at marriage for British women was a powerful determinant of very low fertility. A negative relationship between age at marriage in Britain has also been reported earlier by Peel (1970). A similar observation has also been reported by Freeny and Feng (1993). Increases in the percentage of births to mother under age 18 years was associated with higher neonatal mortality and increase in percentage of births to women above 35 years was associated with higher neonatal and infant mortality rates (Rutstein, 2000).

Increase in age at marriage is associated with major social-structural changes such as educational attainment, urbanization, and the emergence of new roles for single women (Lesthaeghe *et al.*, 1989, Kaufman and Meekers, 1998). Cohen (1993) identified later marriage and greater use of modern contraception as being the driving forces behind the African fertility declines. Letamo (1996) suggests that in Botswana, rising age at marriage contributed to the fertility decline by increasing the proportion of never married women who have lower fertility compared to those married or living with a partner. As summarised by Lesthaeghe and Jolly (1995), the increase in the proportions of single women in the age-group 15–19 contributes to a lowering of overall fertility, in as much as it is only partially offset by an increase in premarital teenage fertility. Zathar (1988) has observed that the "Initial rises in mean age at marriage of women to around 18 in Pakistan may lead to higher marital fertility owing to higher fecundity and other factors which seem to lead to very spacing between consecutive births." Any increase in the age at first marriage constitutes an important demographic event (Eltigani 2000).

It may however be noted that age at marriage is also associated with different socio-economic factors. Husain (1970) has suggested that age at marriage has an inverse effect on fertility, but educational status of the mother exerts in turn a great influence on age at marriage. Some studies also show that age at marriage is associated with socio-economic conditions thereby it is difficult to assess its direct impact on fertility (Gulati, 1969, 1988). Nevertheless, it is obvious from the findings on other populations that age at marriage has significant inverse association with fertility rate. In the North-Eastern region, the age at marriage was found to be relatively high whereas it was relatively low in the central region because of the influence of Hindu culture (Sinha, 1986). It was further observed from research investigations that the frequency of abortions, miscarriages, and still-births were found to be much higher in younger mothers below the age of 19 years. The major life threatening complications for very young mothers were pregnancy induced high blood pressure, anaemia and difficulty in delivery due to disproportion between the pelvic-size and the head of the baby.

Many studies conducted in India have also revealed that fertility rate declines with the increasing mean age at marriage (Agarwala, 1962; Driver, 1963; Gulati, 1969; Raman, 1973; Patnaik, 1981, Bharati and Dastidar, 1990; Verma *et al.*, 1999; Khongsdier, 2005; and others). Women getting married at an early age naturally experience more years of reproductive span and tend to have more children when they reach menopause. The reverse is true for women getting married at a later age (Sharma and Abdul, 1990; Muthrayappa, 1998). Syamala (2004) suggested that postponement of female age at marriage to 20 years delays the onset of childbearing. Chaudhury (1984) pointed out that age at marriage is of the most important variable affecting fertility behaviour. According to him late age at marriage can affect cumulative marital fertility by shortening the duration of marriage within the reproductive span. A number of studies conducted in different parts of the world have also revealed the influence of maternal age at delivery on the health and survivorship of children (Stockel and Chaudhury, 1973; Adlakha, 1973; Feeney, 1980; Hobcraft *et al.*, 1985). It is suggested that very young mothers are likely to have chances of pregnancy related complications, and she may not be able to provide good care for the infant. Women who give birth or become pregnant before they attain full physical growth tend to have greater risk of complications during pregnancy or child birth (Govindasamy *et al.*, 1993), whereas children born to mothers aged 35 and over are likely to have elevated risk of mortality because risk of pregnancy complications increases with age of women due to increasing inflexibility of the female reproductive organs (Visaria, 1988; Jain, 1988). Mosley (1983) also observed that higher risk of infant death is biologically associated with child bearing at very young age. He further pointed out that maternal age is associated with higher frequency of anomalies while both extreme ages are associated with higher risk of birth trauma. Dabral and Malik (2004) in their study among the Gujjars of Delhi reported that younger married women tend to have higher infant mortality. It is also observed that younger mothers are at greater risk of pregnancy wastage, whereas babies of older mothers are at greater risk of congenital malformations. Recent studies shows that as in other countries, undergoing economic development, age at first marriage has risen in India (Ravichandran,2002; Shenk,2008).Increased associated parental investment in child health, also leading to greater height, is expected to occur concurrently as insurance against loss(via child mortality) of educational investment (Kaplan *et al.*, 2000).Economic development also tends to reduce extrinsic child mortality risks, and so productive delays are potentially less costly (Quinlan, 2007).

Most studies in North east India have revealed that fertility rate decreases with the increasing mean age at marriage (Khongsdier, 2005; IIPS and Macro, 2000). Barua and Sengupta (2001) reported that the mean conception and live births declines with the increase in age at marriage and the incidence of abortion and stillbirth is relatively high in mothers who got married and experience conception at relatively young age among the Ahom of Assam .It was also pointed out that higher infant mortality are associated with mothers who married at young age, decreases gradually with advancing age at marriage up to 21 years, after that a sudden increase in infant mortality rate from the preceding category is observed. Gogoi (2002) observed that the mean number of conception and live births decrease as the age at marriage increases. Further there is an inverse relationship between the age at marriage and number of pregnancies. Mukherjee (2002) also reported the effect of age at marriage in influencing fertility rate in the population. Khongsdier *et al.* (2001) also revealed the influence of age at marriage on the number of live births. It may however be noted that age at marriage is also associated with different socio-economic factors. Nevertheless, it is obvious from the findings on other populations that age at marriage has significant inverse association with fertility rate. Thus, it is imperative on the part of not only demographers but also the anthropologists to look into this problem in order to have a better understanding of the fertility trend in a population.

SOCIO-ECONOMIC CONDITION

Education

Maternal education has been considered to be the most important determinant of fertility behaviour and its effect in lowering the number of children a women desire has been observed in many studies (Breierova and Duflo, 2004; Handa, 2000; Kim, 2004; Uchudi, 2001; National Research Council, 1999; Cleland and Rodrigue, 1988; Jejeebhoy, 1995; Toroitich-Ruto, 2001; Adhikari, 2010). Education, especially female education, is an essential pre-requisite of all round development of individuals towards better quality of life. Education makes a difference through a multitude of mechanisms in order to influence service use, including increasing female decision-making power, awareness of health services, changing marriage patterns, greater self-confidence and creating shifts in household dynamics. Mother's education seems to be directly related with the health of a child (Mondal *et al.*, 2009). Better educated women are more aware of health problems, know more about the availability of health care services, and use this information more effectively to maintain or achieve good health status. Mother's education may also act as a proxy variable of a number of background variables representing women's higher socioeconomic status, thus enabling her to seek proper medical care whenever she perceives it necessary (Chandrasekhar *et al.*, 2007). It is also closely related to demographic variables and other indicators of health and socio-economic conditions of a population, or a nation as a whole. Educating girls also has a functional importance in terms of benefits for the next generation, as the socioeconomic status, actions, and choices of more educated mothers during pregnancy and child rearing can have a large impact on children's nutritional status, well-being, and survival (Frongillo *et al.,* 1997, Pelletier 1998; Webb and Block 2004).Educated members of society are more likely to be the agents of changes that will encourage the diffusion of an innovation such as fertility limitation (Weeks, 2002). It has been suggested by many authors (Jejeebhoy, 1995; World Bank, 2000; Ashford, 2001) that women schooling improve women's autonomy and that this leads to lower fertility. Female education has been claimed to alter household power relations making women more autonomous and giving them greater control over various dimensions of their lives (Jejeebhoy and Sathar, 2001). This greater control could be reflected in the independent decisions educated women take in adoption of family planning. Angeles, Guilkey and Mroz (2003) examined the relevance of increases in female education as a driving force for lower fertility. They suggested that many women with higher levels of education were likely to have low fertility. However, in the case of the matrilineal Khasis, although high female autonomy does empower women to take decisions on their own, especially decisions regarding their own health care and reproduction, but this does not necessarily mean that these decisions will reduce family size .The study suggested that social norms and values in the traditional tribal societies wield a stronger influence than individual values in determining the fertility behaviour in those societies (Saikia *et al.*, 2001). Education can affect preferences for fertility timing and outcomes, raise female autonomy, increase contraceptive use and raise the opportunity costs of childbearing (Jejeebhoy, 1995; Kravdal and Rindfuss, 2007; Skirbekk *et al.*, 2004). Jain (1981) and Gustavsson (2006) argued that education can reduce fertility strongly if opportunity costs increase with schooling, which for example could be the case when labour force participation rates correlate with educational levels.

Scientists focusing on cultural issues often interpret fertility differentials among women at different educational levels as a consequence of the greater range of possible lifestyles and other choices increasingly available to women with greater educational attainment (Lesthaeghe, 1983; Van, 1987; 1996; Surkyn and Lesthaeghe, 2004; Lappegård, 2002). It is also argued that women lower their preferences for children as they proceed with their education (Rindfuss *et al.*, 1996) and thus a higher rate of childlessness among more educated women, which in part can be attributed to their longer stay in education. Empirical studies (Rindfuss and Bumpass, 1976; Rindfuss *et al.*, 1980; Kravdal, 2001; Gustafsson, 2001) have found that prolonged education may therefore lead to a postponement of childbearing to a later age, when biological factors may make it more difficult to conceive. Also the desire for having children is likely to decline when women have greater range of options (Jan *et al.*, 2006). The fertility levels of any population are very much influenced by the levels of childlessness (both voluntary and involuntary) in the population and it plays an important role in determining the levels and differentials of fertility (Roberts, 1972). The evidence in the past has suggested that the decline in impaired fertility leads to an increase in the Total Fertility Rate (Larsen, 1996). Education, especially female education, is an essential pre-requisite of all round development of individuals towards better quality of life.

Female education is believed to have a great influence on the maternal and child health as it enhances the knowledge and skills of the mother concerning age at marriage, contraception, nutrition, prevention and treatment of diseases (Mosley and Chen, 1984). This also means that the higher infant and child mortality rates among the poorly educated mothers are due to their poor hygienic practices and lack of connection with the modern medical facilities. Moreover, maternal education is related to child health because it reduces the cost of public health programmes relating to information on health technology, increases household income and productivity of health inputs (McIntosh and Finkle, 1995). Thus it is suggested that the best health development agenda for the developing countries is to increase investment in formal education, particularly female education (Caldwell, 1979, 1982; Cochrane, 1983; Bicego and Boerma, 1993). In fact, the 1994 International Conference on Population and Development (ICPD) in Cairo has strongly recommended that all countries should take immediate steps to achieve the goal of universal primary education before the year 2015, and to ensure that girls and women should get the widest and earliest possible access to secondary and higher levels of education (McIntosh and Finkle, 1995; Knodel and Jones, 1996). It is argued that about 75 per cent of 960 million illiterate persons in the world are women. India is one of the best examples of such a country with sex disparity in literacy rate till the last census, despite research evidences of the important role of female education in regulating demographic transition and other socio-economic parameters. Besides, several studies have revealed that female education is more important than paternal education in exerting a negative effect on fertility, though the influence of the latter is also significant in certain studies (Murthi *et al.*, 1995). Khongsdier (2003) has summarised the following reasons why female education is expected to reduce birth rates: First, educated women are likely to have more voice with regard to lightening the burden of repeated pregnancies because they have more control over household resources and personal behaviour. Second, educated women are likely to be less dependent on their children as a source of social status and old age security, thereby leading to a reduction in a desired family size. Third, educated women have higher aspirations for the better achievements of their children, which is conducive to a reduction in a desired family size. Fourth, educated women often have a higher age at first marriage, which is in turn affecting fertility rate. Fifth, educated women often have higher rate of adoption of family planning method, despite certain contradictory results.

Although the relationship between fertility and level of education varies among countries and it is not always linear or monotonic, women with more than primary education have substantially lower fertility than women with no education in all surveys (Jejeebhoy, 1995; Rutstien, 2003). This relationship is associated with other factors such as family income, rural-urban residence, and husband's education. After controlling for such factors in multivariate analyses, the effect of wife's education remains statistically significant and it is more powerful than the effect of husband's education or the family's economic status (Jejeebhoy, 1995). Moursund and Kravdal (2003) concluded that women who spend some years at school will be more inclined to restrict their childbearing. They also confirmed that frequent use of contraception among women with some education reflects both a stronger desire to stop childbearing and better implementations of this intension through contraceptive use, and the higher level of general knowledge among the better educated are better able to absorb information from media, health institutions or other sources. Most women do not like to have children before the end of education, and the longer the education the later they have children. Important reasons for this is that many women prefer financial security before having children, including getting a job with long term prospects and rights for child support, as well as being able to afford adequate accommodation (Blossfeld and Huinink, 1991; Skirbekk *et al.*, 2004). Higher education of women has also been associated with the more effective use of available contraceptives due to greater access to information and greater specialized knowledge of effective contraceptive practices, regardless of the method chosen (Kasarda, 1979; Wolfe, 1980).

Educated women may also influence other uneducated women or neighbors in the village. Kravdal (2002) also show in a recent analysis that women's birth rate was strongly influenced by the average education of other women. Such community effects had also been reported by Hirschman and Guest (1990). Analyzing the data for 22 sub-Saharan countries, Kravdal (2002) found that besides the effect of individual women's education on fertility, there exists a spillover effect of the average educational level in a village or a community. However, he also reported that such negative effects of community education do not appear consistently when the data is analyzed for each country separately (Kravdal, 2000). Breierova and Duflo (2004) used the Indonesian school construction program to identify the effect of education on fertility and child mortality; it shows that female education is a stronger determinant of age at marriage and early fertility than male education. Moursund and Kravdal (2003) also reported that husband's education has a much weaker effect than wife's education, especially for secondary education, and inclusion of husband's education has almost no influence on the estimated effect of the women's own education. On the whole, models that have included both partners education have suggested that husband's education is the less important (Cleland and Rodriguez, 1988), but this conclusion is not very strongly supported empirically. In a report based on Demographic and Health Survey (DHS) data for many countries, it was shown that husband's education was more important than wife's education for cumulated fertility in two of the three South Asian Countries (United Nations, 1995). an increase in a woman's marriage age may lead to a more than proportional change in her education attainment (Field and Ambrus, 2005).

Studies in India have also revealed that education, especially female education is very important factor in influencing fertility rate. Steady decline in fertility rate with increasing educational level has been reported by Driver (1963), Bharati and Ghosh Dastidar (1990) who reported the existence of negative relation between maternal education and fertility. Instances of such evidence can be seen from the state of Kerala, where dramatic reduction in the growth rate of population is achieved through cent percent female literacy and adoption of contraception. Social scientists have put forth many explanations for the spectacular decline in Kerala's fertility. Factors like high female literacy, agrarian reforms, matrilineal customs, better health and educational facilities, government sponsored welfare measures and political consciousness are believed to be responsible for the rapid and unusual demographic transition in Kerala. The state is also known for its notable achievements in the social sector, particularly in literacy and primary health care (Sekher *et al.*, 2001). In other words, fertility decline in Kerela is due to high literacy of women there. A very strong negative impact on fertility has also been reported by Dreze and Murthi (2001) and Bhat (2002) who showed that the expansion of education has been responsible for a considerable part of the country's recent fertility decline. However, Bhat's study also demonstrated that the decline in fertility within each educational group and especially among the uneducated has been much more important than the decline associated with the increase in educational level. Better-educated couples are more likely to know about and use of contraception, and they tend to have smaller families than people with less education. In addition, women's education contributes to lower infant mortality besides its influence on fertility behavior (Sudan, 2004). Das Gupta (2004) suggested that educated women not only gets more exposed to new ideas and innovation but tends to have more favourable attitude towards them as well. Education also generates higher ambitions, desires for upward mobility as well as economic and social freedom which are responsible for a small family. Apart from all these, education also affects other determinants of fertility (Singh, 1990; Singh *et al.*, 1993). It is positively related to age at marriage and further it improves condition of infant and child survival, effects family size, preference and the structure of demand of child and enhances contraceptive practices. Education also opens economic opportunities for women; it is also expected to create greater intimacy between spouses and better communication between them, which includes matters relating to family planning. It is interesting to note that, even a small amount of education has significant negative effect as far as higher number of births is concerned (Singh *et al.*, 2002). Educated women are more likely to be aware of their family size and they know consequences of more births on their health and burden of increased cost of children. Husain (1970) also has suggested that parents with higher educational status are likely to limit their family size as they are more aware of the socio-economic and well-being of their children. However, there is still little quantitative evidence in support of a strong mediating factor between education and fertility which has not been convincingly established (Basu, 1996). The effect that is estimated may capture also the effect of her husband's education, which may operate through many of the same factors as her own education given that husband's and wife's education are positively correlated (Basu, 2002).

Like fertility, infant mortality is also influenced by a number of factor such as parents education particularly that of mothers (UN, 1994; Bhasin and Kshatriya, 1990; Hobcraft *et al.*, 1984; Mahfouz *et.al.*,2009). Maternal illiteracy was reported to be associated to higher offspring mortality in developing countries (Hussain *et al.*, 2001). Several studies have also suggested that child mortality in developing countries is associated more closely with maternal education than with any other socioeconomic factor (Behm, 1983; Hobcraft *et al.*, 1984; Caldwell *et al.*, 1990; Gupta, 1990). Some studies have suggested that maternal education is associated with greater emphasis on child quality i.e. being healthier, better educated, more affluent, and emotionally better developed (Levine *et al.*, 1991). A number of researchers (Hobcraft *et al.*, 1984; Pandey *et al.*, 1998) have noted that even a small amount of education is usually associated with improved chances of child survival and that gains generally increased with higher levels of education. It has also been suggested that the best health development agenda for the developing countries is to increase investment in formal education, particularly female education (Cochrane, 1983; Bicego and Boerma, 1993). Maternal education is related to child's health because it reduce the cost of public health programmes relating to information on health technology, increases household income and productivity of health inputs (Mckintosh and Finkle, 1995). A number of researches augmented direct causal relationship between mother's literacy and infant mortality. However, there are some studies which revealed that mother's education is just an indicator of socio-economic factors that affects the infant mortality directly (Koenig, 1992; Khasakhala, 2003). Maternal education child survival relationship has been found to be weak in Sub-Saharan African countries (Hobcraft, 1993). In developing countries like India, mother's education has been considered to have a strong effect on mortality of young children (Das and Devamoni, 2003; Khasakhala, 2003; Rama Rao *et al.*, 1997). Educated mothers are more likely to ensure healthy environment, nutritious food and they have better knowledge of health care facilities for their children. As a result, literate mothers give birth to healthier babies because they themselves tend to be healthier than the mothers who are not educated, and they are likely to experience lower mortality among their children at all ages. Mothers empowered with education are more likely to perceive their children's illnesses and seek healthcare (Pokhrel and Sauerborn, 2004)

In North-east India, few studies have been carried out on the effect of education on fertility and mortality rates (Khongsdier, 1993; Sengupta and Gogoi, 1997; IIPS and Macro, 2000; Singh, 2006 etc.). Barua and Sengupta (2001) reported that fertility level declines considerably with an increase in the educational level of the mother. Similarly, Singh (2006) reported inverse relationship between fertility and educational level in Manipur. According to him, higher the literacy rates lower the number of live birth and illiterate mothers have highest average number of live births. Rajan and Nair (2000) also link high fertility and mortality to low levels of female literacy and educational attainment. It is also observed that infant and child mortality rates are lower for households with higher levels of education. High influence of education on fertility is also reported by Gogoi (2002). Education may also affect fertility through the use of contraceptive methods. NFHS (1998-99) has revealed that the pattern of use of different contraceptive methods varies substantially by education at the state level (IIPS and Macro, 2000).The survey revealed that the current contraception use increase with the rise in educational level of women in every state. Among the Lois of Manipur, Chanu (2007) reported that mothers without education or with lower educational levels are likely to have a higher prevalence of reproductive wastage. Gangte (2009) also reported that maternal education is important in regulating fertility differentials. The findings of the National Family Health Survey (NFHS, 1999) have revealed that education of the mothers are inversely related to fertility and mortality rates in some states like Mizoram, Arunachal Pradesh and Tripura, though it is not clearly perceptible in the states of Meghalaya and Nagaland. In Meghalaya, a recent micro-study among the War Khasi has indicated that education has no significant effect on the fertility after controlling other factors like maternal age and household income (Khongsdier, 2002). Mukherjee (2002) also observed that education of mothers does not play a significant role in regulating the fertility rate among the Muslim and Christian Khasis, although it is important among the Niam Khasi women. However, Gangte (2009), found a close relationship between education of both maternal and paternal on fertility.

Economic Condition

It is theoretically believed that economic development is associated with the decline in fertility and mortality rates (Guzman, 1994; Pritchett, 1994). Recent studies in China and Taiwan have clearly indicated that the decline in fertility rate is associated with the economic development in these two countries (Poston, 2000). In fact, many studies have revealed that economic variables like household income and occupation are negatively associated with fertility rate in many developing countries (Mahadevan, 1986; Kost and Amin, 1992; Bicego and Boerma, 1993). Low income group couples shows high fertility and mortality than middle income group couples (Reddy and Sudha, 2010). A women's fertility behaviour depends on the household's economic status as indicated by the couple's participation and positions in the labour market. For a woman, her status is influenced both by her husband's and her own position in the productive process and earning structure of the society (Uchudi, 2001). Employment influences fertility through delaying marriage, increasing opportunity costs of women's time within marriage, and increasing the cost of children as aspirations increase (Diamond *et al.*, 1999). Employment in the market also brings women into contact with new role models and new ideas and values that enhance a women's self-worth and autonomy and exposes them to knowledge of women with small families and practicing modern family planning (Uchudi, 2001). In Bangladesh, low socio-economic groups were more likely to adopt sterilization as compared to high socio-economic groups and women who have professional jobs are more likely to use periodic abstinence (Kamal *et al.*, 2007). Studies also showed that the use of contraceptives increases as household income increases (Khan and Khan, 2010). Billari *et al.* (2000) reported that employment hastens a man's marriage but delays that of a woman, because once married a wife has to undertake nearly all the housework and childcare, this makes it hard to work and have a large family. Empirical evidence shows that women committed to continuous employment are more likely to delay the onset of childbearing compared to their non-working counterparts (Dewit, 1991). Besides bringing women into the economic mainstream, participation in the paid labour force gives women prestige and security in the family and the community. By this standard, economic visibility is a crucial measure of progress for woman. It has also influence on family size, though the link varies according to occupation. Mother's occupation is also associated with nutritional status of their children (Mondal et al., 2009). Mother's occupation outside the home provides exposure as well as interaction to acquire knowledge and develop self confidence among women to take decision (Buvinic *et al.*, 1992). Retherford *et al.* (1996) also suggested that many of the more important value changes affecting fertility are bound up with major educational and job gains by women, which have led to greater economic independence and increasing emphasis on values of individualism and equality between the sexes. The empowering effects of employment for women are likely to depend not only on their nature of occupation, but also by the continuity of their workforce participation and the extent to which they earn and control their income. Thus, it is argued that women who work at a regular are more likely to be empowered than those unemployed women (Sen, 1990; Mahmood and Jhonson, 1994). However, there is evidence that the decision to have a second child depends less on the wife's characteristics as compared to those of the husbands (Kreyenfeld, 2002).

Studies in India also shows that women, who were engaged in professions and higher jobs, had significantly lower fertility than those who were either unemployed or lowly employed (Desai and Jain, 1994; Bardhan, 1985). A study on the relationship between women's occupation and fertility patterns by the United Nations Population Division, based on the findings of the World Fertility Survey ,suggests that "women who work in the modern sector tend to have lower fertility than women who work in the traditional agricultural sector and women who do not work" (Sudan, 2004). Das Gupta (2004) also observed that women, who are engaged in highest occupations such as professions, tended to reproduce lesser number of children because their roles as professional women come in direct conflict with that of their role as a mother. However, there is also considerable literature suggesting that standards of living as reflected in basic measures of social welfare like level of education and health care can be more relevant to fertility than the degree of economic prosperity and modernization (Freedman, 1982; Malhotra *et al.*, 1995). Jain (1975) also suggested that effect of income particularly that of occupation on fertility is "fragmentary and inclusive". Thus, it is necessary to carry out further studies on the relationship between fertility and economic condition of the populations especially in Northeast India where there has been a lack of such studies (NFHS, 1999).

With respect to mortality, improvement in socio-economic status such as income and occupation is generally considered to be essential for improvement in children's health condition, thereby reducing infant and child mortality (Wagstaff, 2000).

Household income may serve as an indicator of children's consumption of goods and services that affect their health. A higher household income is expected to be associated with low child mortality risks. This assumption is based on the premise that children in higher income households will consume more health enhancing goods and services per capita than will children in lower income households. Among the economically advantage populations of all countries, infant and childhood mortality rates are generally lower (Kuate Defo, 1994). A low income groups are also believed to have lesser resources to combat illness and environmental hazards resulting in higher infant mortality. This association is well documented (United Nations, 1985; Das Gupta, 1990). It is reported that infant and child mortality has been declining in many developing countries from the mid 1980s and throughout the 1990s. Rutstein (2000) suggested that such a trend in infant and child mortality is no doubt associated with improvement in socio-economic status along with the improvement in a number of factors like nutritional status, environmental health condition, breastfeeding and the use of health services. The relatively few studies focusing on the relation between infant mortality and income at the household level in developing countries found consistently negative associations. It may also be mention that these studies vary only in terms of explanatory powers attributed to income in relation to other factors (United Nations, 1985). Despite the availability of numerous studies of the relationship between income and mortality, the interpretation of such relationship is not straightforward.

In India, it is also suggested that income is an indicator of children's consumption of calories and nutrients, and the accessibility to health care facilities (Pandey *et al.*, 2004). On the other hand, children born in households belonging to lower standard of living index are more likely to have higher exposure to diseases than those born in households with higher standard of living. However, Murthi *et al.* (1995) have suggested that the relationship between mortality and poverty may deserve careful examination. They have observed that the association between poverty and child mortality is rather weak in India. "The question remains whether poverty has a strong effect on mortality or fertility after controlling for other explanatory variables". The general opinion is that infant and child mortality is associated with many socio-cultural and environmental factors (Mosley and Chen, 1984). The above suggestion given by Murthi *et al.* (1995) maybe taken into consideration with a view to having a better understanding of the effect of family income on infant and child mortality.

In North East India, Singh (2006) reported that women engaged in manual labour work give birth to higher number of children, however, among the labours, those engaged in agriculture give birth to highest number of live births. He further pointed out that the prevalence of highest fertility among the labours is due to the reason that they need more working hands and children become assets for them. Mukherjee (2002) observed that the mean number of live birth tends to decrease significantly with the increasing of income level of the mother for all the religious groups. Such a trend is also observed among the Lois of Manipur (Chanu, 2007). It was reported that the effect of household income on live births is significant even after adjusting for other factors and this significant effect of the household income on fertility rate is likely to be related to the contention 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 such facilities (Mukherjee, 2002; Varte, 2006). NFHS (1998-99) pointed out that contraceptive use increases with the rise of the standard of living index in every state of Northeast India (IIPS and Macro, 2000). In the study among the Lotha of Nagaland it is mentioned that the infant mortality rate deceased with increasing in income level (Murry *et al.*, 2005). Hemam and Reddy (1998) also observed that high-income group had considerably lower child mortality in all the three subsistence categories, indicating reduction in child mortality with improvement in household income level. In Northeast India there has been lack of information about such type of study except those given by the IIPS and Macro (2000) and few researchers (Sengupta and Gogoi, 1997; Singh, 2006; Saikia *et al.*, 2001; Khongsdier, 2002).

PHYSICAL GROWTH

Human growth studies have been an essential part of anthropological research since the birth of the discipline itself. Growth assessment best defines the health and nutritional status of children, because disturbances in health and nutrition, regardless of their etiology, invariably affect child growth and hence provide an indirect measurement of the quality of life of an entire population (De Onis *et al.*, 1993).Early anthropologists, especially Franz Boas are well known for their contribution to growth studies. **Growth** is defined as a regular process of quantitative increase in size or mass of different tissues and organs of the body especially from conception to adulthood. For example, the growth in height and weight can be measured from one age group to another or the number, weight and size of cells can be used to measure the growth of body organs like liver and kidney from one stage to another. On the other hand, **Development** consists in the "progression of changes" in form and function, thus, it can be defined not only as a change in functional capacity due to increase in size or mass, but also as a unified network of the differentiation and modification that translates a single fertilized egg into a complex-multicellular individual of mature state (Bogin, 1999). For example, the development of skills and functional capacity to stand up and walk on two feet due to increase in size of locomotion parts of the body, or the development of an embryo into fetus, or the development of reproductive organs plus their functions, and so on. Thus, according to Bogin (1999), development refers to the "progression of changes, either quantitative or qualitative, that leads from an undifferentiated or immature state to a highly organized, specialized, and mature state."

The study of human growth is also essential to understand not only the health and nutritional status of a population, but also the interaction between biology and culture. For example, the pattern of human growth is indirectly influenced by several socio-economic factors through their direct influence on nutrition and infection. Several studies have revealed that children belonging to different socio economic groups have shown differences in their growth pattern (Tanner, 1962, 1966; Garn, 1966, 1980; Eveleth and Tanner, 1976; Frisancho, 1978; Musaiger *et al.*, 1989; Hazzaa, 1990; Terrell and Mascie-Taylor, 1991; Hauspie *et al.*, 1992; Misuraca *et al.*, 1995; Edward *et al.*, 1996; Russo and Toselli, 1997; Das Gupta *et al.*, 1997; Milani *et al.*, 1999; Reddy and Rao, 2000; and many others).

Nutrition

Eveleth and Tanner (1990) have shown that populations living under chronic low dietary intakes have a pattern of growth characterized by (1) slow growth during childhood and adolescence, (2) late adolescence growth spurt and (3) a prolonged period of growth. Adequate nutritional intakes are generally considered to be necessary for normal growth and development as well as for prevention of deficiency diseases (Mitchell *et al.*, 1976; WHO, 1986). Inadequate intake of protein and other nutrients during the preschool age period had an adverse effect on the child, leading to retardation in both physical growth and mental development (Jelliffe, 1966; Galler *et al.*, 1990; Stinson, 1998). In Kenya, Ongeri (1975) has suggested that malnutrition, particularly protein calories, is a common cause of poor growth in preschool children. Hertzig *et al.* (1972) have observed through a controlled study of children in Jamaica that malnourished children were shorter, and had lower intelligence and smaller head circumference than controlled children in the same school or their sibs. In fact, small body size of children in developing countries is largely due to effects of poor diet and frequent infection (Martorell and Ho, 1984).

Greulich's (1957) study on Physical growth and development of the American born and the native Japanese children has revealed that those children brought up in the United States were taller and heavier than their counterparts in Japan because of improved standard of nutrition and physical environment. Data from Malaysia (Chong *et al.*, 1984) have also shown a positive effect of protein energy malnutrition on growth pattern of the pre-school and primary school children. In Nigeria (Antinmo and Hart, 1980; Nnanyelugo, 1983) have indicated that malnutrition in primary school children could be attributed to low nutrient intake, low socio economic conditions and unfavourable environmental factors. Lampl *et al.* (1978) have reported that among the New Guinean school children, protein supplement has contributed largely to a faster growth and malnutrition. Similar observation has been made by Addo *et al.* (1988) while studying the school children of Nigeria.

Turning to Indian situation also, Rao (1961) pointed out that the pattern of growth was strongly influenced by dietary intakes. Easwaran *et al.* (1972, 1974), observed that boys and girls in the 'better fed' groups were heavier and taller than those in 'poorly fed' ones. Bisai *et al.* (2011) found that the prevalence of underweight was significantly found to be higher in boys than in girls. In India and most developing countries, undernutrition is prevalent in almost all the states in India and reports have stated that it has risen in recent years (Chatterjee, 2007; Som *et al.*, 2006.). Recent studies have studied the problem of undernutrition among rural children in different parts of India (Rajeram *et al.*, 2003.; Medhi *et al.*, 2006.; Bose *et al.*, 2007.; Mitra *et al.*, 2007.; Tiwari *et al.*, 2007.; Das and Biswas 2005; Griffith and Bently 2001; Malhotra and Passi 2007; Singh *et al.*, 2006; Vashisht *et al.*, 2005). A study conducted by Satyanarayana *et al.* (1980) has indicated that the main cause of growth retardation among the pre-school boys in rural Hyderabad is nutritional deficiencies. However, it is suggested that in a vast and multiethnic country like India, the extent and type of malnutrition among children varies from region to region, depending upon the geography, socio economic factors, food habits, level of literacy, climate, and religious cultural practices (ICMR, 1972; Gopalan, 1988; WHO, 1989). In developing countries, undernutrition continues to be a primary cause of ill-health and premature mortality among children in developing countries (Nandy *et al.*, 2005).

Economic condition

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

Bransby *et al.* (1956) observed that children from homes defined as 'poor' were consistently smaller and lighter than those from 'good' homes. Some studies suggest that within a given country children from economically advanced areas are taller and heavier than children belonging to the economically underprivileged areas (Ferro-Luzzi, 1967; Ferro-Luzzi *et al.*, 1979). In American children, height and weight were found to increase with increasing annual income or educational level (Hamill *et al.*, 1972). In Cambodia, a study has shown that the prevalence of child stunting declines with increasing household wealth (Miller and Rodgers, 2009).

According to Tanner (1986), growth may be described as "mirror of the conditions of the society" and height as a proxy for health. It is observed that growth retardation, or delay in growth appropriate for an individual or a population, takes place even in some sections of the populations in developed countries due to deprivation, illness, psycho-social stress and increased family size (Norgan, 2000). Growth retardation due to inadequate nutrition and infection is reported to be common in developing countries especially in the early stages of growth and development. It is generally agreed, on the basis of data from different continents, that variation in growth pattern of children in developed countries of Europe and North America on one hand and in the developing countries of Asia, Africa and Latin America on the other are mostly due to differences in their socio-economic status, and not because of genetic differences (Habicht *et al.*, 1974, Stephenson *et al.*, 1983; Eveleth and Tanner, 1990; Gopalan, 1992).

Abraham *et al.* (1975) also observed that in the United States, the boys and girls aged 1-17 years of above poverty level were taller, heavier and greater in skinfold thickness than those belonging to the below poverty level group. Rona *et al.*(1978) reported that children of unemployed fathers were shorter on average than those of employed ones. In England, it has been reported that children, belonging to the middle and upper classes are taller than those belonging to the unskilled working class (Goldstein, 1971). Amirhakimi (1974) conducted a study among the Iranian school children and found that the children of better economic condition are heavier and taller than those with low economic status. A similar observation has also been made by Lampl *et al.* (1978) while studying the New Guinean school children. Groenewold and Tilahun (1990) have observed the effect of income and father's occupation on weight for age and weight for height of Ethiopian children. A study conducted on Malaysian children by McKay (1969) has also revealed that the mid upper arm circumferences of the higher income group children are greater than those of children with lower socio economic status. In developing countries such as Bolivia, low socioeconomic status of the family, poor nutrition and vigorous physical activity are seen as major factors affecting children growth (Beall *et al.*, 1977; Stinson, 1980, 1982; Yip *et al.*, 1988). Post *et al.* (1997)

carried out a study among the high altitude Bolivian children and suggested that nutritional intake was influenced by socioeconomic status, but not by altitude.

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

Studies using household-level data have found mother's education to be positively associated with a number of measures of infant and child health and nutritional status (see, for example, Wolfe and Behrman, 1982; Thomas *et al.,* 1991, Bicego and Boerma, 1993; Hobcraft, 1993; Miller and Korenman, 1994; Desai and Alva, 1998; Waters *et al.,* 2004; Boyle *et al.,* 2006). Results pointing to the importance of socioeconomic status indicators such as mother's education to children's nutritional status are consistent with findings in Yip *et al.* (1992) that poor growth status among Asian children—as measured by low birth weight, low height-for-age, and low weight-for-height is mostly associated with nutritional and health determinants rather than genetic factors. At the macroeconomic level, higher female literacy rates are a positive predictor of lower infant and child mortality, with the implication that educating women and girls in low-income countries is associated with reduced child mortality (Bhargava, 2006). Empirical work has also shown that education can serve as a means of adopting new health beliefs, gaining general knowledge, and applying specific knowledge about health and nutritional practices that promote child health (Glewwe, 1999). Furthermore, women's education can also affect child health because more education is linked with higher household income, which in turn strengthens families' abilities to handle adverse economic or environmental shocks, finance health care needs, and afford more nutritious food. Studies have also shown that individuals that migrate from poor to developed countries are usually characterized by better growth patterns than their same- ethnicity counterparts who do not migrate (Yip *et al.*, 1992; Duggan and Harbottle, 1996; Mei *et al.*, 1998; Nguyen *et al.*, 2004; Tarozzi, 2008.)

In India, some studies have shown that within the same community children from the well-to-do sections had higher values of height and weight than their counterparts in poor economic groups (Mitra, 1939; Mukherjee, 1951; Dutta Banik *et al.*, 1970; Bharati and Basu, 1990). Rajyalakshmi (1981) has also observed that the children of higher income groups are heavier and taller than those of lower income groups. The Indian Council of Medical Research (ICMR, 1972) has also reported that height, weight, subcutaneous tissue and other anthropometric variables are positively associated with socio-economic status. Similarly Vijayaraghavan *et al.*, (1974) and Rao (1980) reported that the arm circumference and fat fold at triceps of Indian children belonging to low socio-economic groups were considerably smaller than those of well to do children of corresponding ages. The effect of socio-economic condition on growth pattern of Indian children also been revealed in other studies (Rao and Sastry, 1977; Satyanarayana *et al.*, 1980; National Nutrition Monitoring Bureau, 1980; Bharati and Basu, 1990). Sveral studies (Chaterjee, 2007; Graitcer and Gentry , 1981; Serenius, 1988; Dugdale *et al.*, 1994; Loka *et al.*, 1994; Quinn *et al*, 1995; Mei *et al.*,1988.) have shown that dietery and environmental constraints are the major determinants of differences in growth performance between children of developed and developing countries.

In North-east India, many growth studies have been published for the populations of Assam (Das, 1969-71, 1972; Hazarika, 1974; Das 1973, 1974; Choudhury *et al.*, 1992; Das and Choudhury, 1992; Begum and Choudhury, 1999; see reviews Khongsdier and Ghosh, 1998; Choudhury and Begum, 2003). Some studies have been published for other populations of Northeast India (Gaur and Singh, 1995; Talwar and Singh, 1995; Khongsdier, 1996, 1999; Singh and Singh, 2000; Khongsdier and Mukherjee, 2003a, 2003b; Khongsdier *et al.*, 2005). Most of the growth studies in Northeast India are concerned with the physiological changes and variation between populations. Only some studies used growth as an indicator of the nutritional status, and very few studies deal with the relationship between growth and socioeconomic conditions of the populations. Recently, it has been shown that growth and nutritional status of the Khasi children was greatly influenced by economic condition and by the intermixture with other populations

(Khongsdier and Mukherjee, 2003a, 2003b). In another study, an attempt has also been made to assess the sex differences with respect to the nutritional status in the context of patrilineal and matrilineal systems of society (Khongsdier *et al.*, 2005). It is suggested that sex discrimination in Northeast India is not as strong as in other parts of India, although sex preference may exist in terms of lineage continuity. More growth studies are needed to carry out in populations of Northeast with a view to understanding the nutritional status of children in relation to socioeconomic condition and morbidity patterns. Contrary to other findings in other parts of India, Rao *et al.* (2004) based on NFHS-II data found that nutritional status of female children of North-east children have a nutritional edge over male children. Studies based on the NFHS –II shows that Meghalaya had the highest percentage of stunted (44.6%) and children with wasting (14%) in comparison with children of other north-eastern region (Rao *et al*, 2004).

ADULT BODY DIMENSIONS

Several studies have revealed the association between adult anthropometry or adult body dimensions and socio-economic conditions (Shapiro, 1939; Eveleth and Tanner, 1990; Naidu and Rao, 1994; Visweswara Rao *et al.*, 1990, 1995; Nube *et al.*, 1998; Reddy, 1998). For example, Rothammer and Spielman (1972) have suggested that socio-economic condition has a great influence on variation in adult body dimensions which are in turn a reflection of health and nutritional status of an individual, or a population. In India, Bharati (1989) has observed that almost all anthropometric measurements and indices considered under the study are higher in the higher income groups among the Mahishyas of West Bengal. Similarly, Rao *et al.* (1990) have found that both male and female adults belonging to the upper middle income group are taller and heavier than those belonging to the lower income groups. Recently, similar observation has been made among the south Indian population (Reddy, 1998). In Northeast India, there are hardly any studies on the relationship between adult anthropometry and socioeconomic conditions (Khongsdier, 1997, 2002, 2005c). Thus, it is quite imperative on the part of physical anthropologists to carry out such a study with a view to understanding the nutritional and socioeconomic status of the different populations of this part of the country.

ADULT NUTRITIONAL STATUS AND MORBIDITY

The nutritional status of a population depends fundamentally on the interaction between genetic, environmental, and socio-political factors (Infant and Cordeo, 1997). 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). Nutritional status is the state of body in relation to the consumption and utilization of nutrients. Adequate nourishment in terms of quantity and quality is necessary for sustainable life (Kumar, 2006). According to Swaminathan (1982), good nutrition is a function of both economy and education. Ronzio (2004), revealed that women are usually vulnerable to malnutrition for both social and biological reasons, throughout their life cycle. There is an increasing interest of epidemiologists on the socio-economic inequality and its relation with health of a population. It is the most robust and well documented findings in social science (Wilkinson and Peckett, 2006). There is consistent evidence throughout the world that individuals belonging to lower SES experience higher level of morbidity (Saul and Payne, 1999 ; Marmot *et al.*, 1991) and mortality (Lantz *et al.*, 1998; Subramaniam *et al.*, 2006) in almost every category of disease than their better-off counterparts. It is also found that socio-economic status strongly affects health even when controlling for economic resources and access to health care (Lynch *et al.*, 2000; Ross *et al.*, 2000).

One of the major health problems in many developing countries is the widespread prevalence of under-nutrition and infectious diseases (WHO, 1990). Also, an increasing dual burden of under nutrition and over nutrition is being faced in many developing countries (Popkin *et al.*, 2001). Inadequacies in nutritional intake, or under-nutrition, can be considered a major scourge of many adverse effects on growth and health of individuals (Gordon *et al.*, 1968; Chandra and Newberne, 1977; Chen *et al.*, 1981; Chandra, 1981, 1983; Martorell and Ho, 1984; Mitra, 1985; Mascie-Taylor, 1991; Edmundson *et al.*, 1992). It is generally reported that the basic causes of under-nutrition and infections in developing countries are poverty, poor hygienic conditions and little access to preventive and health care (Mitra, 1985; WHO, 1990). Hence, assessment of the nutritional status of population has attracted the attention of not only the nutritionists and other biological scientists, but also the economists and other social scientists with a view to understanding the health and socioeconomic status of the population (Osmani, 1992). Nutritional status was found to be positively related with education of respondent, education of husband, household standard of living (Rout, 2009).There are various parameters for assessment of nutritional status but anthropometry is considered as one of the most reliable and practical tool to assess nutritional status (Ghosh *et al.*, 2001, Khongsdier *et al.*, 2005, Bhardwaj and Kapoor, 2007). Of the different methods, anthropometry is generally used for measuring the magnitude of under-nutrition both at individual and population levels. Anthropometric measurements and indices like weight, height, mid upper arm circumference, skinfold thickness, weight for age, height for age, weight for height and indices of upper arm circumference (Jelliffe, 1966; Frisancho, 1990) are commonly used for assessing the nutritional status of children. In the case of adult individuals, Quetelet or body mass index (BMI = weight in kg/height in m^2) and upper arm muscle area are widely accepted as one of the best indicators of the nutritional status of adult individuals and/or populations (James *et al.*, 1988, Ferro-Luzzi *et al.*, 1992; Shetty and James, 1994). It is suggested that the BMI may be more nutritionally than genetically related (Rolland-Cachera, 1993), despite the fact that there is a wide variation between human populations in weight and height (Eveleth and Tanner, 1990; Majumder *et al.*, 1990). Thus, the use of BMI as an anthropometric indicator of nutritional status may be more appropriate in a country with diverse ethnic groups like India (Khonsgdier, 2001). It is also reported that BMI is closely associated with morbidity and mortality (Garrow, 1981, 1988; Garrow and Webster, 1985; WHO, 1990; Shetty and James, 1994; Henry, 1994). BMI is the most established anthropometric indicator used for assessment of adult nutrition status (Lee and Nieman, 2003, Pirlich and Lochs, 2001) and also found to be inexpensive, non-invasive and suitable for large scale surveys (Ferro-Luzzi *et al.*, 1992, James *et al.,* 1994; Tyagi *et al.,* 2004, Sinha *et al.*, 2007, Tungdim *et al.,* 2008). Thus, BMI not only is widely accepted as one of the best indicator of nutritional status in adults (James *et al.*, 1988, Ferro-Luzzi *et al.*, 1992, Shetty and James., 1994, Naidu and Rao, 1994: Lee *et al.,* 2003; Bailey *et al.*, 2005) but also the socio-economic condition of a population, especially adult populations of developing countries (Ferro-Luzzi *et al.*, 1992; Shetty and James, 1994; Nube *et al.*, 1998; Khongsdier, 2002, Adak *et al., 2006*, Kapoor *et al.*, *2009,*). However, literature on

BMI of adult Indians is concerned mostly with populations in south India (Shetty, 1984; Ferro-Luzzi *et al.*, 1992; Shetty and James, 1994; Naidu and Rao, 1994; Visweswara Rao *et al.*, 1990, 1995; Reddy, 1998), but it was very limited in the Northeast region of the country (Bharati 1989; Khongsdier, 1997). Khongsdier (2001) used the anthropometric data published by the Anthropological Survey of India for 12 populations of Northeast India. The results indicated that the majority of adult males in Northeast India were lean or thin in body composition as indicated by body mass index. Almost all of the 12 populations are characterized by a high prevalence of chronic energy deficiency. It was also observed that the prevalence of CED was lower in the tribal populations than in the Hinduized and Caste groups. It is suggested that further researches are needed to know about the morbidity and health status of the populations in Northeast India.

Further, it has been shown that MUAC is particularly effective in the determination of malnutrition among adults in developing countries (James *et al.*, 1994). MUAC is a simpler measure than BMI requiring a minimum of equipment and in practice has now been found to predict morbidity and mortality as accurately as deficits in weight (Breind *et al.*, 1989). James *et al.*, (1994) after an extensive study of 8 countries (Mali, India, Senegal, Zimbabwe, Somalia, Ethiopia, Papua New Guinea and China) suggested that MUAC could be used for simple screening of nutritional state. Several recent investigations have studied the relationships of socio-economic status with BMI and CED among different populations (Delpeuch *et al.*, 1994; Ahmed *et al.*, 1998; Reddy, 1998; Khongsdier, 2002; Pryer *et al.*, 2003; Monteiro *et al.*, 2004; Clausen *et al.*, 2006; Mahmud *et al.*, 2006).

As for the relationship between morbidity and nutritional status, several studies in developed countries have revealed the relationship between obesity and morbidity/mortality (WHO/FAO, 2003). It is also well documented that mortality risk increases with the increase in BMI values (Garrow, 1981, 1988; Garrow and Webster, 1985; WHO, 1990). With regard to the lower value of BMI, a number of studies have suggested the higher mortality rate in individuals with low BMI (Waaler, 1984; Harris *et al.*, 1993). Henry (1994) has suggested that BMI below 13.0 kg/m^2 in adult males and 11.0 kg/m^2 in adult females may be considered the lowest thresholds of mortality risk. Of course, it has been reported that the relationship between BMI and mortality is U-shaped (Troiano *et al.*, 1996). However, it is not yet clear whether the BMI<18.5 kg/m^2, which is suggested as the cut-off point for screening CED individuals (James *et al.,* 1988; Ferro-Luzzi *et al.*, 1992; Shetty & James, 1994; WHO, 1995), is also associated with morbidity, especially in developing countries. In Bangladesh, it has been suggested that morbidity rates among adult males increases when the BMIs are below 17.0 kg/m^2 (James *et al.*, 1988). Using Probit analysis of data collected by IFPRI and the World Bank from four developing countries, viz., Philippines, Kenya, Pakistan and Ghana, Garcia and Kennedy (1994) have observed that the increase in morbidity is not consistent with the CED grades of BMI, although it is perceptible in Pakistan. However, a report from Brazil has indicated that there is a marked increase in morbidity among adult individuals with BMI below 18.5 kg/m^2 (de Vanconcellos, 1994). Also, Strickland and Ulijaszek (1993) have observed that the symptoms of self-reported illness are negatively associated with BMI among the Iban tribe of rural Sawarak. In the Indian subcontinent, less is known about such a relationship, although data from a South Indian population have revealed that mortality rate tends to increase with the decrease in BMI (Shetty and James, 1994).

In Northeast India, one study was conducted on the relationship between BMI and self-reported morbidity among the War Khasis (Khongsdier, 2002, 2005c). The results indicated that there was no significant relationship between BMI and morbidity, but morbidity was significantly influenced by poor socioeconomic condition. However, when BMI was separated into two components body fat mass index and fat free mass index the results indicated the significant relationship between self-reported morbidity and fat mass index but not with BMI (Khongsdier, 2005a). More studies are needed to carry out among populations in Northeast India in order to understand the relationship between anthropometric indices especially BMI and morbidity.

NUTRITIONAL ANAEMIA

Nutritional anaemia due to iron deficiency is a global problem and it affects more than a billion people in the entire world. Anaemia can occur in children, adolescent and adults, although it is more common in females. Studies show that in both men and women, the prevalence of anaemia was highest among those with severe undernutrition (ACC/SCN, 2000). In the developing world alone, 370 million women suffer from anaemia (Vijayaraghavan, 2007). Anemia is a widespread public health problem associated with an increased risk of morbidity and mortality, especially in pregnant women and young children. In the adult population, anaemia is a risk factor for cardio-vascular health and early death. In addition, it also causes fatigue and leads to negative impact on cognitive and physical functions as well as on the quality of life (Gabrilove, 2005). Most of the existing studies (Gillespie and Johnston, 1998; Toteja *et al.*, 2006) point out that anaemia among women causes increased risk of low birth weight, inadequate iron stores for the newborn, higher risk of maternal morbidity and mortality as well as a decline in mental concentration and physical activity. The consequences of anaemia are reduced levels of energy and productivity, impaired immune function, reproductive failure (miscarriages, still births, prematurity, low birthweight, peri-natal mortality etc.) and maternal death during childbirth (Levine *et al.*, 1993). Numerous studies have demonstrated that anaemia is not only detrimental to the health status of women themselves (UNICEF/UNU/WHO/MI, 1999), but it can have negative effects on their pregnancy outcomes (Allen.2000). In both men and women, prevalence of anaemia was found to be highest among those with severe undernutrition (BMI <16 kg/m2). Among the numerous factors, both nutritional (such as vitamin and mineral deficiencies) and non-nutritional (such as infection and hemoglobinopathies), that contribute to the onset of anemia, iron deficiency and malaria play an important role (Kraemer and Zimmerman, 2010). According to the WHO Scientific Group (WHO, 1968), nutritional anemia is a "condition in which the haemoglobin content is lower than normal as a result of a deficiency of one or more essential nutrients, regardless of the cause of such deficiency." At a global level, anemia prevalence is a useful indicator to assess the impact of widespread or highly effective interventions and to track the progress made towards the goal of reducing anemia in pregnant women and preschool children by one third that was adopted by the UN Special Session on Children in 2002 (UNCIEF, 2004). Thus, it is suggested that data on haemoglobin content are very helpful in understanding the health and nutritional status of a population (Garn *et al.*, 1977). The WHO Scientific Group has recommended that the normal values of haemoglobin content should be 13g/dl and 12g/dl for adult males and female, respectively. In the case of pregnant women the normal value is 11 g/dl. The prevalence of anemia as a public health problem is categorized as follows: <5%, no public health problem; 5–19.9%, mild public health problem; 20–39.9%, moderate public health problem; M40%, severe public health problem (Ramakrishnan *et al.*, 2002).

Iron deficiency is the main cause of anemia, especially in developing countries (Khusun *et al.*, 1999). As stated by the World Health Organization (WHO), "the numbers are staggering: 2 billion people over 30% of the world's population are anemic with about 1 billion suffering from iron deficiency anemia. In many developing countries one out of two pregnant woman and more than one out of every three preschool children are estimated to be anemic" (WHO, 2007) It has been reported in many studies that the differences in haemoglobin level are associated with nutrition, socioeconomic conditions, age, sex, etc. (Vijayalakshmi and Devaki, 1976; Garn *et al.*, 1977, Das and Mukherjee 1978; and others). Vijayalakshmi and Devaki (1976) have found higher level of haemoglobin content among those individuals who belong to the higher socio-economic strata than those in the lower ones. Bharati (1983) has found a similar trend in the case of Mahishyas males of West Bengal but in case of females, the lower economic groups have higher haemaglobin level than those belonging to the higher economic group. Das and Mukherjee (1978) have reported that there is a gradual rise in haemoglobin level with the rise in age of males and females.

In Northeast India, little is known about such relationship between haemoglobin content and socio-economic conditions. One study among the War Khasi of Meghalaya has revealed that haemoglobin level is positively associated with the economic levels (Khongsdier, 1997).

As noted earlier, the review of related literature given above is far from being exhaustive, but it is obvious that there is an urgent need to carry out research relative to health and nutritional status of a population, especially in understanding the relationship between health and socio-economic factors. Such studies are very limited in Northeast India in general and in Meghalaya in particular.

CHAPTER III

MATERIALS AND METHODS

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

Study Area and Population

The present study was conducted in Domiasiat area of the West Khasi Hills district of Meghalaya during the months of January-June 2005 and January- June 2006. It is located between 25° 47' and 25° 57' north latitude and between 91° 10' and 91° 57' east longitude. It is situated to the south-western part of the West Khasi Hills district about 60 km from Nongstoin. The Domiasiat area as well as the whole West Khasi Hills district is dominated by the Khynriam Khasis, one of the Khasi sub-groups, who speak the Mon-Khmer language of the Austro-Asiatic group and have been following the matrilineal system of society. Thus in the present study, the term "Khasis" refers to the "Khynriam Khasis" inhabiting mainly in the West Khasi Hills district of Meghalaya, particularly those living in Domiasiat area.

The sampling design for this study was based on the geographical distribution of villages, which are located within 10 Km radius from the uranium mining site. Therefore, in this thesis, the term "Domiasiat area" refers to the area within 10 km radius from the uranium mining site. According to our survey, there were altogether 10 villages with total households of 443 and about 2826 souls. These villages include Phlangdiloin (106 households), Umjarain (63 households), Domiasiat (8 households), Mawkhlaitngap (33 households), Wahkajee (76 households), Nongjynrin (10 households), Nongtynger (56 households), Nongtynniaw (75 households), Mawthabah (10 households) and Mawlaikhap (6 households). We made complete enumeration of households for demographic information. For other measurements, only those individuals who were willing to co-operate to this study were included in our samples.

As already mentioned, data were also collected from 239 households of Rangblang village, which is located about 25 km from Domiasiat. Rangblang is the biggest village in the northern part of Domiasiat area. It is considered to be more advanced than Domiasiat area in terms of socioeconomic conditions. The basic purpose is to make a comparative analysis of data between the two areas of study for better understanding of the health status of the people in Domiasiat area, i.e., even if Rangblang sample is not necessarily considered as a control group.

NATURE OF DEMOGRAPHIC DATA

The nature of demographic data collected for the present study was based on those parameters suggested by the World Health Organization Working Group (WHO, 1964, 1968; Mahadevan, 1986). These may be briefly described as follows:

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

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

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

***Socio-economic variables*:** These include occupation, education, monthly and annual income of the household, monthly expenditure of the household, age at marriage, and religion.

The entire demographic data were collected through schedules from all the 682 households in the eleven villages, viz., Wahkajee, Nongjynrin, Mawthabah, Umjarain, Mawlaikhap, Nongtynger, Phlangdiloin, Mawkhlaitngap, Domiasiat, Nongtynniaw and Rangblang. 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. 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 because 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.

Measures of Fertility and Mortality

Age Specific Fertility Rate: The total marital fertility rate is estimated by generalized Poisson regression using SPSS. The dependent variable is the number of births over the three years preceding the survey; we include five-year age groups (as dummy variables) on the right hand side of the model and control for the length of exposure (three years for each woman) using a term called **the offset**. Fertility rates are obtained as exponents of the regression coefficients for each of the five age groups (Schoumaker, 2004), and the total fertility rate is equal to the sum of the rates multiplied by five.

Mortality: For analysing data on mortality, three parameters are taken into consideration. These are: infant mortality (i.e., those who died before one year of life); child mortality (i.e., death between1-4 years); juvenile mortality (deaths between 5-14 years of age) and reproductive wastage (abortions and still-births). In the present study, abortion refers to any foetus or embryo which is expelled from its mother's womb on or before the twenty eight weeks of pregnancy because of its failure to develop or otherwise. It refers to both spontaneous and induced abortions. Still-birth is defined as "any child which has been issued forth from its mother after the twenty eight weeks of pregnancy and which did not at any time after being expelled from its mother, breaths or shows any other signs of life" (Marry Cross and Mackintosh, 1954).

Completed Family Size

It is a fertility measure showing the number of live-births per woman who married only once and lived continuously in wedlock till the age of 45 years and above. It is obtained with the help of the following formula:

$$CFR = B/M \times K,$$

Where,

CFR = Completed family size,

B = Total number of live-births to married women of completed family size,

M = Total number of women who married only once and lived continuously in wedlock till the age of 45 + years,

K = Constant (in the present study, we have taken as 1)

ANTHROPOMETRY

Following are the anthropometric measurements taken on adults aged 18-60 years and children aged 2-6 years of age, following standard techniques (Weiner and Lourie, 1981, Heyward and Wagner, 2004):

Weight (Kg)

Height (cm)

Sitting Height (cm)

Mid Upper Arm Circumference (MUAC)

Hip Circumference (cm)

Waist Circumference (cm)

Besides the above measurements, following indices and ratio were computed for both adult males and females for correlating with body composition:-

1. Body mass index or BMI = weight (kg)/height $(m)^2$

2. Fat free mass index or FFMI = FFM (kg)/height $(m)^2$

3. Body fat mass index or BFMI = BFM (kg)/ height $(m)^2$

4. Cormic index or relative-sitting height = sitting height (cm)/height (cm)

5. Conicity index or CI = waist circumference (m)/0.109×√{weight (kg)/height (m)}

6. Waist-to-Hip ratio or WHR = waist circumference (cm)/ hip circumference (cm)

Anthropometric measurements were used to estimate the body composition (FM and FFM), using the prediction equations of Durnin and Womersley (1974) and Siri (1961) based on age, weight, height, and skinfold thickness. Body density was calculated according to Durnin and Womersley formula, which was in turn used to estimate the percent body fat (PBF) or percent BFM by using Siri's equation:

%BFM = (4.95/density-4.50) × 100

BFM was calculated as body weight multiplied by percent FM and then divided by 100:

BFM = weight (kg) × %BFM/100

FFM was then calculated as body weight minus BFM:

FFM = weight (kg) – BFM (kg)

The BMI (body weight in kg divided by the square of height in meters) was separated into two components: body fat mass index (BFMI = BFM in kg divided by the square of height in meters) and fat-free mass index (FFMI = FFM in kg divided by the square of height in meters) to test the relationship between body composition in terms of BFMI and FFMI with morbidity and other parameters.

Methods of Taking Measurements

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

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

Sitting height: It measures the vertical distance from the vertex to the sitting surface of the subject. The subject was made to sit on the stool, or a flat wooden chair, or at the end of wooden bench. Then he/she was positioned in an erect sitting posture, with ankles crossed, knees spread about 20 cm apart and hands rested on the thighs. The anthropometer was placed at the back and between the two buttocks, taking care that the lumbar curve of the subject was not flattened, but concave from behind. The sliding sleeve was then lowered down to touch the vertex lightly.

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

Waist Circumference: Waist circumference was measured midway between the lower rib margin and the superior anterior iliac spine. This measurement was taken with a steel tape at the right angle to the axis of the body when the subject exhaled normally.

Hip Circumference: Hip circumference was taken at the widest point over the greater trochanters. This measurement was taken with a steel tape at right angle to the axis of the body when the subject exhaled normally.

Biceps: The skinfold was picked up between the thumb and forefinger and the caliper jaws was applied at exactly the level marked. The measurement was read after the full pressure of the caliper jaws was applied to the skinfold. Harpenden Skinfold Caliper was used for taking the skinfold thickness. The skinfold was picked up on the front of the upper arm directly above the centre of the cubital fossa and the level marked on the skin for the arm circumference.

Triceps: The skinfold was picked up at the back of the upper arm about 1 cm above the level marked on the skin for the arm circumference and directly in line with the olecranon process.

Sub-scapular: The skinfold was picked up under the inferior angle of the left scapula. According to the natural cleavage of the skin, the fold was measured either vertical or slightly inclined downward and laterally.

Anthropometric Analyses

Anthropometric measurements were used to evaluate the growth and nutritional status of participants. Human growth is generally measured in terms of anthropometric measurements like height and weight at different age intervals. The velocity or rate of change in these measurements over time is indicative of the growth of an individual. As already mentioned, the comparison of these measurements with growth references or standards relative to age and sex is known as *growth assessment.* The quantities of such comparison are often expressed in terms of *anthropometric indices*, which are used as indicators of nutritional status.

In the present study, three anthropometric indices, such as weight-for-age, height-for-age and weight-for-height were used as indicators of the nutritional status of children (WHO, 1995). These indices are expressed as a Z-score of a child's measurement to the median weight of the WHO reference population (WHO, 2006a), using the Lambda-mu-sigma (LMS) method (Cole, 1990). The formula for obtaining the Z-score for a given measurement relative to the WHO growth reference is given as:

$$Z = \frac{\left(\frac{X}{M}\right)^{L} - 1}{L \times S}$$

where, X is the anthropometric measurement (weight or height) and L (power in the Box-Cox transformation), M (median) and S (standard deviation) are the reference values corresponding to a given sex and age in months. For example, according to the WHO growth reference 2006, the L, M and S values for the height of boys aged 24.0 months are 1.0, 87.1161 and 0.0351, respectively. If the height of 24.0 months old boy in our study population is 82.25 cm, the height-for-age Z-score of the boy will be as follows:

$$Z = \frac{\left(\frac{82.25}{87.1161}\right)^{1} - 1}{1 \times 0.0351} = -1.59$$

The Z-score of - 2 was used as the cut-off point for screening the children who were likely to be undernourished. Children with the Z-score below – 3 were arbitrarily categorized as having moderate to severe undernutrition.

The Z-score, as calculated above, is a measure of the distance between the child's measurement and the median of the growth reference. It depends to a great extent on the growth reference. The choice of appropriate growth reference is therefore very crucial for getting comparable and reliable information on growth and nutritional status. It has become an academic issue that has received considerable attention during the last three decades (Khongsdier, 2009). The justification for the use of international growth reference is that the effect of ethnic/genetic differences in growth of young children, especially below 5 years of age, is not large enough when compared with the effects of environmental factors including poverty and inadequate nutrition (Habitch *et al.,* 1974). In India, several studies have supported such a contention (Gopalan, 1992; Bhandari *et al.*, 2002). In other words, growth retardation among under-five children is generally considered an indicator of poor nutritional status, or a failure in the expression of the "genetic potential" for growth.

It may also be noted that the clinical and public health implications of the use of growth reference are more important than the choice of reference. It is, therefore, necessary to distinguish between *reference* and *standard.* A reference is a statistical tool used to classify and analyse data, whereas standard "embodies the concept of a norm or target, and thus involves a value judgment" (WHO Working Group, 1986; WHO, 1995). Accordingly, the WHO growth reference was used in the present study as a means for screening and monitoring to detect children at greater risk of health and nutritional problems, but not as a fixed target or diagnostic tool which is the main characteristic of the standard. In addition, the WHO growth reference was used with a view to making our data comparable at the national and international levels.

Weight-for-age index: It is a composite measure of body weight or body mass relative to age. It is used an indicator of ***underweight*** when the children are below − 2 Z score of the median of the WHO reference population. Such a decrease in body weight is associated with a reduction in body fat mass (body fat stores) and lean tissues (fat-free mass), besides a disproportionate loss of skeletal tissues and a tendency to over-hydration of the body, depending upon the time and levels of undernutrition. Weight-for-age index is, however, a crude measure of underweight, because it is not independent of height.

Weight-for-height index: It is widely used as a practical measure of fatness or body fat stores in terms of body weight relative to height among children. Low weight-for-height (− 2 Z score of the reference population) is an indicator of ***thinness*** or ***wasting*** characterized by a deficit in body fat mass and other tissues. Wasting is considered to be a short-term response to nutritional and socioeconomic deprivation. It can develop rapidly under poor environmental conditions, but it can also be restored rapidly under favourable conditions. Along with weight-for-age index, weight-for-height index is very important for assessing the current health and nutritional status of an individual, or a population.

Height-for-age index: It is a composite measure of height relative to age among children. Low height-for-age (− 2 Z score of the reference population) is an indicator of growth retardation, or ***stunting*** (short stature) relative to a given age. Stunting is considered to be the result of slow skeletal growth, which is generally a long-term response to nutritional and socioeconomic deprivation.

Body mass index (BMI): It is also known as Quetelet's index which is obtained as weight in kg divided by the square of height in meter (m). It is widely used as a measure of fatness, or the nutritional status of adult individuals. For example, a BMI of $<18{\cdot}5$ kg/m^2 is widely used as an indicator of chronic energy deficiency (CED), i.e., a 'steady' underweight in which an individual is in energy balance irrespective of a loss in body weight or body energy stores (Khongsdier, 2005). Such a 'steady' underweight is likely to be associated with morbidity or other physiological and functional impairments.

The above cut-off points were taken after taking into consideration the recent studies from many Asian countries. It may be noted that the WHO (1995) has recommended the cut-off points of 25.0 kg/m^2 and 30.0 kg/m^2 for defining overweight and obesity, respectively. However, there is considerable evidence that these cut-off values are not applicable across ethnic groups, especially among Asian populations. It has been reported that Asian Indians, for example, have higher percentage body fat, waist-to-hip ratio and abdominal fat at a lower level of BMI compared with the Caucasian populations (Ramachandran *et al.,* 1997; Deurenberg-Yap *et al.*, 2000; Deurenberg *et al.*, 2002; Chakraborty *et al.*, 2009). In Asian subjects, the risk of association with diabetes and heart disease occurs at lower levels of BMI compared with the Caucasians (McKeigue and Shah, 1991; Banerji *et al.*, 1999; Chandalia *et al.*, 1999). In this connection, the WHO Regional Office for Western Pacific Region, along with the International Association for the Study of Obesity and the International Obesity Task Force, has proposed new BMI cut-off points of 23·0 kg/m^2 and 25·0 kg/m^2 for defining overweight and obesity, respectively, for Asian populations (WHO, 2000).

HAEMOGLOBIN ESTIMATION

Data on haemoglobin content of adults were collected using Sahli's Haemometer by following standard techniques (WHO, 1980), which may be described as follows:

1. 3 to 4 ml or 3 g/dl of N/10 HCL was taken in the clean graduated tube or measuring tube.
2. The blood sample was taken directly from the subject after piercing his/her left middle finger tip. Sahli's pipette with rubber tubing and mouthpiece was used for drawing or sucking the capillary blood up to 0.02 ml of the pipette. After drawing the capillary blood up to the desired mark, the outside of the pipette was wiped with absorbent or filter paper, making sure that the blood was still on 0.02 ml mark.
3. The blood was then blown from the pipette into the graduated tube containing N/10 HCL. The mixture was shaken thoroughly and allowed to stand for five minutes or so in the Sahli's Haemometer.
4. After 5 minutes or so, two or three drops of distilled water were added to the mixture with the help of dropping pipette. Special care was taken that the blood was thoroughly diluted bus tiring it with the glass rod.
5. Seeing that the mixture had changed its colour, care was taken by adding drop by drop of distilled water after stirring it thoroughly. Reading was recorded when the colour of the mixture matched with those of the two reference tubes in the Haemometer.

Precautions

1. All apparatus were cleaned thoroughly.
2. The first drop of the capillary blood was avoided for taking the measurement.
3. Care was taken not to allow air bubbles to enter Sahli's pipette before sucking or drawing the blood from the middle finger tip of the subjects.

BLOOD PRESSURE

Mercury sphygmomanometer was used to measure blood pressure of the individuals included in the present study. All measurements were taken on left hand when subjects were being seated position. Each participant was asked to relax and take rest for 10 minutes before taking the measurement. Systolic blood pressure was recorded as the first Korotkov sound (phase 1). Distolic blood pressure was taken as the disappearance of the Korotkov sounds (Phase V). Measurements were recorded for three times, and the average of the three was taken as recorded measurement. Digital blood pressure monitor (M2 Model, Omron Health Care Co. Ltd., Japan) was also used to cross-check the measurement. However, mercury type of measurement was reported for the present study.

DATA ON MORBIDITY

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. Despite its limitations (Sadana, 2000), SRM might be considered to be the second alternative proxy for assessing the morbidity status of populations in developing countries. Nevertheless, the term "morbidity" in this study was defined simply in terms of the number of 'days ill' and/or 'days unable to work' in the last four weeks before the survey. Each subject included in the study was asked whether or not he had been ill at any time in the last four weeks? If the answer was yes, he was asked how many days had he been in bed or unable to work due to illness? A subject who reported at least two days ill was classified as being "ill."

The study was symptom-based in which the symptoms were grouped into three categories as suggested in many studies (Strickland and Ulijaszek, 1994; Strickland and Tuffery, 1997; Sadana, 2000). For the present analysis, self reported symptoms of morbidity are broadly classified into three groups: (i) **Cold and respiratory** include those symptoms such as cough, runny nose, fever, breathing problem, chest pain, sore throat, etc. (ii) **Intestinal disorders** include diarrhea, dysentery, worms, vomiting, and other self-reported problems of stomach pain. (iii) Self-reported symptoms of morbidity like headache, diabetes, hypertensions and other than the two categories above were included in the category of **other health problems**.

SOCIO-ECONOMIC CATEGORIES

In the present study, three important socio-economic variables were taken into consideration. These include age at marriage, 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 demographic characteristics, growth, health and nutritional status of the study population. Our classification may be briefly described as follows:

Income groups: Data on household income were collected directly from the heads of the households 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 per capita monthly income of the households was classified as follows:

Above 75th percentile (>Rs.667) = High income group (HIG)

50th to 75th percentile (Rs.400-667) = Middle income group (MIG)

Below 50th percentile (<Rs. 400) = Low income group (LIG)

Educational Level: Data on educational attainment of individuals in the present study were arbitrarily classified into four broad educational levels, namely, illiterate, primary, secondary and above secondary. In the present study, the number of illiterates (i.e., those individuals who were not able to read or write) was included in the category of illiterates. **Primary level** of education includes lower primary and upper primary, i.e., up to standard VIII. In the **secondary level** of education, we included those individuals who attended standard VIII to X. **Higher Secondary** or above secondary **level** included other individuals who attended standard XI and other higher levels of education. This educational classification is highly arbitrary. However, we assumed that if education is really important in regulating nutritional and health indicators like in the western countries, its effects can be observed even if the individuals were dichotomized only into two categories, say, lower and higher levels of education.

Family Size: The family size was classified into three categories. The individuals who lived in a household with less than 4 family members were considered as having a *Small Family Size*. The *Average/Medium Family Size* includes those individuals who lived in a household with 4-8 family members. The individuals who lived in a household with more than 8 family members were grouped in the category of *Large Family Size*.

Statistical analyses

The basic design of the study is to analyse and present comparative data between Domiasiat and Rangblang. In addition, the main focus of analysis was to understand how nutritional and health status is related to biosocial variables, such as age, sex, anthropometric variables, self-reported morbidity, blood pressure, household income, education and family size in both the areas of study.

All data were managed and analysed using SPSS/PC Software. The analysis was first carried out to present the basic descriptive statistics of demographic and anthropometric variables, blood pressure, hemoglobin, and morbidity prevalence in relation to socio-economic characteristics of the study samples for both Domiasiat and Rangblang. 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 characteristics of the population. Logistic regression analysis was used for analyzing the effects of biosocial variables on dependent variables that are dichotomous. Receiver operating characteristic (ROC) was adopted for determining the necessary cut-off points by using MEDCALC 12 Windows Software. Curve fitting and graphical presentations were carried out by using ORIGINLAB 8.5 Software for Windows.

CHAPTER IV

DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

In this chapter, we shall analyze and describe the demographic characteristics of the Khasis of Domiasiat area based on data collected from Domiasiat area (10 villages) and Rangblang village. An attempt will be made to correlate the demographic parameters with certain biosocial factors to understand the health status of the Khasi population of Domiasiat area.

Age, Sex and Marital Status

Table 4.1 and **4.2** shows the total population by age, sex and the marital status in Domiasiat and Rangblang areas respectively. It is found that 49.93%, 41.72% and 8.35% of the total population in Domiasiat area belong to the age groups 0-14, 15-19 and 50 + years, respectively. In Rangblang area, these frequencies are 47.15%, 44.31% and 8.32% respectively. According to Sundbarg's classification of population in terms of these age groups, a population is said to be progressive when the number of persons in relation to total population are 40%, 50% and 10% in the age groups 0-14, 15-19 and 50 + years, respectively. The population is referred to as *stationary* if these frequencies are 33%, 50% and 17% respectively, whereas the frequencies of 20%, 50% and 30% respectively are the characteristics of *regressive* population (Khongsdier, 2005c). Thus, according to Sundbarg's classification of population, the Khasi population in both Domiasiat and Rangblang may be categorized as *progressive type*, which may be characterized by high fertility rates. The population pyramids for Domiasiat population (**Figure 4.1**) and

Rangblang (**Figure 4.2**) also show that the base is quite broad, indicating that the fertility rate is fairly high in both the areas.

Table 4.1 also shows that 94.27 % of the unmarried males and 99.19% of the unmarried females belong to the age group of 24 years and below. Of the married males, 88.78% of them are aged 25 years and above. On the other hand, about 76.54% of the married females belonged to the age group 25 years and above. In Rangblang area, **Table 4.2** shows that 95.05% of unmarried males and 96.42% of the unmarried females belonged to the age group of 24 years and below. Of the married males, 91.70% of them are aged 25 years and above. On the other hand, about 82.20% of the married females belonged to the age group 25 years and above. Thus, these findings reveal that marriage is more delayed in males, and females get married earlier than males in both the Domiasiat and Rangblang areas.

Table 4.1. Population by age, sex and marital status in Domiasiat areas

Age Group (yrs)	Unmarried		Married		DSW		TOTAL		PERSONS
	M	F	M	F	M	F	M	F	
0-4	254	260	0	0	0	0	254	260	514
%	8.98	9.20	0	0	0	0	8.98	9.20	18.18
5-9	220	212	0	0	0	0	220	212	432
%	7.78	7.50	0	0	0	0	7.78	7.50	15.28
10-14	227	237	0	0	0	1	227	238	465
%	7.99	8.39	0	0	0	0.03	8.03	8.42	16.45
0-14	**701**	**709**	**0**	**0**	**0**	**1**	**701**	**710**	**1411**
%	**24.80**	**25.09**	**0**	**0**	**0**	**0.03**	**24.80**	**25.12**	**49.93**
15-19	112	78	6	23	0	5	118	106	224
%	3.96	2.76	0.21	0.81	0	0.18	4.17	3.75	7.92
20-24	75	28	44	83	2	18	121	129	250
%	2.65	0.99	1.55	2.94	0.07	0.64	4.28	4.56	8.84
25-29	35	10	66	68	1	8	102	86	188
%	1.24	0.35	2.34	2.40	0.03	0.28	3.61	3.04	6.65
30-34	10	0	64	57	2	9	76	66	142
%	0.35	0	2.26	2.01	0.07	0.32	2.68	2.33	5.02
35-39	2	0	72	81	3	8	77	89	166
%	0.07	0	2.54	2.87	0.10	0.28	2.72	3.14	5.87
40-44	2	0	46	42	3	9	51	51	102
%	0.07	0	1.62	1.48	0.10	0.32	1.80	1.80	3.60
45-49	2	2	44	45	3	11	49	58	107
%	0.07	0.07	1.55	1.59	0.10	0.38	1.73	2.05	3.78
15-49	**238**	**118**	**342**	**399**	**14**	**68**	**594**	**585**	**1179**
%	**8.42**	**4.18**	**12.10**	**14.12**	**0.50**	**2.41**	**21.02**	**20.70**	**41.72**
50-54	0	2	41	18	3	11	44	31	75
%	0	0.07	1.45	0.63	0.10	0.38	1.55	1.09	2.65
55-59	2	1	21	9	5	4	28	14	42
%	0	0.03	0.74	0.31	0.17	0.14	0.99	0.49	1.49
60+	1	0	42	26	12	38	55	64	119
%	0.03	0	1.48	0.92	0.42	1.34	1.94	2.26	4.21
50+	**3**	**3**	**104**	**53**	**20**	**53**	**127**	**109**	**236**
%	**0.10**	**0.10**	**3.68**	**1.88**	**0.71**	**1.88**	**4.49**	**3.86**	**8.35**
TOTAL	**942**	**830**	**446**	**452**	**34**	**122**	**1422**	**1404**	**2826**
%	**33.33**	**29.37**	**15.78**	**15.99**	**1.20**	**4.32**	**50.31**	**49.68**	**100**

Notes: M- Males, F- Females, DSW – Divorced, Separated and widowed;
Sex ratio = 101.28males per females
In: (0-14) years = 98.73males per 100 females;
(15-49) years = 101.54males per 100 females;
(50+) years = 116.51 males per 100 females

Table 4.2. Population by age, sex and marital status in Rangblang area

Age group (yrs)	Unmarried		Married		DSW		TOTAL		PERSONS
	M	F	M	F	M	F	M	F	
0-4	112	130	0	0	0	0	112	130	242
%	7.39	8.58	0	0	0	0	7.39	8.58	15.98
5-9	143	118	0	0	0	0	143	118	261
%	9.44	7.79	0	0	0	0	9.44	7.79	17.23
10-14	99	112	0	0	0	0	99	112	211
%	6.54	7.39	0	0	0	0	6.53	7.39	13.93
0-14	**354**	**360**	**0**	**0**	**0**	**0**	**354**	**360**	**714**
%	**23.38**	**23.77**	**0**	**0**	**0**	**0**	**23.38**	**23.77**	**47.15**
15-19	75	64	1	7	0	4	76	75	151
%	4.95	4.22	0.06	0.46	0	0.26	5.01	4.95	9.97
20-24	51	34	18	35	1	5	70	74	144
%	3.36	2.25	1.18	2.31	0.06	0.33	4.62	4.88	9.51
25-29	20	10	41	47	0	10	61	67	128
%	1.32	0.66	2.70	3.10	0	0.66	4.03	4.43	8.45
30-34	0	2	38	36	1	1	39	39	78
%	0	0.13	2.51	2.38	0.06	0.06	2.57	2.57	5.15
35-39	2	2	32	33	0	5	34	40	74
%	0.13	0.13	2.11	2.18	0	0.33	2.24	2.64	4.89
40-44	1	1	28	26	1	5	30	32	62
%	0.06	0.06	1.85	1.71	0.06	0.33	1.98	2.11	4.10
45-49	2	1	14	16	0	4	16	21	37
%	0.13	0.06	0.92	1.06	0	0.26	1.05	1.38	2.44
15-49	**151**	**114**	**172**	**200**	**3**	**34**	**326**	**348**	**674**
%	**9.97**	**7.73**	**11.36**	**13.21**	**0.19**	**2.25**	**21.53**	**22.96**	**44.31**
50-54	0	1	24	10	1	3	25	14	39
%	0	0.06	1.58	0.66	0.06	0.19	1.65	0.92	2.57
55-59	0	0	9	11	0	6	9	17	26
%	0	0	0.59	0.73	0	0.40	0.59	1.12	22.80
60+	0	0	24	15	8	14	32	29	61
%	0	0	22.80	0.99	0.53	0.92	2.11	1.91	4.02
50+	**0**	**1**	**57**	**36**	**9**	**23**	**66**	**60**	**126**
%	**0**	**0.06**	**3.76**	**2.38**	**0.59**	**1.52**	**4.36**	**3.96**	**8.32**
TOTAL	**505**	**475**	**229**	**236**	**12**	**57**	**746**	**768**	**1514**
%	**33.36**	**31.37**	**15.13**	**15.59**	**0.79**	**3.76**	**49.27**	**50.73**	**100**

Notes: M- Males, F- Females, DSW – Divorced, Separated and widowed
Sex ratio = 97.14 males per females
In:-0-14 years= 98.33 males per 100 females;
15-49 years = 93.68 males per 100 females;
50+ years = 110 males per 100 females

Figure 4.1. Population pyramid of Domiasiat

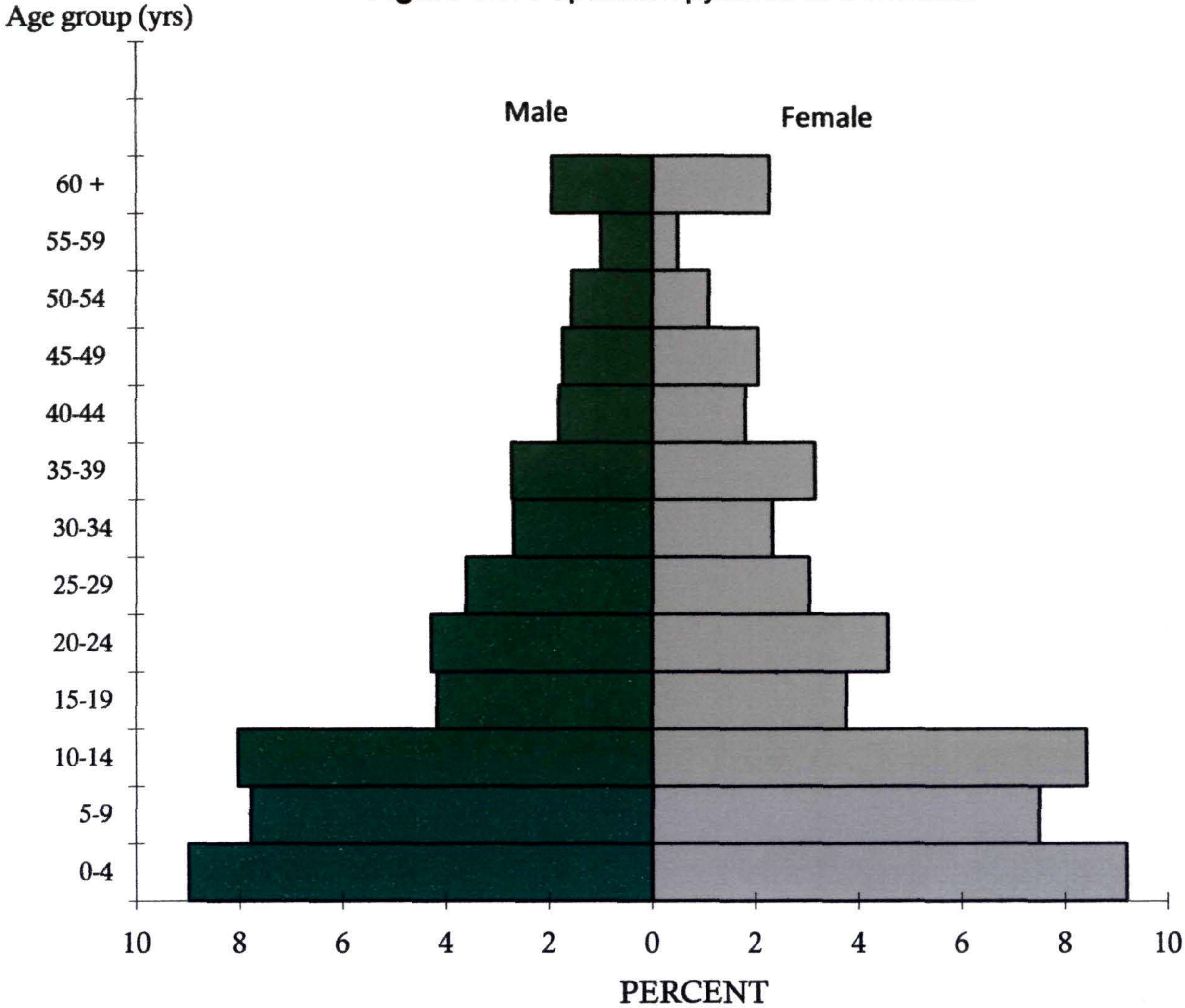
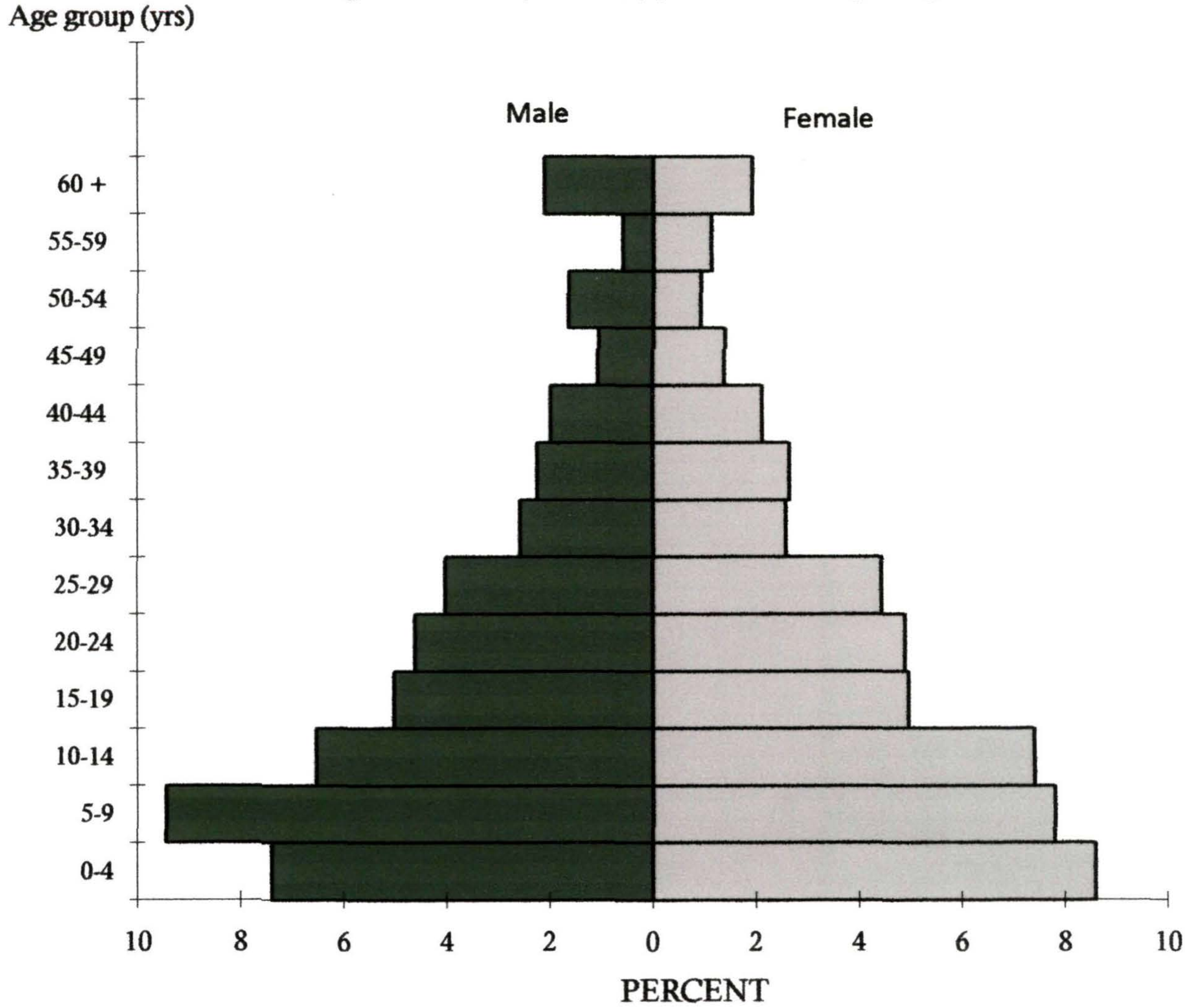


Figure 4. 2. Population pyramid of Rangblang



Sex Ratio

In **Table 4.1**, there are altogether 2826 individuals in Domiasiat area of which 1422 (50.31 %) are males and 1404 (49.68%) females. Thus, the overall sex ratio is 101.28 males per 100 females. This sex ratio is slightly higher than the ideal sex ratio of 1:1 (χ^2 = 0.11, df = 1, p > 0.05). On the other hand, **Table 4.2** shows that there are altogether 1514 individuals in Rangblang area, of which 746 (49.27 %) are males and 768 (50.73%) are females. The sex ratio in Rangblang area (97.14) is lower than the ideal sex ratio of 1:1 (χ^2 = 0.32, df = 1, p > 0.05), but it is not statistically significant (χ^2 = 0.44, df =1, p > 0.05). The difference between these two areas is also not significant (χ^2 = 0.46, df = 1, p > 0.05).

In Domiasiat area, there are 701 males and 710 females in the age group 0-14 years, thereby giving a sex ratio of 98.73, which is low but not statistically significant (χ^2 = 0.06, df = 1, p > 0.05). Similarly, there are 354 males and 360 females in the age group 0-14 years of Rangblang area, with a sex ratio of 98.33, which is low but not statistically significant (χ^2 = 0.05, df = 1, p > 0.05). This suggests that there are no differences between the sexes in respect of infant and childhood mortality rates in both Rangblang and Domiasiat areas **(Tables 4.1**and **4.2)**.

In the age group 15-49 years, there are 594 males and 585 females in Domiasiat area with a sex ratio of 101.54 males per 100 females. This suggests that it may be possible that female mortality was higher than male mortality in this age group, or the another possibility is that of higher female migration. Nevertheless, the chi-square test indicates that the higher sex ratio in the age group 15-49 years was not statistically

Table 4.3. Mean age at marriage (years)

Sex	Domiasiat			Rangblang			t-value (2-tailed)*
	N	Mean	SE	N	Mean	SE	
Males	408	23.11	0.21	196	22.81	0.31	0.41, $p > 0.05$
Females	435	19.31	0.18	220	19.21	0.21	0.34, $p > 0.05$
t-value	13.76, $p < 0.0001$			9.80, $p < 0.0001$			

*Differences between Domiasiat and Rangblang areas

Age at Marriage

The mean age at marriage for both males and females are shown in **Table 4.3**. It is found that the mean age at marriage is significantly higher in males than in females in both Domiasiat ($t = 13.76$, $p < 0.0001$) and Rangblang ($t = 9.80$, $p < 0.0001$). Further, **Table 4.3** shows that there are no differences between Domiasiat and Rangblang areas in age at marriages for both males and females. Nevertheless, it is obvious from these data that females get married earlier than their male counterparts in both Domiasiat and Rangblang areas.

FERTILITY DIFFERENTIALS

Table 4.4. Live-births by age group of mothers

Age group (yrs)	Domiasiat			Rangblang			t-value
	Number of mothers	Mean live-births	SE	Number of mothers	Mean live-births	SE	
≤24	130	1.65	0.12	51	1.43	0.17	0.98
25-29	76	3.14	0.20	57	2.72	0.24	1.36
30-34	66	4.70	0.29	37	4.38	0.36	0.67
35-39	89	5.28	0.29	38	6.26	0.47	1.80
40-44	51	6.59	0.45	31	7.35	0.62	1.01
45-49	56	5.86	0.48	20	8.30	0.77	2.65*
Total	**468**	**4.05**	**0.14**	**234**	**4.37**	**0.22**	**1.28**
F-ratio = 50.12, $p < 0.0001$ Coefficient of correlation(r)=0.56, $p < 0.01$				F-ratio=45.66, $p < 0.0001$ Coefficient of correlation(r)=0.70, $p < 0.01$			

***p < 0.05, SE – Standard error**

Table 4.4 shows the live-births by age groups of married women of all ages. The mean numbers of live-births per married woman of all age groups is slightly lower in mothers of Domiasiat (4.05± 0.14) compared to those in Rangblang area (4.37 ±0.22). However, the t-test indicates that the difference in live-births between these two areas was not statistically significant. In Domiasiat area, the mean live-births per mother are 1.65±0.12, 3.14±0.20, 4.70±0.29, 5.28±0.29, 6.59±0.45 and 5.86±0.48 in the age groups ≤24, 25-29, 30-34, 35-39, 40-44 and ≥45 years, respectively. As for Rangblang area, these figures are 1.43±0.17, 2.72±0.24, 4.38±0.36, 6.26±0.47, 7.35±0.62 and 8.30±0.77 respectively. These results indicate two important aspects. First, the differences in mean live-births between Domiasiat and Rangblang areas are not statistically significant, except in the age group 45-49 years, which indicates that the fertility rate is significantly higher in Rangblang area ($t = 2.65$, p, < 0.05). Second, there are significant differences between age groups of mothers in both Domiasiat and Rangblang areas. In other words, the one way of analysis of variance (ANOVA) indicates that there are highly significant differences between the age groups of mothers in respect of live births for both Domiasiat ($F = 50.12$, $p < 0.000$) and Rangblang (F-ratio = 45.66 $p < 0.000$) areas. The coefficient of correlation is also positively significant for both Domiasiat ($r = 0.56$, $p < 0.01$) and Rangblang ($r = 0.70$, $p < 0.01$) areas. Thus, it indicates that the mean number of live-births increases with the advance in age of mothers for both the areas, which is normally expected.

Table 4.5. Surviving children by all age group of mothers

Age group (yrs)	Domiasiat			Rangblang			t-value
	No of mothers	Mean live-births	SE	No of mothers	Mean live-births	SE	
≤24	130	1.46	0.11	51	1.31	0.15	0.74
25-29	76	2.84	0.19	57	2.47	0.21	1.34
30-34	66	4.35	0.27	37	4.00	0.34	0.44
35-39	89	4.69	0.27	38	5.66	0.42	1.95
40-44	51	5.76	0.40	31	6.48	0.54	1.11
45-49	56	5.34	0.44	20	6.95	0.76	1.85
Total	468	3.64	0.13	234	3.89	0.19	1.11
F-ratio = 47.50, p < 0.0001 Coefficient of correlation (r) = 0.55, p < 0.01				F-ratio = 40.78, p < 0.001 Coefficient of correlation (r) = 0.68, p < 0.01			

SE – Standard error

Table 4.5 shows the number of surviving children per married woman by age groups. It indicates that the overall mean number of surviving children for all age groups of women is similar in both Domiasiat (3.64±0.13) and Rangblang (3.89±0.19) areas ($t = 1.11$, $p > 0.05$). With regard to age groups, the mean surviving-births per mother in Domiasiat area are 1.46±0.11, 2.84±0.19, 4.35±0.27, 4.69±0.27, 5.76±0.40 and 5.34±0.44 in the age groups ≤24, 25-29, 30-34, 35-39, 40-44 and ≥45, respectively. In Rangblang area, these figures are 1.31±0.15, 2.47±0.21, 4.00±0.34, 5.66±0.42, 6.48±0.54 and 6.95±0.76 in the age groups ≤24, 25-29, 30-34, 35-39, 40-44 and ≥45 respectively. The ANOVA test indicates that there are highly significant differences between the age groups of mothers in respect of live births for both Domiasiat areas ($F = 47.50$, $p < 0.001$) and Rangblang

(F-ratio = 40.78, $p < 0.001$) areas. The coefficient of correlation was also positively significant for both Domiasiat ($r = 0.55$, $p < 0.01$) and Rangblang ($r = 0.68$, $p < 0.01$) areas. Thus, it indicates that the mean number of surviving children per woman living in wedlock increases with the advance in age as observed in the case of live births. In other words, it is likely that age is more important as compared to ecological setting in determining the surviving children of the present study.

Table 4.6. Completed family size

Parameters	Domiasiat	Rangblang	t-test
Number of mothers aged 45-49 years	82	50	-
Number of live-births	573	379	-
Mean number of live-births (± SE)	6.99±0.34	7.58±0.47	2.81, p <0.01
Number of surviving children	508	317	-
Mean number of surviving children (±SE)	6.20±0.33	6.34±0.44	0.65, p >0.05

Note: SE stands for standard error

Completed Family Size

Table 4.6 shows the completed family size for both Domiasiat and Rangblang areas. For calculation of completed family size, we have considered only those women who are married once and continuously lived in wedlock till attainment of 45-49 years of age (Khongsdier, 1991). It is found that the mean live-births to these mothers are significantly higher in Rangblang (7.58±0.47) than in Domiasiat (6.99±0.34) areas ($t = 2.81$, $p < 0.05$). However, the difference in mean surviving children between these two areas is not statistically significant ($t = 0.65$, $p > 0.05$). Nevertheless, the present findings indicate that the completed family size in these two areas is fairly high in terms of both live-births and surviving children.

Table 4.7. Age-specific marital fertility rates (ASMFR) and total marital fertility rates (TMFR) estimated from generalized Poisson regression model

Age group (years)	Domiasiat		Rangblang		Total after adjusting for place of residence	
	Coefficients (β)	(Exp(β) (ASMFR)	Coefficients (β)	(Exp(β) (ASMFR)	Coefficients (β)	(Exp(β) (ASMFR)
≤ 24	-1.230	0.2923	-1.224	0.2941	-1.193	0.3033
25-29	-1.023	0.3597	-0.952	0.3860	-0.983	0.3742
30-34	-1.040	0.3535	-0.818	0.4414	-0.933	0.3933
35-39	-1.527	0.2172	-1.073	0.3421	-1.336	0.2629
≥ 40	-2.636	0.0717	-2.217	0.1046	-2.470	0.0846
TMFR	-	1.2944×5 = 6.45	-	1.5682 ×5 = 7.85	-	1.4183 ×5 = 7.09

Wald's χ^2 test for the overall effect of residence = 4.12, df = 1, $p < 0.045$

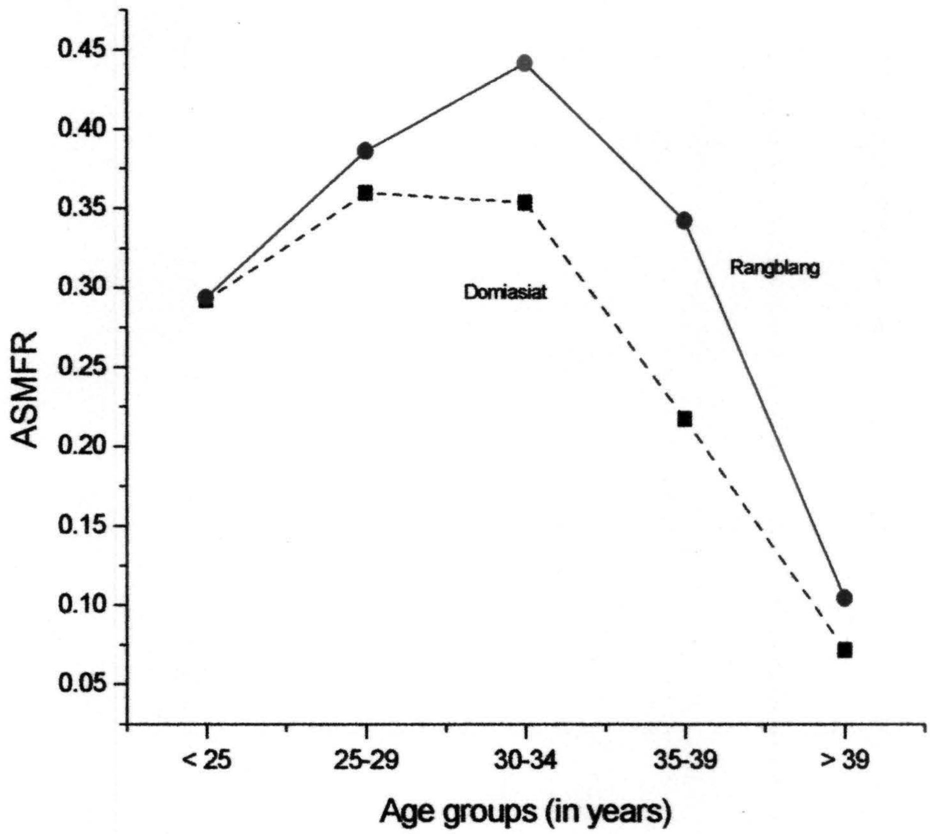
Table 4.8. Multiple range test (Bonferroni's test) for differences in the overall ASMFR (Domiasiat + Rangblang) between age groups

Age groups (years) of mothers	Bonferroni's significant level				
	≤ 24	25-29	30-34	35-39	40-44
≤ 24	-	0.068	0.032	0.267	0.001
25-29	0.210	-	0.686	0.007	0.001
30-34	0.260	0.050	-	0.003	0.001
35-39	0.143	0.353	0.403	-	0.001
40-44	1.277	1.487	1.537	1.134	-

Figures below the diagonal show the differences between two means

Wald's χ^2 test for the overall effect of age group = 79.96, df = 4, $p < 0.001$

Figure 4.3: Age-specific marital fertility rates (ASMFR)



Age Specific Fertility Rate

Table 4.7 shows the TFR is estimated by using the generalized Poisson regression model (Schoumaker, 2004). The analysis was carried out by selecting the number of live-births over three years prior to the survey as a dependent variable with a Poisson distribution and a log link function exclusive of intercept. **Table 4.7** presents the regression coefficients, age-specific-fertility rates (ASMFRs) and total marital fertility rates (TFRs) for women living in Domiasiat and Rangblang areas. The table shows that ASMFR increases up to the second age group and thereafter it decreases with the increasing age in both the areas. **Figure 4.3** depicts that ASMFR reaches its peak point when the mothers are aged 30-34 years. The TFR is 6.45 live-births per woman in Domiasiat and 7.85 live-births per woman in Rangblang. Therefore, TFR is 1.22 times higher in Rangblang relative to Domiasiat area. Adjusting for urban-rural residence, the TFR is **7.09** live-births per woman (Wald's $\chi^2 = 4.12$, df = 1, $p < 0.04$). Like in the case of live-births for women aged 45 years and above, the TFR is also significantly higher in Rangblang than in Domiasiat. Therefore, on the basis of completed family size and TFR, we may conclude that the fertility rate in Domiasiat is lower than in Rangblang.

The differences between age groups after adjusted for residence (Domiasiat coded as 1 and Rangblang coded as 2) are also shown in **Table 4.8**. It is seen from the multiple range tests (Bonferroni's test) that women in the older age group 40-44 years were statistically significant from all younger age-groups. Specifically, the ASMFR in women aged 24 years and below is statistically lower than those in the age groups 30-34 and 40-44 years. Women aged 25-29 years are statistically lower in ASMFR than those in the age group 35 years and above, whereas women in the age group 30-34 years are lower in

ASMFR than those in the age group 35 years and above. Thus, we may suggest that place of residence and age of mothers are important factors for regulating ASMFR in the present population.

Fertility and Socio-demographic characteristics

We have observed that the completed family size and total fertility rate are significantly higher in Rangblang than in Domiasiat area. In this section, we shall deal with some socioeconomic factors that may influence fertility rates. We shall take into consideration age at marriage, maternal education and household income. The effects of these factors are tested by using the analysis of variance (ANOVA) covariance (ANCOVA). The results are presented in terms of both adjusted and unadjusted means of live-births.

Age at Marriage:

Table 4.9 shows the adjusted and unadjusted means of live-births by age at marriage for both Domiasiat and Rangblang areas as well as for the total of both the areas. It is found that unadjusted mean live-births to Domiasiat women who married at the age of ≤ 19, 20-24 and > 24 years are 4.67±0.19, 3.93±0.24 and 3.52±0.35, respectively. In Rangblang, these figures are 4.92±0.13, 3.73±0.19 and 2.53±0.32, respectively. It shows that the mean number of live-births decreases with the increase in mean age at marriage as theoretically expected. Using the one-way analysis of variance (ANOVA), these differences in live-births (unadjusted) are highly significant (Domiasiat: $F = 4.80$, $df = 2, 432$, $p < 0.009$; Rangblang $F = 10.18$, $df = 2, 217$, $p < 0.001$). The higher mean live-births in mothers with lower age at marriage as compared to those with higher age at marriage are statistically significant even after adjusting for mother's age, maternal education, and household income (Domiasiat: $F = 29.55$, $p < 0.001$; Rangblang $F = 21.25$, $p < 0.001$).

The same is true for the total mean live-births of both Domiasiat and Rangblang areas ($F = 51.43$, $p < 0.001$). This indicates that age at marriage is very important in regulating fertility rate in the present population.

Table 4.9. Adjusted means of live births by age at marriage

Age at marriage (years)	Number of mothers	Mean number of live-births per married woman			
		Unadjusted		Adjusted*	
		Mean	SE	Mean	SE
Domiasiat					
< 19	276	4.67	0.19	4.92	0.13
20-24	115	3.93	0.24	3.73	0.19
≥ 25	44	3.52	0.35	2.53	0.32
F-statistics		4.80, p < 0.009		29.55, p < 0.001	
Rangblang					
< 19	130	5.23	0.29	5.26	0.17
20-24	75	4.25	0.35	4.15	0.23
≥ 25	15	1.53	0.42	1.96	0.53
F-statistics		10.18, p < 0.001		21.25, p < 0.001	
Total					
< 19	406	4.85	0.16	5.04	0.10
20-24	190	4.06	0.20	3.87	0.15
≥ 25	59	3.02	0.30	2.33	0.27
F-statistics		12.16, p < 0.001		51.43, p < 0.0001	

*Adjusted for maternal age, education and household income

Maternal Education:

Table 4.10 shows the adjusted and unadjusted means of live-births by educational level of mothers. The mothers are divided into four educational groups, that is, those who are illiterate, primary, secondary and above secondary. In Domiasiat, the unadjusted mean of live-births according to these educational levels are 4.94±0.66, 4.15±0.21, 3.82±0.21 and 3.80±0.49, respectively. In Rangblang, these figures are 5.10±0.74, 4.91±0.44, 3.95±0.27 and 3.50±0.58, respectively. These results indicate a decreasing trend in live-births with increasing educational levels of mothers. However, the ANOVA test indicates that the differences in live-births between educational groups are not statistically significant for both Domiasiat ($F = 1.42$, $df = 3, 464$, $p < 0.0001$) and Rangblang ($F = 2.13$, $df = 3, 230$, $p > 0.05$). Therefore, the ANCOVA test for adjusting other variables was not carried out. An attempt was, however, made to apply the test for linearity in order to make sure whether or not the trend is significant. It is found that the trend is not significant for Domiasiat ($F = 3.40$, $df = 1, 454$, $r = -0.085$, $p > 0.05$), but significant for Rangblang ($F = 5.81$, $df = 1, 230$, $r = -0.157$, $p < 0.02$).

Pooling the data for both Domiasiat and Rangblang, we found that the differences in live-births between educational groups of mothers were significant ($F = 3.09$, $df = 3, 698$, $p < 0.03$). Similarly, the linearity test was found to be negatively significant ($F = 8.73$, $df = 1, 698$, $r = -0.011$, $p < 0.02$). However, the differences and trend disappeared after adjusting for maternal age and household income ($F = 0.16$, $p > 0.05$).

Therefore, we may conclude that maternal education, in general, did not play a significant role in influencing fertility among both the Domiasiat and Rangblang women, especially after adjusting for maternal age and household income. However, although the differences in live-births among educational groups are not significant among the Rangblang women, it is likely that live-births decline with increasing educational levels of mothers.

Table 4.10. Adjusted means of live births by educational level of mothers

Educational level Of mothers	Number of mothers	Mean number of live-births per married woman			
		Unadjusted		Adjusted*	
		Mean	SE	Mean	SE
Domiasiat					
Illiterate	32	4.94	0.66	-	-
Primary	226	4.15	0.21	-	-
Secondary	185	3.82	0.21	-	-
Above secondary	25	3.80	0.49	-	-
F-statistics		1.42, p > 0.05		-	
F-test for linearity		3.40, p > 0.05			
Rangblang					
Illiterate	30	5.10	0.74	-	-
Primary	75	4.91	0.44	-	-
Secondary	111	3.95	0.27	-	-
Above secondary	18	3.50	0.58	-	-
F-statistics		2.13, p > 0.05		-	
F-test for linearity					
Total					
Illiterate	62	5.02	0.48	4.69	0.28
Primary	301	4.34	0.19	4.29	0.13
Secondary	296	3.87	0.17	4.52	0.12
Above secondary	43	3.67	0.37	4.82	0.32
F-statistics		3.09, p < 0.03		0.16, p > 0.05	
F-test for linearity		8.73, p < 0.02			

*Adjusted for maternal age and household income

Household Income:

Table 4.11 shows the adjusted and unadjusted means of live-births by household income groups of mothers. Mothers are grouped into three income groups based on the median of monthly per capita income of the households. It is seen from the Table that the unadjusted mean live-births among the Domiasiat mothers are 4.73±0.20, 3.45±0.22 and 3.45±0.31 in the low, middle and high income groups, respectively. Among the Rangblang mothers, these mean values are 4.66±0.16, 3.66±0.20 and 3.34±0.25, respectively. The one way ANOVA test indicates that these differences are significant for both Domiasiat ($F = 10.97$, $df = 2, 465$, $p < 0.001$) and Rangblang ($F = 8.19$, $df = 2, 231$, $p < 0.001$) mothers. Further, it is found that 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 for both Domiasiat ($F = 12.49$, $p < 0.001$) and Rangblang ($F = 8.\ 71$, $p < 0.001$) mothers. This indicates that household income is very important in regulating fertility rate among both Domiasiat and Rangblang mothers, i.e., the effects of household income on live-births is significant even after adjusting for the effects of other factors mentioned above.

Table 4.11. Adjusted means of live births by household income groups

Income group	Number of mothers	Mean number of live-births per married woman			
		Unadjusted		Adjusted*	
		Mean	SE	Mean	SE
Domiasiat					
Low	222	4.73	0.20	4.64	0.16
Middle	146	3.45	0.22	3.66	0.20
High	100	3.45	0.31	3.34	0.25
F-statistics		10.97, $p < 0.001$		12.49, $p < 0.001$	
Rangblang					
Low	119	5.21	0.34	5.00	0.22
Middle	77	3.60	0.28	3.80	0.27
High	38	3.29	0.50	3.53	0.38
F-statistics		8.19, $p < 0.001$		8.71, $p < 0.001$	
Total					
Low	341	4.89	0.18	4.77	0.13
Middle	223	3.50	0.18	3.71	0.16
High	138	3.41	0.26	3.36	0.21
F-statistics		19.32, $p < 0.0001$		21.68, $p < 0.0001$	

*Adjusted for maternal age, age at marriage and maternal education

Table 4.12. Differences in socio-economic characteristics of married women(aged<50yr)

Characteristics	**Domiasiat**		**Rangblang**		χ^2 -value
	Frequency	%	Frequency	%	
Age at marriage					
≤ 19	276	63.45	130	59.09	5.16,
20-24	115	26.44	75	34.09	$p > 0.05$
≤ 25	44	10.11	15	6.82	
Family size					
Small	109	23.29	52	22.22	0.49,
Medium	235	50.21	124	52.99	$p > 0.05$
Large	124	26.50	58	24.79	
Maternal education					
Illiterate	32	6.84	30	12.82	
Primary	226	48.29	75	32.05	19.64,
Secondary	185	39.53	111	47.44	$p < 0.001$
Above secondary	25	5.34	18	7.69	
Income group					
Low	222	47.44	119	50.85	
Middle	146	31.20	77	32.91	2.61,
High	100	21.37	38	16.24	$p > 0.05$

Domiasiat-Rangblang Differences in Socio-economic Characteristics:

Table 4.12 shows the in the distribution of married women according to socio-economic characteristics. The analysis was carried out to understand the differences in the magnitude of socio-economic factors that may bring about the differences in fertility between Domiasiat and Rangblang. It is seen from the Table that there are significant differences between Domiasiat and Rangblang only in respect of the distribution of mothers according to age groups and educational level. Otherwise, both Domiasiat and Rangblang mothers are similar with respect to age at marriage, family size and household income. On the other hand, the analyses of ANOVA and ANCOVA (shown in **Tables 4.9** to **4.11**) indicated that fertility in terms of live-births was to a great extent influenced by age at marriage and household income. Thus, it suggests that the lower fertility rates among the Domiasiat mothers compared to the Rangblang mothers were not because of age at marriage and household income. Similarly, maternal education does not seem to be very important factor, because of the lack of significant difference in live-births according to educational levels of mothers, although there was evidence for declining fertility rates with increasing educational levels among the Rangblang mothers. In other words, the declining trend of fertility with increasing educational levels among the Rangblang mothers does not seem to be important among the Domiasiat mothers, because the fertility rate is higher among the former than in the latter. Therefore, it is likely that other factors, which were not considered in the present study, are important in bringing about the differences in fertility between Domiasiat and Rangblang mothers. Whether or not it was because of other environmental factors like uranium ore deposits is altogether beyond the scope of the present study. We hope future studies will shed more light on what we pointed out here.

DIFFERENTIAL MORTALITY

Reproductive Wastage

The prevalence of reproductive wastage among the Domiasiat and Rangblang mothers of the present study is given in **Table 4.13**. It is found that the still birth rate (i.e., number of still births per 100 live-births) is 1.85 % in Domiasiat and 0.88% in Rangblang, whereas the miscarriage rate (i.e., number of miscarriages per 100 pregnancies) are 5.73% and 7.11%, respectively. Thus, the rate of reproductive wastage (i.e., number of miscarriages and still births per 100 pregnancies) is 7.58% in Domiasiat and 7.92% in Rangblang areas. It may be noted here that still-birth rate is also expressed as per 100 live-births and miscarriage (abortion) rate as per 100 women (Poston and Bouvier, 2010). In the present study, we expressed as 100 pregnancies or conceptions to make our data comparable with the earlier reports in other populations.

Using the chi-square test, it is found that the differences between Domiasiat and Rangblang are significant in respect of still-births ($\chi^2 = 5.30$, df = 1, $p < 0.02$), but not in respect of abortion ($\chi^2 = 2.35$, df = 1, p=0.13) and total reproductive wastage ($\chi^2 = 0.12$, df =1, p=0.73). Nevertheless, it indicates that the still-birth rate is significantly higher among the Domiasiat mothers than among the Rangblang mothers. We shall carry out further analysis in the next section.

Table 4.13. Reproductive wastage

Parameters	Domiasiat	Rangblang
Total number of mothers	468	234
Total number of pregnancies	2058	1111
Total number of miscarriages	118	79
Total number of still-births	38	9
Miscarriage rate (%)	5.73	7.11
Still birth rate (%)	1.85	0.81
Rate of reproductive wastage (%) i.e. abortions and still births	7.58	7.92
χ^2 calculation for: Reproductive wastage: $\chi^2 = 0.12$, df =1, $p > 0.05$ Miscarriage (abortion): $\chi^2 = 2.35$, df = 1, $p > 0.05$ Still birth: $\chi^2 = 5.30$, df = 1, $p < 0.02$		

Table 4.14. Infant, child and juvenile mortality

Parameters	Domiasiat	Rangblang
No of Mothers	468	234
No of live births	1897	1022
No of Infant deaths (< 1 year of life)	117	66
No of children deaths(1-4 years of life)	40	28
Juvenile deaths (5- 14 years of life)	25	18
Infant Mortality rate (%)	6.17	6.46
Child Mortality rate (%)	2.11	2.74
Juvenile Mortality rate (%)	1.32	1.76
Infant: $\chi^2 = 0.10$, df = 1, $p > 0.05$ Child: $\chi^2 = 0.19$, df = 1, $p > 0.05$ Juvenile: $\chi^2 = 0.90$, df = 1, $p > 0.05$		

Infant, child and juvenile mortality

Table 4.14 shows the infant, child and juvenile mortality rates among the Domiasiat and Rangblang as reported by the ever-married women aged 15-49 years. The infant mortality rates (i.e. number of deaths before 1 year of life per 100 live births) are 6.17% and 6.46%

in Domiasiat and Rangblang, respectively, whereas the child mortality rates are 2.11% and 2.74%, respectively. The differences between Domiasiat and Rangblang are not statistically significant for both infant mortality ($\chi^2 = 0.10$, df = 1, $p < 0.05$) and child mortality ($\chi^2 = 0.19$, df = 1, $p > 0.05$). Similarly, the juvenile mortality rate (per 100 live-births) is more or less similar in both Rangblang (1.32%) and Domiasiat area (1.76%) areas. Therefore, it is obvious that the infant, child and juvenile mortality rates are similar in both the areas.

Mortality and Socio-demographic Variables

In this section, we deal with the relationship between socio-demographic variables and types of mortality. The results presented in **Tables 4.13** and **4.14** indicated that the differences between Domiasiat and Rangblang were significant only in the case of stillbirths. Therefore, it suggests that both the areas are similar in mortality rates, except in respect of still-births. Two questions are arising out of these results: First, what are the socio-demographic factors that influence the different types of mortality in both Domiasiat and Rangblang areas? Second, what are the factors that could have brought about the differences between Domiasiat and Rangblang? These questions are also related to one of the objectives of the present study. In order to address these questions, we shall carry out simple regression analyses.

Table 4.15: Correlation coefficient (r) between socio-demographic variables and types of mortality.

Variables	Abortion	Still-birth	Reproductive wastage	Infant mortality	Child mortality
Maternal age	0.190*	0.050	0.192*	0.156*	0.193*
Maternal education	-0.080*	-0.023	-0.082*	-0.119*	-0.092*
Family size	0.044	-0.008	0.036	0.063	0.012
Household income	-0.027	0.013	-0.019	-0.082*	-0.032

*Significant at 5% level

Table 4.16. Coefficient of regression on the relationship between socio-demographic variables and types of mortality.

Parameters	Coefficient of regression (b) and its standard error (SE)		t-value	P-level
	b	SE		
Abortion				
Maternal age	0.080	0.017	4.85	**0.001**
Maternal education	0.051	0.038	1.35	0.178
Reproductive wastage				
Maternal age	0.090	0.018	4.89	**0.001**
Maternal education	-0.059	0.042	1.41	0.160
Infant mortality				
Maternal age	0.050	0.013	3.72	**0.001**
Household income	-0.048	0.029	1.64	0.102
Maternal education	-0.069	0.031	2.23	**0.026**
Child mortality				
Maternal age	0.036	0.007	4.87	**0.001**
Maternal education	-0.028	0.017	1.69	**0.092**

Table 4.15 shows the correlation between socio-demographic variables and types of mortality considered in the present study. It is seen that abortion, total reproductive wastage and child mortality are significantly correlated with maternal age and education.

Infant mortality is significantly correlated not only with maternal age and education, but also with household income. On the other hand, still-birth was not correlated with any of the socio-demographic variables included in the present study. On the basis of the results shown in **Table 4.15**, we may suggest that the differences in still-births between Domiasiat and Rangblang areas are not because of socio-demographic variables considered in the present study. Instead, it is likely that other factors are playing a very important role in bringing about the differences between Domiasiat and Rangblang areas with respect to the prevalence of still-births.

Table 4.16 shows the results of regression analysis on the relationship between socio-demographic variables and types of mortality. The regression analysis was carried out in view of the findings shown in **Table 4.15**. For example, in the case of abortion, we included only maternal age and education in the regression model, because it was only these two variables that were correlated with abortion. The rationale for such analysis is to understand the relative importance of maternal age and education in regulating abortion rate. It is seen from **Table 4.16** that the effect of maternal education was not significant, whereas the effect of maternal age was significant. Thus, we may suggest that the effect of maternal age is more important than education in regulating the abortion rate in both Domiasiat and Rangblang areas. The same is true with respect to reproductive wastage (i.e., the total of both abortions and still-births) and child mortality. With respect to infant mortality, **Table 4.15** shows that there was significant correlation with maternal age, education and household income. When these three variables are included in the regression model (**Table 4.16**), it is found that the effect of household income is less important compared to maternal age and education. It may also be mentioned here that the effects of maternal age and education on infant mortality are significant even when only both of them were included in the model (not shown in the Table). Thus, we may suggest that infant mortality is more associated with maternal age and education compared to household income.

CHAPTER V

GROWTH AND NUTRITIONAL STATUS

In this chapter we shall describe the growth pattern of Domiasiat and Rangblang children with respect to body weight, height, sitting height, hip circumference, waist circumference and mid upper arm circumference (MUAC). We shall also describe the nutritional status of these children using anthropometric indices such as weight-for-age, height-for-age and weight-for-height.

Sample Size

Table 5.1. Sample size for all anthropometric measurements taken in the present study

Age (yrs)	Domiasiat		Rangblang	
	Boys	Girls	Boys	Girls
2	38	41	20	24
3	33	37	26	21
4	35	33	28	22
5	42	25	20	22
6	40	31	38	30

Table 5.1 shows the sample size for each sex and age group from 2 to 6 years of age. The sample size is equal for all the anthropometric measurements taken in the present study. Although the sample size is small for growth analysis, the findings of the present study are supposed to reflect to certain extent the growth and nutritional status of

the Khasi population in Domiasiat and Rangblang areas, which can be tested and/or refuted by future studies with large sample size.

Table 5.2. Statistical constants of weight (kg) for boys and girls

Age (yrs)	Boys			Girls			t-value
	Mean	SD	Increment	Mean	SD	Increment	
Domiasiat							
2	10.46	1.65	-	10.39	2.21	-	0.16
3	12.70	2.01	2.24	12.11	2.48	1.72	1.08
4	14.17	1.49	1.48	13.62	2.00	1.51	1.30
5	15.13	2.21	0.96	15.52	3.22	1.90	0.59
6	17.40	3.60	2.27	16.81	2.78	1.29	0.76
Rangblang							
2	10.58	1.47	-	10.83	1.38	-	0.59
3	12.35	2.39	1.77	11.55	1.66	0.71	1.30
4	13.55	2.11	1.21	13.87	1.29	2.33	0.62
5	15.45	1.87	1.90	15.32	1.93	1.45	0.22
6	16.71	1.68	1.26	15.78	1.57	0.47	2.33*
Total							
2	10.50	1.58	-	10.55	1.95	-	0.16
3	12.54	2.18	2.04	11.91	2.22	1.35	1.57
4	13.90	1.81	1.36	13.72	1.75	1.82	0.54
5	15.23	2.10	1.34	15.43	2.67	1.70	0.42
6	17.06	2.83	1.83	16.30	2.31	0.88	1.70

*$p < 0.05$

Weight

Table 5.2 shows the means and standard deviations of the body weight of boys and girls by age groups and areas of study. In Domiasiat area, boys are heavier than girls across age groups, except at age 5. The differences are, however, not statistically significant. The same is true for Rangblang area. This clearly indicates that sex difference is not the major concern for the body weight of children in both the areas.

The mean values are graphically compared with the WHO growth references (WHO, 2006) as shown in **Figures 5.1A** and **5.1B** for boys and girls, respectively. It is seen that both Domiasiat and Rangblang boys are by and large above the 5th percentile of the WHO growth reference. However, Domiasiat boys are heavier than Rangblang boys especially from about 2.5 to 4.5 years of age. On the other hand, the body weight of both Domiasiat and Rangblang girls is above the 10th percentile of the WHO reference **(Figure 5.1B)**. However, the curve for Rangblang girls is below the 10th percentile after 5 years of age. They are also lighter than Domiasiat girls from about 2.5 to 3.5 years of age.

Figure 5.1A. Body weight of Domiasiat and Rangblang boys compared with WHO References

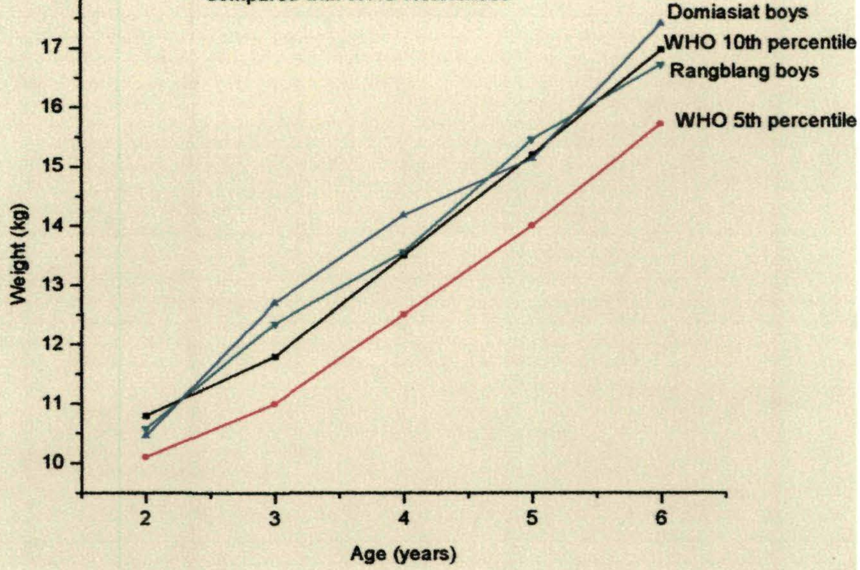


Figure 5.1B. Body weight of Domiasiat and Rangblang girls compared with WHO References

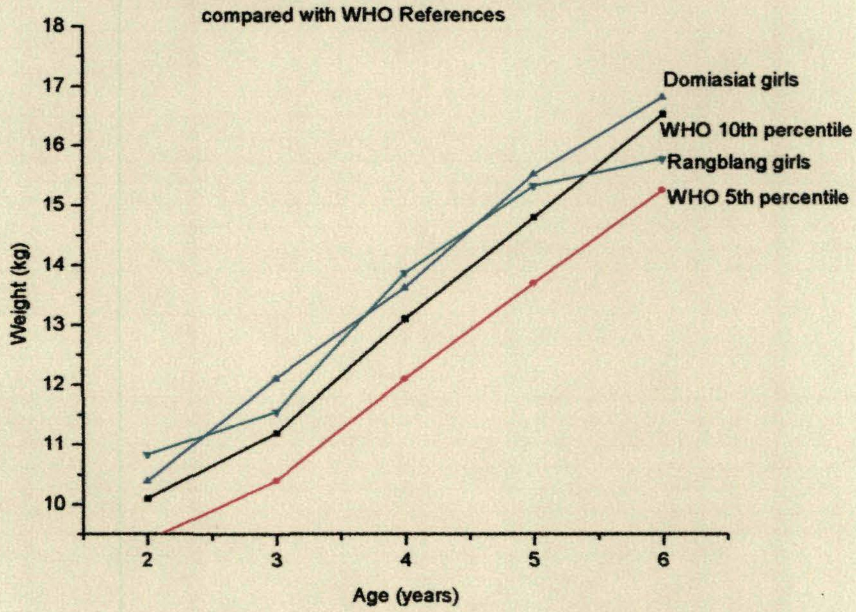


Figure 5.2A. Velocity curves for body weight of Domiasiat and Rangblang boys

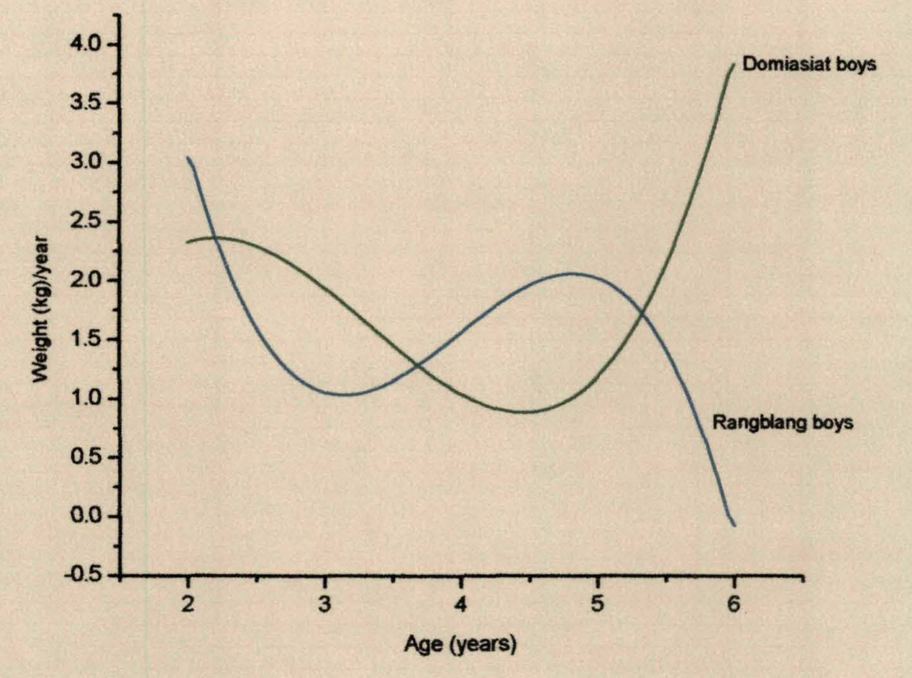
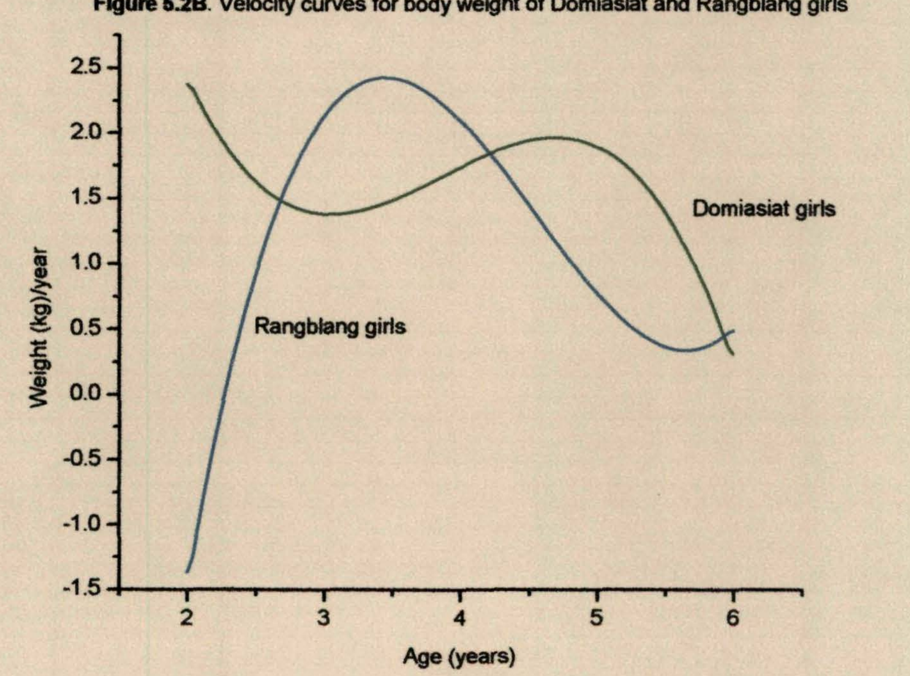


Figure 5.2B. Velocity curves for body weight of Domiasiat and Rangblang girls



The annual increment or growth rate in body weight is plotted against age in **Figures 5.2A** and **5.2B** for boys and girls, respectively. The curves were fitted by differentiating the first derivatives of the fourth degree polynomial curve, i.e., the distance curve fitted according to the following polynomial model:

$y = a + b_1(age) + b_2(age)^2 + b_3(age)^3 + b_4(age)^4$, where,

a is the constant and b stands for the coefficient of regression.

The plots show the differences in growth rates only between the two areas of study, because there were no sex differences with respect to body weight. It is seen that the velocity is highly fluctuating in both the sexes. In the case of boys **(Figure 5.2A)**, the growth rate declines from 2 to 3 years for Rangblang boys and 2 to about 5 years for Domiasiat boys. The velocity curve tends to be U-shaped in the case of Domiasiat boys, indicating the absence of a peak in growth rate between 2 and 6 years of age. However, it is likely to form a peak after or at 6 years of age. Rangblang boys, on the other hand, are much lower in growth rate than Domiasiat boys from 5 years onward, although they have higher growth rates from 3.5 to 5 years of age. Indeed, the deceleration rates from 2 to 5 years of age are lower in Rangblang than in Domiasiat boys. It is theoretically expected that the growth rates should decrease from birth to 3 or 4 years of life, especially when nutritional intakes are inadequate (Cameron, 2002). Considering the velocity curves in **Figure 5.2A**, it is obvious that the magnitude of decline in growth is greater in Domiasiat boys compared with Rangblang boys. Perhaps, the spurt from 5 to 6 years of age has certain implications for the catch-up growth among Domiasiat boys. **Table 5.2** shows that the catch-up growth (2.27 kg) between 5 and 6 years among Domiasiat boys accounts about 33% of the total gain (6.94 kg) from 2 to 6 years of age. As for Rangblang boys, the deceleration rate in body weight seems to be greater after 5 years of age, i.e., about 2 kg (see **Figure 5.2A**).

Figure 5.2B depicts the fitted velocity curves for girls of both the study areas. Unlike the case of boys, Rangblang girls showed a maximum of gain from 2 to 3.5 years of age. Thereafter, the velocity curve tends to decline up to about 5.5 years of age, thereby forming a bell-shaped curve. Among Domiasiat girls, there was a decline in growth rate from 2 to about 3.5 years, and thereafter, the velocity increases with a peak at 5 years. It is further seen that the growth rate declines at greater rate than their Rangblang counterparts after 5 years of age.

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

Age (yrs)	Boys			Girls			t-value
	Mean	SD	Increment	Mean	SD	Increment	
Domiasiat							
2	81.76	4.76	-	81.39	6.81	-	0.28
3	87.25	6.96	5.49	85.06	10.98	3.68	0.98
4	94.65	6.71	7.40	93.61	8.93	8.54	0.55
5	97.15	8.66	2.50	95.40	7.39	1.80	0.84
6	105.90	8.48	8.75	104.68	9.22	9.28	0.58
Rangblang							
2	79.29	3.86	-	79.60	5.38	-	0.21
3	85.42	5.26	6.13	84.43	5.30	4.84	0.63
4	91.58	6.35	6.17	90.96	6.01	6.53	0.35
5	96.80	7.17	5.21	97.07	8.28	6.10	0.11
6	103.54	6.43	6.75	100.78	5.63	3.71	1.85
Total							
2	80.91	4.59	-	80.72	6.34	-	0.18
3	86.44	6.28	4.84	84.84	9.28	4.11	1.10
4	93.29	6.68	6.53	92.55	7.94	7.71	0.55
5	97.04	8.15	6.10	96.18	7.78	3.63	0.55
6	104.75	7.60	3.71	102.76	7.86	6.58	1.51

Height

Table 5.3 shows the means and standard deviations of height for both boys and girls from 2 to 10 years of age. As expected, height increases with the increase in age for both boys and girls. It is observed that boys are taller than girls at many age groups, except at 5 years when Rangblang girls are slightly taller than their male counterparts. However, the differences between boys and girls in height are found to be statistically insignificant across age groups. Thus, according to the present findings, there are no statistical differences between boys and girls with respect to height, although it does look as boys were taller than girls at many age groups.

Figure 5.3A shows that the distance curves for the height of boys. It shows that Domiasiat boys are taller than Rangblang boys across age groups. They are also above the 5^{th} percentile of the WHO growth reference from 2 to about 4.5 years of age. Thereafter, they are below the 5^{th} percentile up to below 6 years of age. Rangblang boys are below the 5^{th} percentile of the WHO growth reference across ages.

Figure 5.3A. Height of Domiasiat and Rangblang boys compared with WHO references

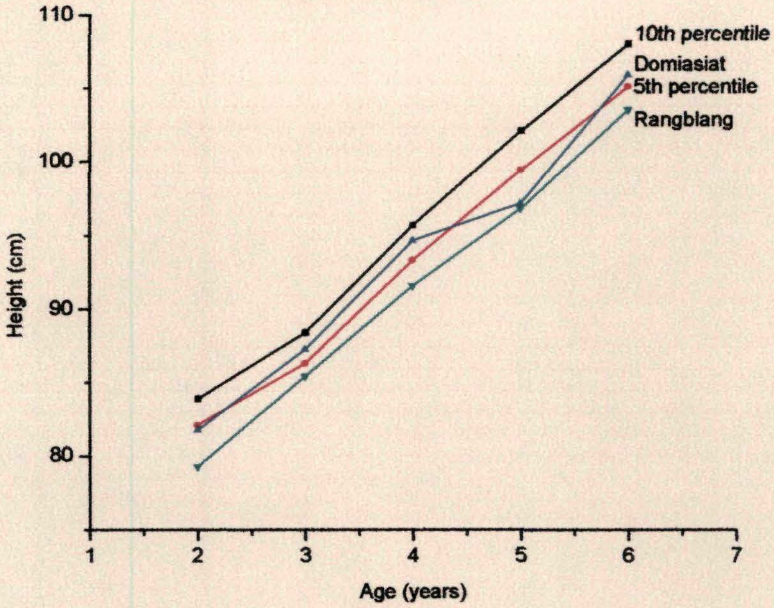


Figure 5.3B. Height of Domiasiat and Rangblang girls compared with WHO references

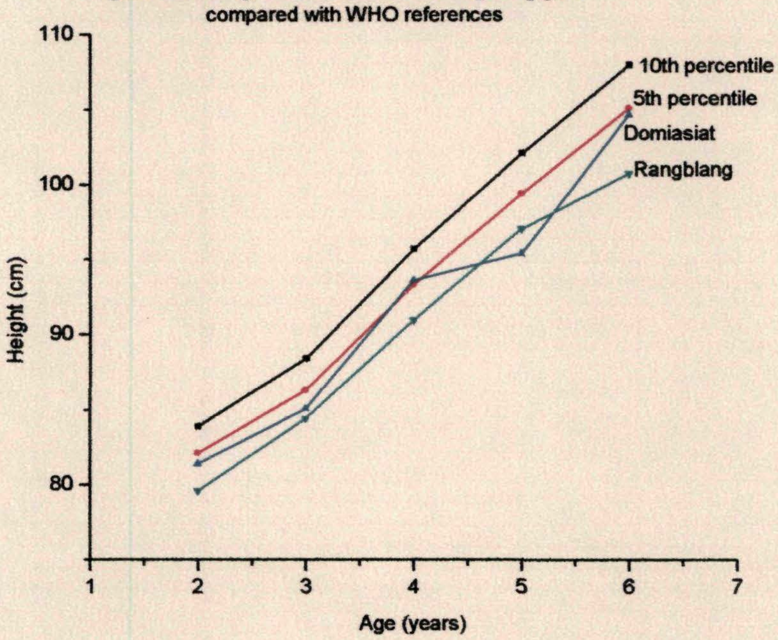


Figure 5.3B shows that the distance curves for the height of girls. Unlike the case of boys, both Domiasiat and Rangblang girls are by and large below the 5th percentile of the WHO growth reference. Domiasiat girls are similar to the 5th percentile of the WHO reference from 3.5 to about 4 years, and they are shorter than Rangblang girls from 4 to 4.5 to about 5.5 years of age. The point to be noted here is that the prevalence of stunting is high when the growth curve is below the 5th percentile of the growth reference.

Figure 5.4A shows the velocity curves for height of Domiasiat and Rangblang boys fitted according to the fourth order polynomial model as described in the case of weight. It can be observed that the growth rate is more stable in Rangblang boys compared with Domiasiat boys. In other words, the growth rate is more fluctuating in Domiasiat boys than in Rangblang boys. The growth rate is higher in Domiasiat boys from 2.5 to about 4 years of age, and thereafter it is greater in Rangblang boys up to about 5.5 years of age when the former surpassed the latter.

Figure 5.4B shows that girls are similar to boys in the pattern of growth rate. The growth rate is more fluctuating in Domiasiat girls than in Rangblang girls. The fitted curves for Domiasiat girls depicted a negative growth before 2.5 years of life. It is only from 2.5 to below 4 years that the growth rate is greater in Domiasiat girls. Domiasiat girls are also greater in growth rate from 5.5 years onward. With respect to Rangblang girls, the fitted curve depicted a steady decline in growth rate from 4 to 6 years of age. It may be mentioned that the maximum increase in height (**Table 5.3**) occurs between 5 and 6 years for boys (Domiasiat = 8.55 cm; Rangblang = 6.75 cm) and 3 and 4 years for girls (Domiasiat = 8.54 cm; Rangblang = 6.53 cm). The total gain in height from 2 to 6 years of age is greater in Domiasiat girls than in Rangblang girls (Domiasiat = 23.29 cm; Rangblang = 21.18 cm). However, boys are similar in total gain (Domiasiat = 24.14 cm; Rangblang = 24.15 cm).

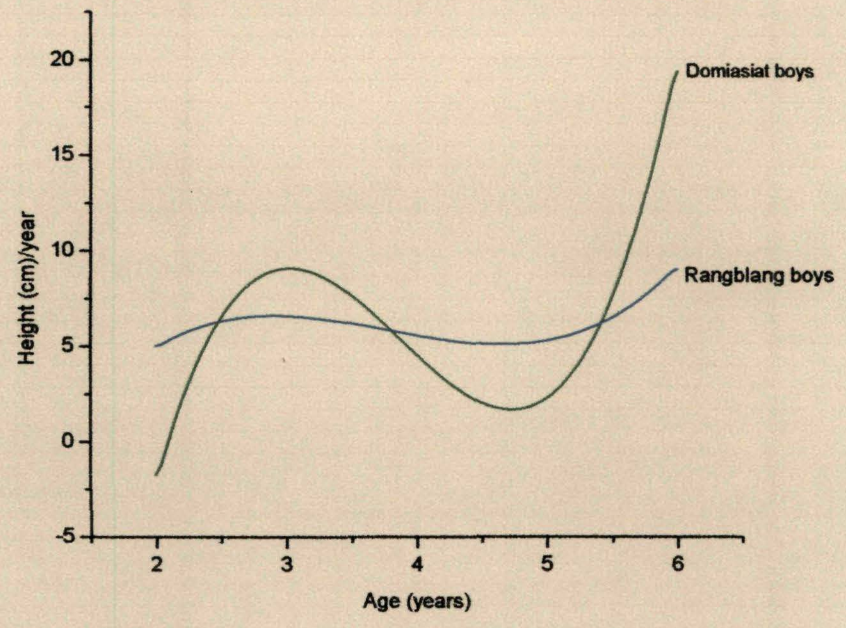


Figure 5.4A. Velocity curves for height of Domiasiat and Rangblang boys

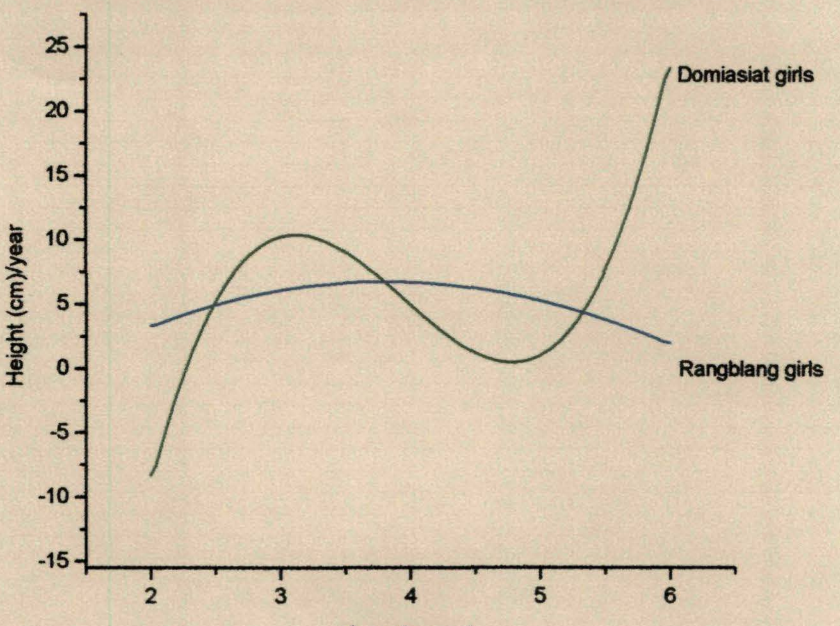


Figure 5.4B. Velocity curves for height of Domiasiat and Rangblang girls

Table 5.4. Statistical constants of sitting height (cm) for boys and girls

Age (yrs)	Boys			Girls			t-value
	Mean	SD	Increment	Mean	SD	Increment	
Domiasiat							
2	47.95	3.83	-	46.16	2.80	-	2.38*
3	50.22	3.46	2.27	49.33	4.63	3.17	0.90
4	52.69	4.08	2.47	53.04	3.95	3.71	0.35
5	54.10	4.00	1.41	54.64	3.97	1.60	0.54
6	56.88	4.27	2.78	56.13	3.81	1.48	0.77
Rangblang							
2	47.20	2.19	-	47.24	3.11	-	0.05
3	49.18	3.87	1.98	48.40	2.95	1.16	0.76
4	52.25	3.95	3.07	52.02	2.28	3.62	0.24
5	54.88	2.90	2.63	54.72	2.88	2.70	0.18
6	58.16	5.03	3.28	55.43	3.70	0.71	2.49*
Total							
2	47.69	3.35	-	46.56	2.94	-	1.99*
3	49.76	3.65	2.07	48.99	4.10	2.44	1.07
4	52.49	4.00	2.73	52.63	3.40	3.64	0.20
5	54.35	3.67	1.86	54.68	3.47	2.05	0.48
6	57.50	4.67	3.15	55.79	3.74	1.10	2.33*

*$p < 0.05$

Sitting height

Table 5.4 shows the means and standard deviations of sitting height for boys and girls of both the study areas from 2 to 6 years of age. There is a gradual increase in sitting height with the increase in age. Boys are significantly higher in sitting height than girls at ages 3 and 6. These sex differences at 3 and 6 years of age are accounted for by the significant differences in Domiasiat and Rangblang, respectively. **Figure 5.5A** shows that Domiasiat boys are greater in sitting than Rangblang boys from 2 to about 4.5 years of age, and thereafter they are surpassed by Rangblang boys. In the case of girls, the situation is different **(Figure 5.5B)**. It is found that Domiasiat girls have a greater trunk length than their Rangblang counterparts from 2.5 to 5 years of age. In other words, Rangblang girls are greater in sitting height from 2 to 2.5 years and 5 to 6 years of age.

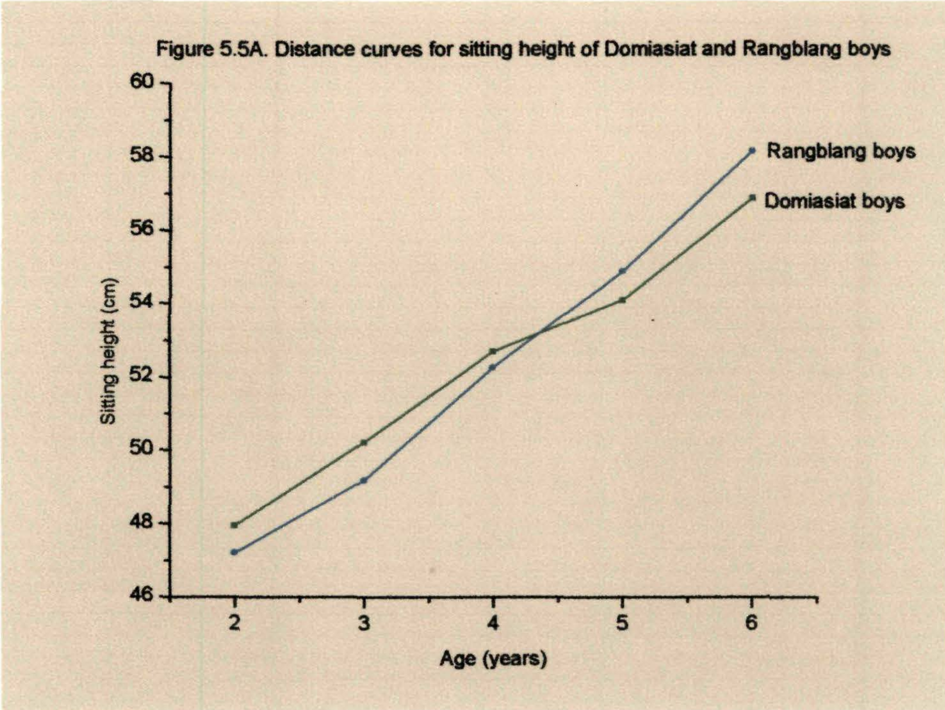


Figure 5.5A. Distance curves for sitting height of Domiasiat and Rangblang boys
60
58
56
54
52
50
48
46
Sitting height (cm)
Rangblang boys
Domiasiat boys
2
3
4
5
6
Age (years)

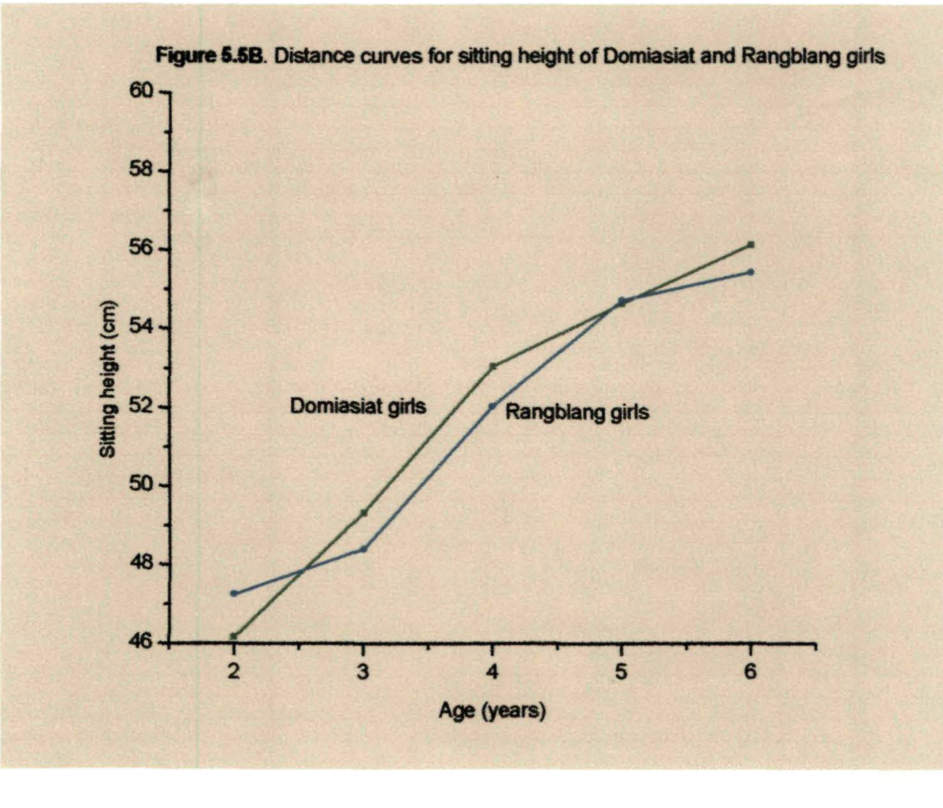


Figure 5.5B. Distance curves for sitting height of Domiasiat and Rangblang girls
60
58
56
54
52
50
48
46
Sitting height (cm)
Domiasiat girls
Rangblang girls
2
3
4
5
6
Age (years)

Figure 5.6A. Velocity curves for sitting height of Domiasiat and Rangblang boys

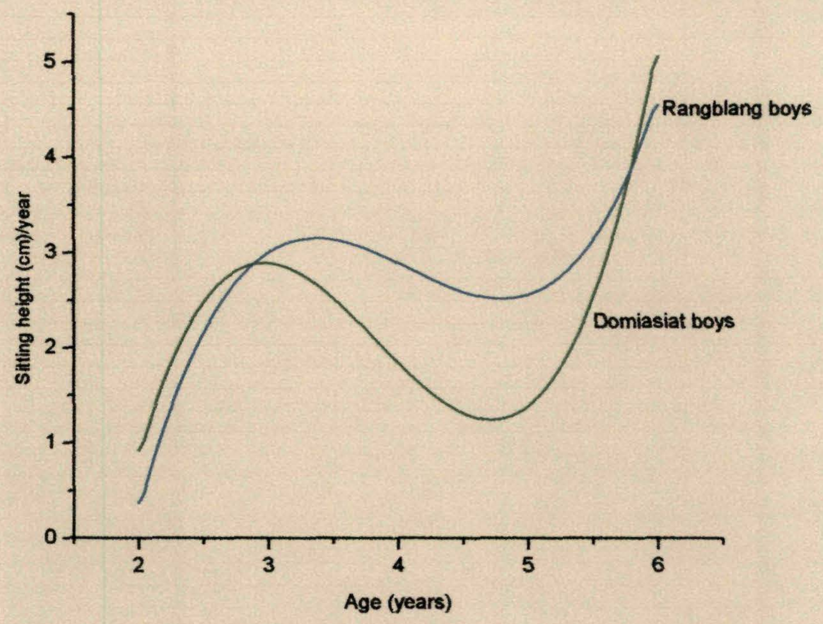
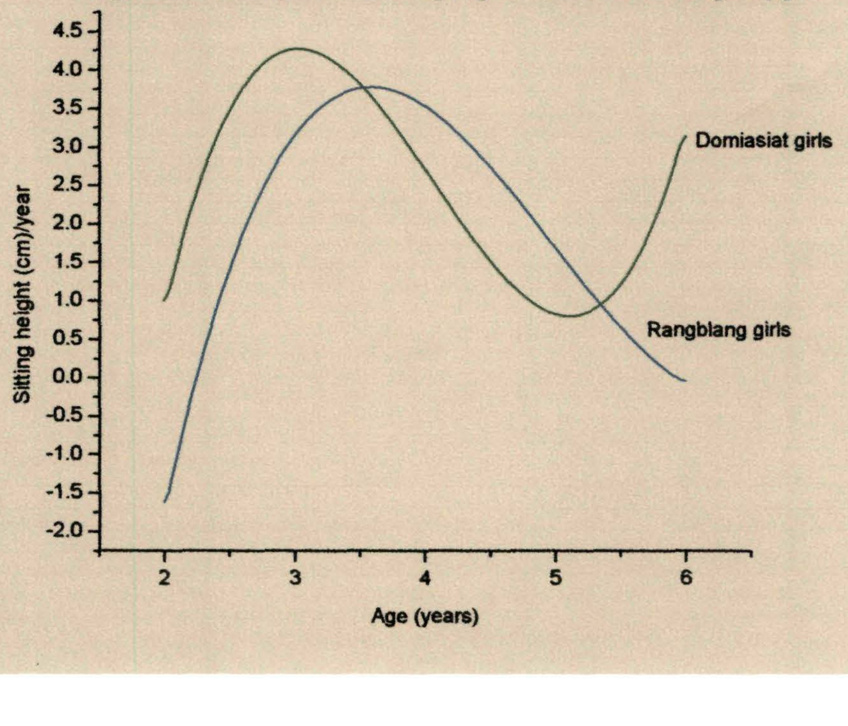


Figure 5.6B. Velocity curves for sitting height of Domiasiat and Rangblang girls



The velocity curve (**Figure 5.6A**) shows the growth rates of sitting height for Domiasiat and Rangblang boys. It is observed that Domiasiat boys are slightly greater in growth rate of sitting height before 3 years of age, and thereafter both the groups experienced a decline in growth rate up to about 5 years of life. The rate of decline seems to be greater in Domiasiat boys than in Rangblang boys. It is only after 5 years of age that both the groups showed an increase in growth rate, and the increased growth rate was greater in Rangblang boys till about 5.8 years of life. Thus, it suggests that growth rate in sitting height is by and large better in Rangblang boys than in Domiasiat boys.

As for girls, the fitted curve for sitting height **(Figure 5.6B)** suggests a negative growth rate in Rangblang girls before 2.5 years of life. In comparison with Domiasiat girls, Rangblang girls are also lower in growth rate from 2.5 to 3.5 years, although the peak of growth rate occurred at about 3.5 years of age. On the other hand, Domiasiat girls reached their peak of growth rate at about 3 years of age. **Figure 5.6B** further shows that both the groups experienced a deceleration in growth rate from 3.5 to about 5.5 years of age. The deceleration rate seems to be greater in Domiasiat girls than Rangblang girls during the above period. It is only after 5.5 years of life that Domiasiat girls surpassed their Rangblang counterparts in terms of growth rate. However, Rangblang girls continued to decelerate even after 5.5 years of age. Therefore, the velocity curves suggested that Domiasiat girls are better in growth rate before 3 and after 5.5 years of age than Rangblang girls. However, the deceleration rate from 3.5 to 5 years of age is greater in Domiasiat than Rangblang girls, although the latter continued to decelerate up to 6 years of age.

Waist Circumference

Table 5.5 shows the means and standard deviations of waist circumference for boys and girls of both the study areas. In Domiasiat area, boys are greater than girls in waist circumference across ages. The situation is different in Rangblang area where girls have broader waist than their male counterparts across age groups. Therefore, the greater waist circumference for girls of the pooled data is mainly accounted for by the Rangblang pattern of growth. It may, however, be noted that these differences between the sexes are not significant across age groups and areas of study.

Figures 5.7A and **5.7B** show the graphical comparison between the two areas of study for both boys and girls, respectively. It is seen from **Figure 5.7A** that Domiasiat boys are greater in waist circumference than Rangblang boys from 2 to about 4 years of age, and thereafter the former are surpassed by the latter. Overall, the pattern of growth in boys seems to be more stable in Domiasiat than in Rangblang area. This can also be observed from the growth pattern of girls. **Figure 5.7B** shows that Domiasiat girls have greater waist circumference than Rangblang girls almost across ages. We shall look into this aspect in terms of growth rates.

Figure 5.8A shows the fitted velocity curve for the waist circumference of boys. As expected on the basis of distance curve, the growth rate in Domiasiat boys is more stable compared to that of Rangblang boys. It is seen that Rangblang boys experienced two times of deceleration – one from 2 to 3 years of age, and the other from 4.5 to 6 years of age. On the other hand, Domiasiat boys have by and large a steady growth rate from 2 to 5 years of age, and thereafter they experience an acceleration growth rate. Therefore, we may conclude that the growth rate in waist circumference among Domiasiat boys is better than that among Rangblang boys. With respect to girls, the velocity curve for the waist circumference is given in **Figure 5.8B**. It is seen that the curve is by and large U-shaped for Domiasiat girls, and bell-shaped for Rangblang girls, i.e., in the opposite direction. Domiasiat girls experienced a deceleration rate from 2 to about 4 years, and thereafter they experienced an acceleration rate of growth pattern. On the other hand, Rangblang girls had a gradual increase in growth rate from 2 to 4 years, and thereafter they experienced a deceleration rate. Therefore, it suggests a fluctuating pattern of growth spurt in both the study areas. From the nutritional point of view, one may suggest that Domiasiat girls might have experienced a nutritional deprivation from 2 to 4 years of age, whereas Rangblang girls had a similar experience after 4 years of age.

Table 5.5. Statistical constants of waist circumference (cm) for boys and girls

Age (yrs)	Boys			Girls			t-value
	Mean	SD	Increment	Mean	SD	Increment	
Domiasiat							
2	50.07	3.43	-	48.43	5.99	-	1.48
3	51.24	3.82	50.07	50.88	4.58	2.44	0.35
4	52.21	2.68	51.24	51.34	4.49	0.46	0.98
5	52.60	3.45	52.21	52.08	4.63	0.73	0.53
6	54.13	4.21	52.60	55.16	5.41	3.08	0.90
Rangblang							
2	49.66	3.58	-	50.28	4.31	-	0.51
3	50.28	3.78	0.62	51.26	3.21	0.98	0.94
4	50.76	6.28	0.48	53.05	3.29	1.79	1.54
5	53.85	3.38	3.09	54.94	2.75	1.89	1.15
6	53.86	3.08	0.01	54.36	2.35	-0.58	0.74
Total							
2	49.93	3.45	-	49.12	5.47	-	0.98
3	50.82	3.80	49.93	51.02	4.11	1.90	0.27
4	51.57	4.65	50.82	52.03	4.11	1.01	0.56
5	53.00	3.45	51.57	53.42	4.09	1.39	0.57
6	54.00	3.68	53.00	54.77	4.18	1.35	1.15

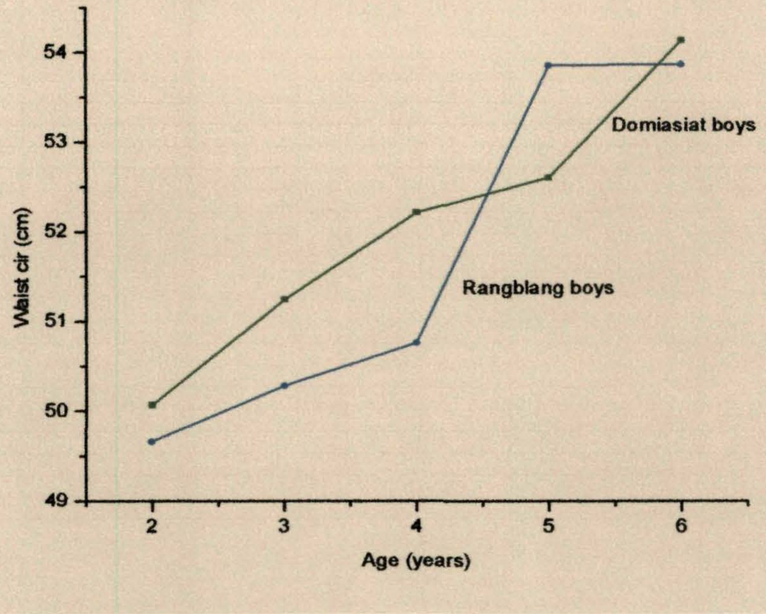


Figure 5.7A. Distance curves for waist circumference of Domiasiat and Rangblang boys

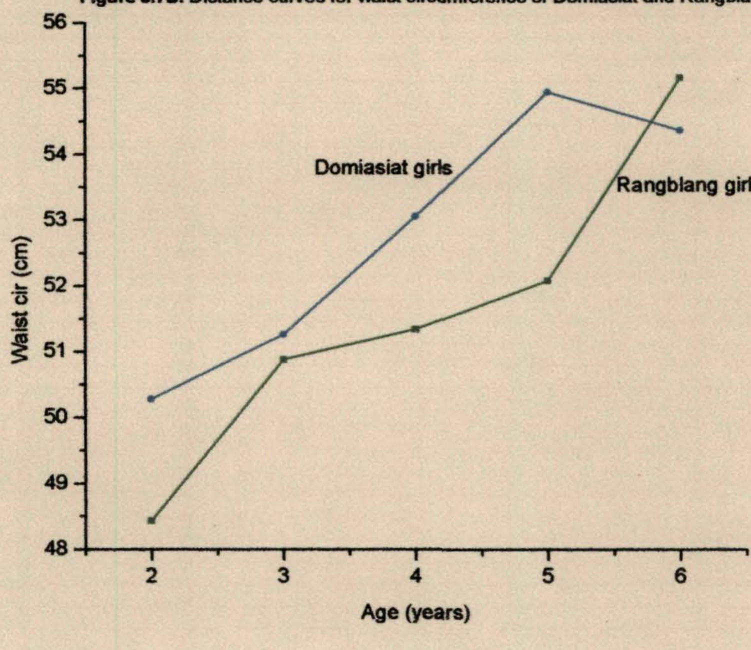


Figure 5.7B. Distance curves for waist circumference of Domiasiat and Rangblang girls

Figure 5.8A. Velocity curves for waist circumference of Domiasiat and Rangblang boys

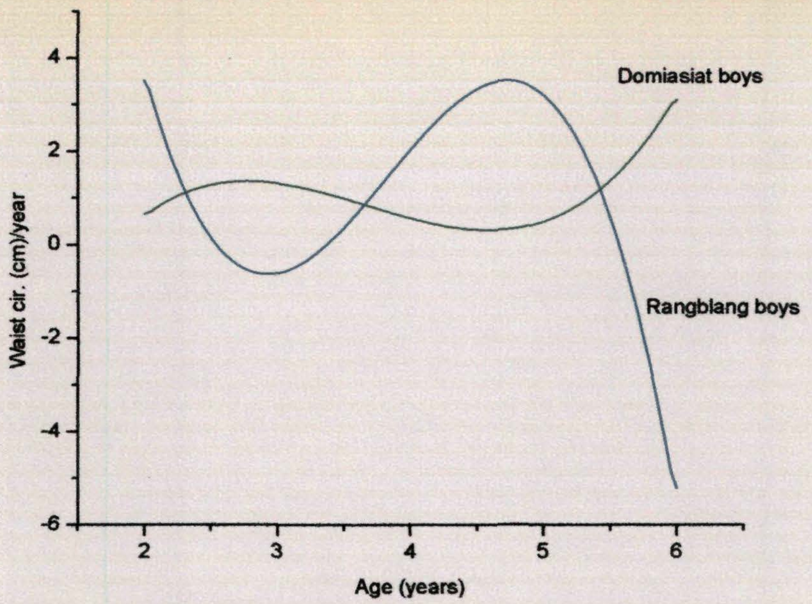


Figure 5.8B. Velocity curves for waist circumference of Domiasiat and Rangblang girls

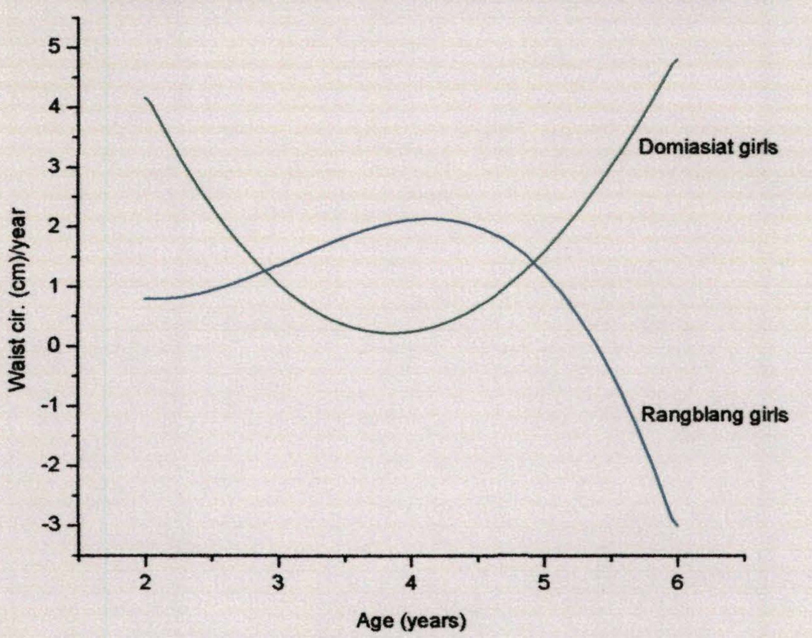


Table 5.6. Statistical constants of mid upper arm circumference (cm) for boys and girls

Age (yrs)	Boys			Girls			t-value
	Mean	SD	Increment	Mean	SD	Increment	
Domiasiat							
2	14.58	1.21	-	13.99	1.74	-	1.75
3	15.02	1.34	0.44	14.73	1.52	0.74	0.85
4	15.13	1.12	0.10	15.24	1.08	0.51	0.43
5	15.38	1.21	0.26	15.32	1.27	0.08	0.22
6	15.79	1.51	0.41	15.55	1.47	0.23	0.68
Rangblang							
2	14.79	1.31	-	14.39	0.97	-	0.38
3	14.83	1.26	0.05	14.60	1.26	0.21	0.63
4	15.01	1.43	0.18	15.10	1.04	0.50	0.24
5	15.23	1.38	0.22	15.18	1.14	0.08	0.14
6	15.59	1.28	0.36	15.29	1.14	0.11	1.02
Total							
2	14.65	1.24	-	14.14	1.51	-	2.05*
3	14.94	1.30	0.29	14.68	1.42	0.55	1.02
4	15.07	1.26	0.13	15.18	1.06	0.50	0.50
5	15.33	1.25	0.26	15.25	1.20	0.07	0.35
6	15.69	1.40	0.36	15.42	1.31	0.17	1.17

Mid Upper Arm Circumference

Table 5.6 shows the mean and standard deviation of the mid upper arm circumference for boys and girls of both Rangblang and Domiasiat areas. It is seen that, in both Domiasiat and Rangblang areas, boys have greater mid upper arm circumference than girls in all age groups, except at 4 years of age when the former was lower than the latter. However, the t-test indicates that the differences are not statistically significant across ages, except in the case pooled data at age 2. Nevertheless, the sex differences in respect of mid upper arm circumference seem to be insignificant like in the case of other anthropometric measurements.

Figure 5.9A. Distance curves for mid upper arm circumference (MUAC) of Domiasiat and Rangblang boys

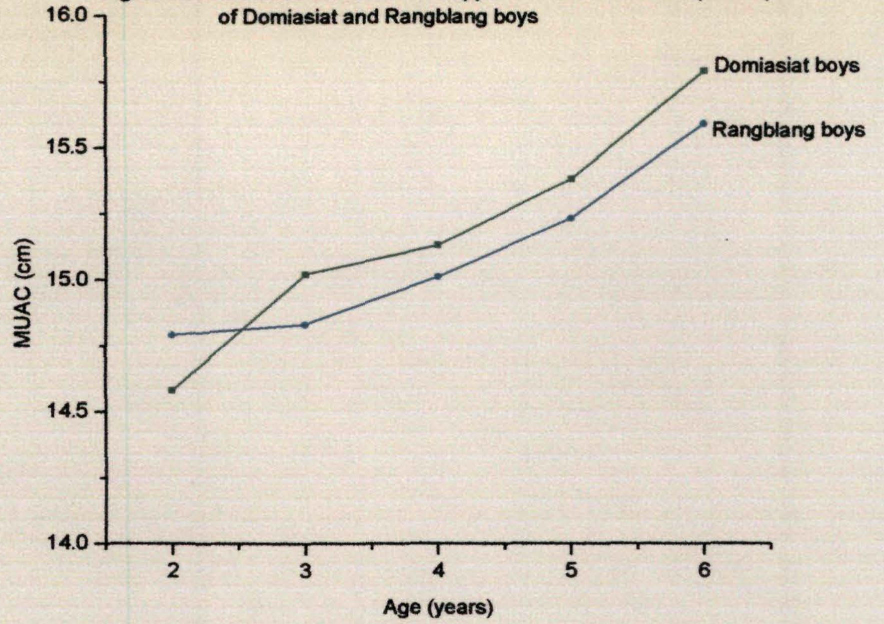


Figure 5.9B. Distance curves for mid upper arm circumference (MUAC) of Domiasiat and Rangblang girls

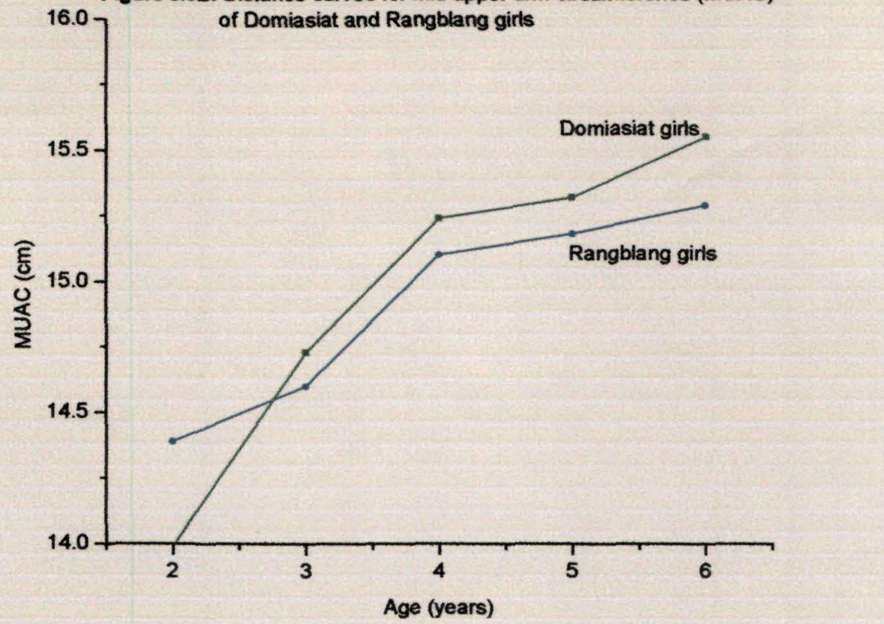


Figure 5.10A. Velocity curves for MAUC of Domiasiat and Rangblang boys

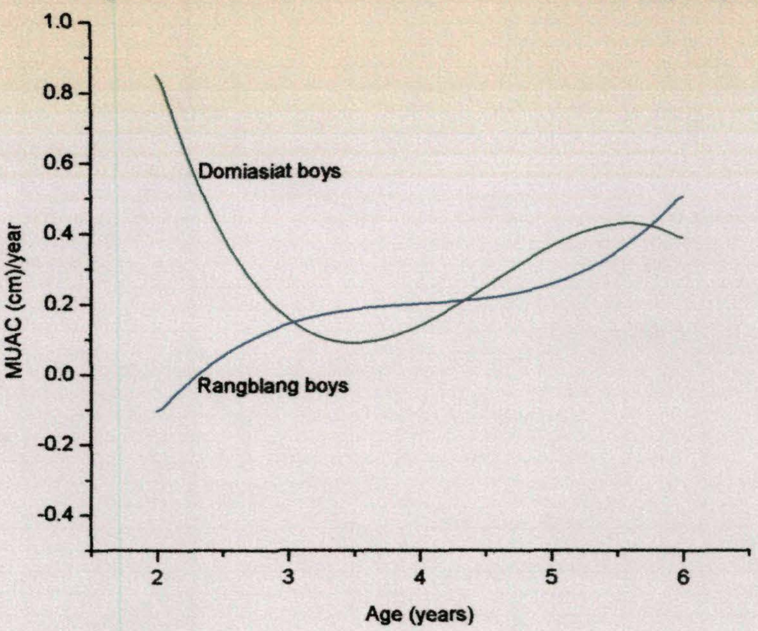
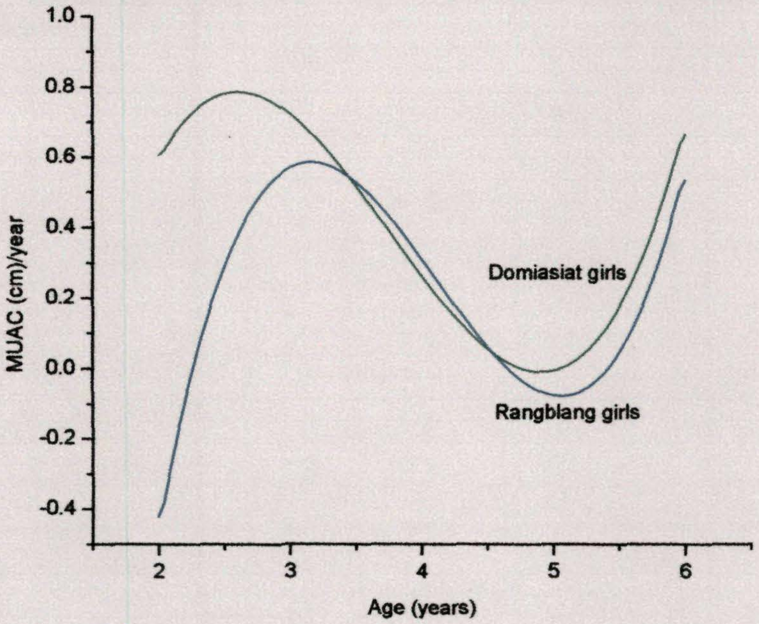


Figure 5.10B. Velocity curves for MAUC of Domiasiat and Rangblang girls



The growth differences in mid upper arm circumference between Domiasiat and Rangblang areas are shown in **Figures 5.9A** and **5.9B** for boys and girls, respectively. It is observed that Domiasiat boys have a greater mid upper arm circumference than Rangblang boys from about 2.5 years onward. The same is true with respect to the growth pattern of girls as shown in **Figure 5.9B**. Therefore, it is obvious that Domiasiat children have a greater arm circumference compared to Rangblang children.

Figure 5.10A shows the fitted velocity curve for the mid upper arm circumference of boys. Although Domiasiat boys have greater mid upper arm circumference, the growth rate seems to be better among Rangblang boys. There is a gradual increase in growth rate among Rangblang boys from 2 to 6 years of age. Domiasiat boys, on the other hand, showed a decline or deceleration growth from 2 to 3.5 years of age. Thereafter, the growth rate among Domiasiat boys increases till 5.5 years of age when it again tilted towards deceleration. Therefore, unlike the case of waist circumference, we may conclude that the growth rate in mid upper arm circumference among Rangblang boys is better than that among Domiasiat boys. It is likely that nutritional and other factors may be associated with such a pattern of growth rate in Domiasiat boys.

The fitted velocity curve for the mid upper arm circumference of girls are shown in **Figure 5.10B**. The growth rate in girls seems to be different from that of boys. Both the groups are by and large similar in pattern of growth rate. Rangblang girls seemed to have experienced growth retardation before 2 years of age, and thereafter they showed a growth spurt with a peak at 3 years of age. Domiasiat girls, on the other hand, had a peak of growth spurt at about 2.5 years of age. Both the groups experienced a deceleration in growth rate up to about 5 years of age, and acceleration from 5 years onward. Therefore, both the groups seemed to have a similar kind of nutritional deprivation.

NUTRITIONAL STATUS

In the present study, we have taken three important anthropometric indices, i.e., weight-for-age, height-for-age, and weight-for-height for assessing the nutritional status of the children. We have also made an attempt to correlate these indices with certain socioeconomic variables such as household income, maternal education and family size. The findings of the study may be presented briefly as follows:

Weight-for-age

Weight-for-age, expressed as a Z-score of the individual weight to the median or 50th percentile of the WHO population references (WHO, 2006) is generally considered as one of the indicators of underweight. Children with weight Z scores of > + 2.0, -2.0 to + 2.0, < -2.0 to -3.0 and < -3.0 are categorized as above normal, normal, moderate underweight and severe underweight, respectively. **Table 5.7** shows the distribution of children according to their weight status for both Domiasiat and Rangblang areas.

In the case of boys, the overall prevalence of underweight (moderate and severe) is higher in Rangblang (24.24%) than in Domiasiat (17.55%), although the prevalence of moderate underweight is slightly higher in the latter (18.18%) than in the former (11.70%). The odds ratio (OR) for the difference between Domiasiat and Rangblang in the overall prevalence of underweight is found to be 1.50, that is, the risk of being underweight is about 1.50 times higher in Rangblang boys compared to Domiasiat boys. However, the chi-square test indicates that the difference in the prevalence of underweight between these two groups is not statistically significant (χ^2 = 2.14, df = 1, p

> 0.05). This can also be referred to **Figure 5.11**, which indicates the percentage distribution boys according weight-for-age Z-score relative to the WHO growth reference. It is seen that the Gaussian fitted curves are more or less similar for both Domiasiat and Rangblang boys, although the peak of the curve for the latter is slightly higher than the former. Instead, the figure clearly shows that the curves for both Domiasiat and Rangblang boys tended to shift to the left of the WHO growth reference, i.e., lower than -1 z-score of the reference.

The situation is opposite in the case girls. It is found that the overall prevalence of underweight is higher in Domiasiat (20.96%) than in Rangblang (12.61%) areas. The unadjusted risk of being underweight in Domiasiat girls is about 1.83 times as compared to Rangblang girls, despite the absence of statistical difference ($\chi^2 = 3.36$, df = 1, $p > 0.05$). **Figure 5.12** also depicts that the distribution of girls below -2 z-score is greater in Domiasiat than in Rangblang area. However, the fitted curves for the overall distribution of z-score in the two areas seemed to be better than those observed for boys.

It is also observed that the overall prevalence of underweight in Domiasiat is higher in girls (20.96%) than in boys (17.55%). On the contrary, Rangblang boys (24.24%) are more likely to be underweight than their female counterparts (12.61%), and it is statistically significant ($\chi^2 = 5.57$, df = 1, $p < 0.01$). Thus, we may conclude that there are no statistical differences between Domiasiat and Rangblang children in the prevalence of underweight. However, the sex differences are significant in Rangblang.

Table 5.7. Nutritional status according to weight-for-age of children aged 2-6 years

Nutritional status	Domiasiat		Rangblang	
	N	Percent	N	Percent
Boys				
Overweight (> + 2.0 Z-score)	3	1.60	0	0.00
Normal (-2.0 to + 2.0 Z-score)	152	80.85	100	75.76
Moderate underweight (< - 2.0 to -3.0 Z-score)	22	11.70	24	18.18
Severe underweight (< - 3.0 Z-score)	11	5.85	8	6.06
Overall prevalence of underweight	33	17.55	32	24.24
Total number of boys	188	100.00	132	100.00
χ^2 for variation between Domiasiat and Rangblang* = 2.14, df = 1, p > 0.05 Odds ratio (95% CI) = 1.50 (0.87-2.60)				
Girls				
Overweight (> + 2.0 Z-score)	4	2.40	0	0.00
Normal (-2.0 to + 2.0 Z-score)	128	76.65	104	87.39
Moderate underweight (< - 2.0 to -3.0 Z-score)	23	13.77	11	9.24
Severe underweight (< - 3.0 Z-score)	12	7.19	4	3.36
Overall prevalence of underweight	35	20.96	15	12.61
Total number of girls	167	100.00	119	100.00
χ^2 for variation between Domiasiat and Rangblang* = 3.36, df = 1, p > 0.05 Odds ratio (95% CI) = 1.83 (0.96-3.55)				

*Variation in the prevalence of underweight (moderate and severe underweight)

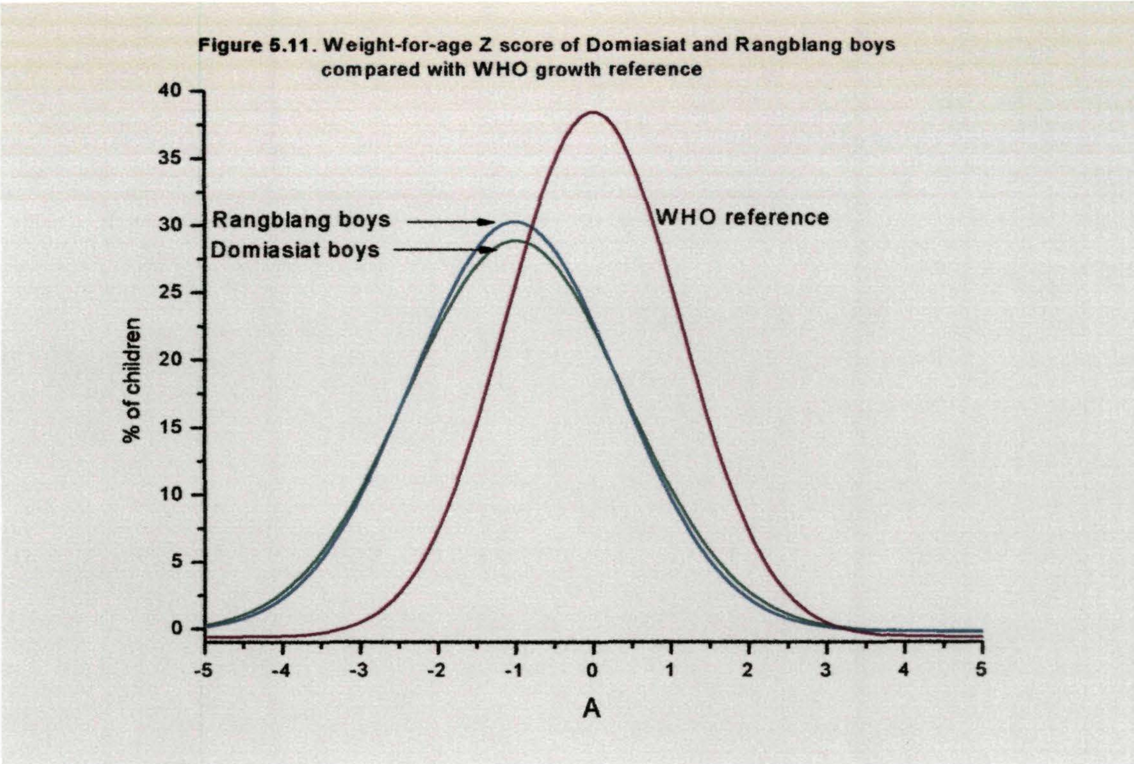


Figure 5.11. Weight-for-age Z score of Domiasiat and Rangblang boys compared with WHO growth reference
% of children
Rangblang boys
Domiasiat boys
WHO reference
A

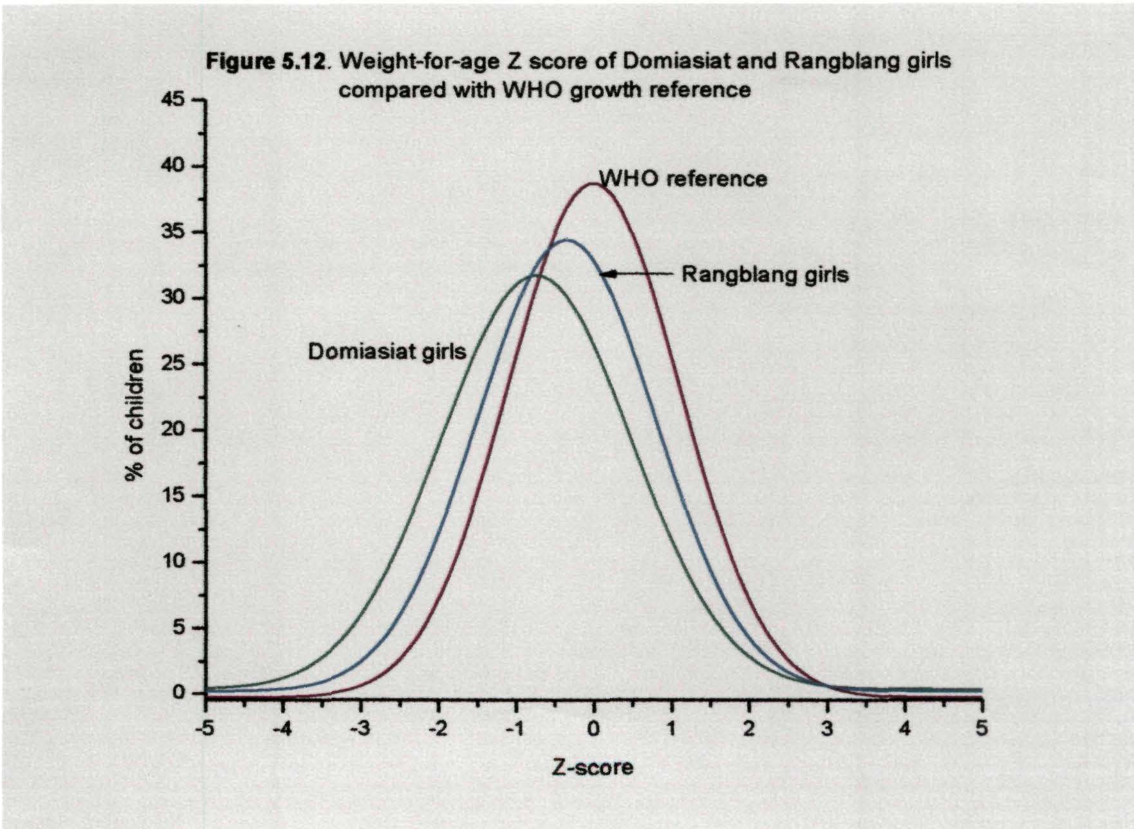


Figure 5.12. Weight-for-age Z score of Domiasiat and Rangblang girls compared with WHO growth reference
% of children
WHO reference
Rangblang girls
Domiasiat girls
Z-score

Table 5.8. Nutritional status according to height-for-age of children aged 2-6 years

Nutritional status	Domiasiat		Rangblang	
	N	Percent	N	Percent
Boys				
Above normal (> + 2.0 Z-score)	8	4.26	0	0.00
Normal (-2.0 to + 2.0 Z-score)	100	53.19	70	53.03
Moderate stunting (< - 2.0 to -3.0 Z-score)	41	21.81	25	18.94
Severe stunting (< - 3.0 Z-score)	39	20.74	37	28.03
Overall prevalence of stunting	80	42.55	62	46.97
Total number of boys	188	100.00	132	100.00
χ^2 for variation between Domiasiat and Rangblang* = 0.61, df = 1, $p > 0.05$				
Odds ratio (95% CI) = 1.20 (0.76-1.87)				
Girls				
Above normal (> + 2.0 Z-score)	10	5.99	1	0.84
Normal (-2.0 to + 2.0 Z-score)	87	52.10	56	47.06
Moderate stunting (< - 2.0 to -3.0 Z-score)	32	19.16	41	34.45
Severe stunting (< - 3.0 Z-score)	38	22.75	21	17.65
Overall prevalence of stunting	70	41.92	62	52.10
Total number of girls	167	100.00	119	100.00
χ^2 for variation between Domiasiat and Rangblang* = 2.90, df = 1, $p > 0.05$				
Odds ratio (95% CI) = 1.51 (0.94-2.52)				

*Variation in the prevalence of stunting (moderate and severe stunting)

Figure 5.13. Height-for-age Z score of Domiasiat and Rangblang boys compared with WHO growth reference

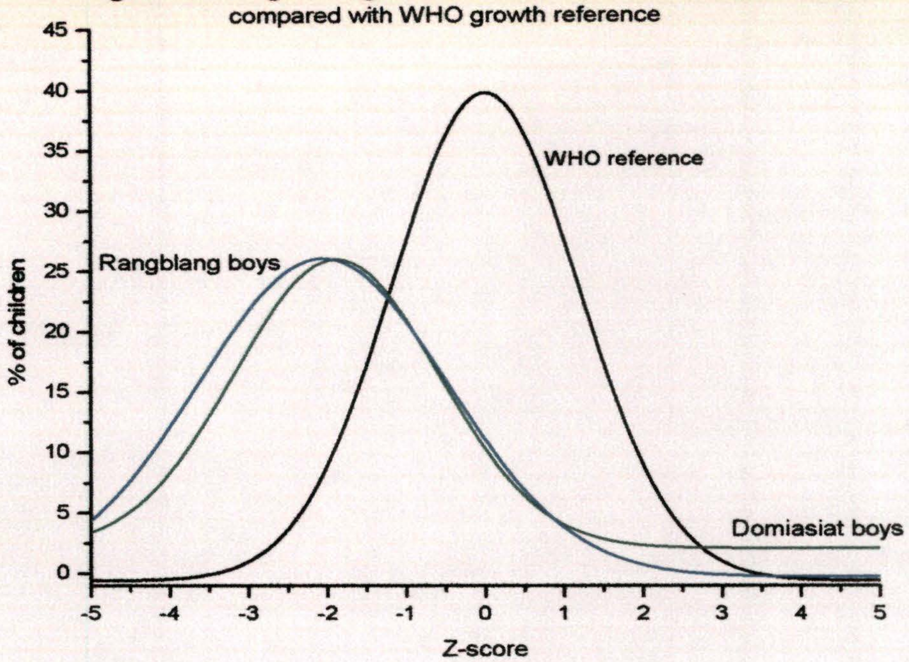
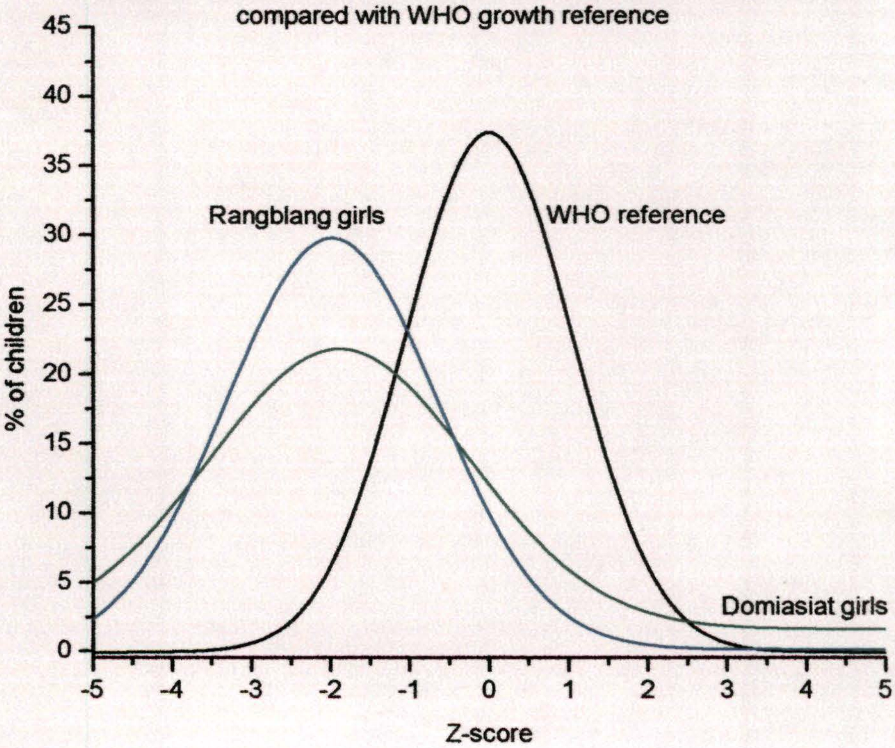


Figure 5.14. Height-for-age Z score of Domiasiat and Rangblang girls compared with WHO growth reference



Height-for-age

Table 5.8 shows the prevalence of stunting as indicated by height-for-age for boys and girls of the two areas of study. It is seen that the proportions of Domiasiat boys with moderate and severe forms of growth retardation are 21.81% and 20.74%, respectively. Among Rangblang boys, these frequencies are found to be 18.94% and 28.03%, respectively. Thus, it indicates that the prevalence of severe stunting is higher in Rangblang boys. Of course, the overall prevalence of stunting was also higher among Rangblang boys (46.97%) than among Domiasiat boys (42.55%). However, like the weight-for-age, the chi-square test suggests that the differences are not sufficient enough to accept that Rangblang boys have a greater prevalence of stunting compared to Domiasiat boys ($\chi^2 = 0.62$, df = 1, $p > 0.05$). It is, however, important to note that the Gaussian fitted curves indicates the high prevalence of stunting in both areas with a peak shifted towards -2 z-score of the WHO reference, which is the critical limit for defining the undernourished children (**Figure 5.13**). Thus, we may suggest that both the groups have experienced high prevalence of stunting, and the differences between them are simply because of small sample size and other chance factors.

The same is true with the case of girls (**Figure 5.14**). The overall prevalence was much greater among Rangblang girls (52.10) than among Domiasiat girls (41.92%), although it is not significant. This is also consistent with the fitted curves (**Figure 5.14**), indicating that the distribution of girls with -2 and – 3 z-scores of height-for-age is greater in Rangblang than Domiasiat girls. Similar to boys, both Domiasiat and Rangblang girls seemed to have a mean of -2 z-score compared with the WHO growth reference.

The percentage points of difference between Domiasiat and Rangblang in respect of stunting seems to be greater in girls than in boys (i.e., 1.50 times in girls and 1.20 times in boys), but the chi-square test suggests that the differences are not real ($\chi^2 = 2.90$, df = 1, $p > 0.05$). Therefore, we may conclude that although the prevalence of stunting is greater in Rangblang than in Domiasiat, there is not enough statistical evidence to accept the hypothesis. However, both the groups experienced a high prevalence of stunting.

Weight-for-height

Weight-for-height is generally considered as the best indicator of body fat mass, or wasting and thinness due to chronic energy deficiency. It is similar to body mass index. The prevalence of stunting according to sex and areas of study is given in **Table 5.9**. The prevalence of wasting is much lower than that of underweight and stunting for both the sexes and areas of studies. It is observed that both Domiasiat and Rangblang boys are similar in the prevalence of wasting, i.e. 6.38% and 6.82%, respectively. **Figure 5.15** shows that both Domiasiat and Rangblang boys are by and large within the norm of the WHO growth reference, and there is a tendency for the curves to shift the right.

However, there was a significant difference between Domiasiat and Rangblang girls in the overall prevalence of wasting ($\chi^2 = 4.52$, df = 1, $p < 0.01$). It is found that Domiasiat girls had about 9 times greater in risk of being wasting compared to Rangblang girls (Odds ratio = 9.14, CI = 1.17-71.25). **Figure 5.16** shows that both Domiasiat and Rangblang girls are by and large similar in the distribution of weight-for-height z-score from 0 to -2 z-score, but the proportion of those girls with below – 2 z-score is greater in Domiasiat. It is also seen that the proportion of girls with above 3 z-score is greater in Domiasiat than in Rangblang girls. This suggests the existence of the double burden of malnutrition. It is also found that Rangblang boys are significantly greater in the prevalence of wasting (6.82) compared to their female counterparts ($\chi^2 = 3.94$, df = 1, $p < 0.05$). Thus, we may conclude that although the prevalence of wasting is moderately lower than that of underweight and stunting, the differences between the sexes and areas of study seemed to be statistically important.

Table 5.9. Nutritional status according to weight-for-height of children aged 2-6 years

Nutritional status	Domiasiat		Rangblang	
	N	Percent	N	Percent
Boys				
Overweight (> + 2.0 Z-score)	14	7.45	9	6.82
Normal (-2.0 to + 2.0 Z-score)	162	86.17	114	86.36
Moderate underweight (< - 2.0 to -3.0 Z-score)	6	3.19	8	6.06
Severe underweight (< - 3.0 Z-score)	6	3.19	1	0.76
Overall prevalence of underweight	12	6.38	9	6.82
Total number of boys	188	100.00	132	100.00
χ^2 for variation between Domiasiat and Rangblang* = 0.02, df = 1, $p > 0.05$ Odds ratio (95% CI) = 0.93 (0.28-2.28)				
Girls				
Overweight (> + 2.0 Z-score)	15	8.98	5	4.20
Normal (-2.0 to + 2.0 Z-score)	140	83.83	113	94.96
Moderate underweight (< - 2.0 to -3.0 Z-score)	4	2.40	1	0.84
Severe underweight (< - 3.0 Z-score)	8	4.79	1	0.84
Overall prevalence of underweight	12	7.19	2	1.68
Total number of girls	167	100.00	119	100.00
χ^2 for variation between Domiasiat and Rangblang* = 4.52, df = 1, $p < 0.05$ Odds ratio (95% CI) = 9.14 (1.17-71.25)				

*Variation in the prevalence of wasting (moderate and severe wasting)

Figure 5.15. Weight-for-height Z score of Domiasiat and Rangblang boys compared with WHO growth reference

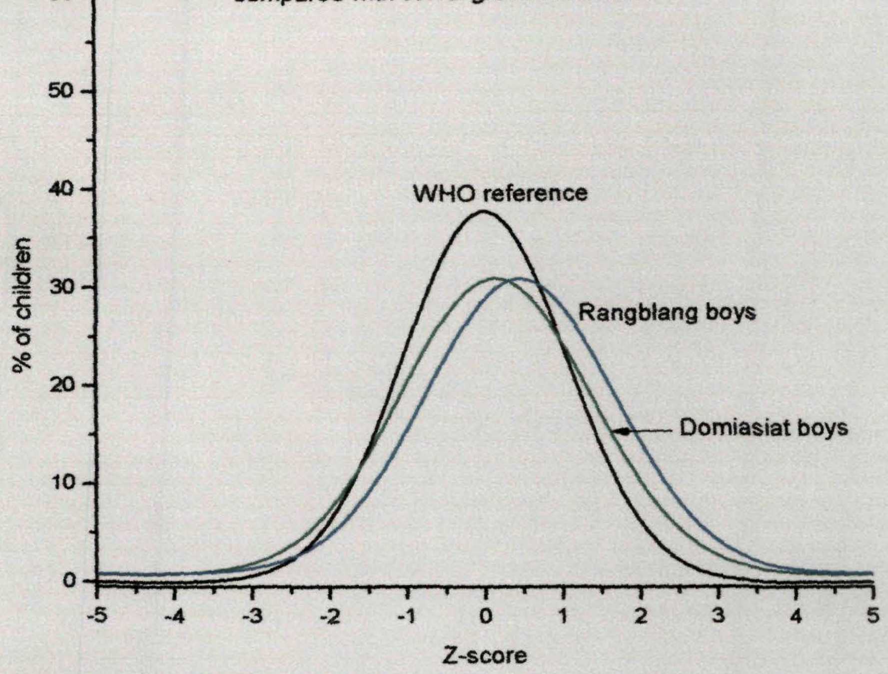


Figure 5.16. Weight-for-height Z score of Domiasiat and Rangblang girls compared with WHO growth reference

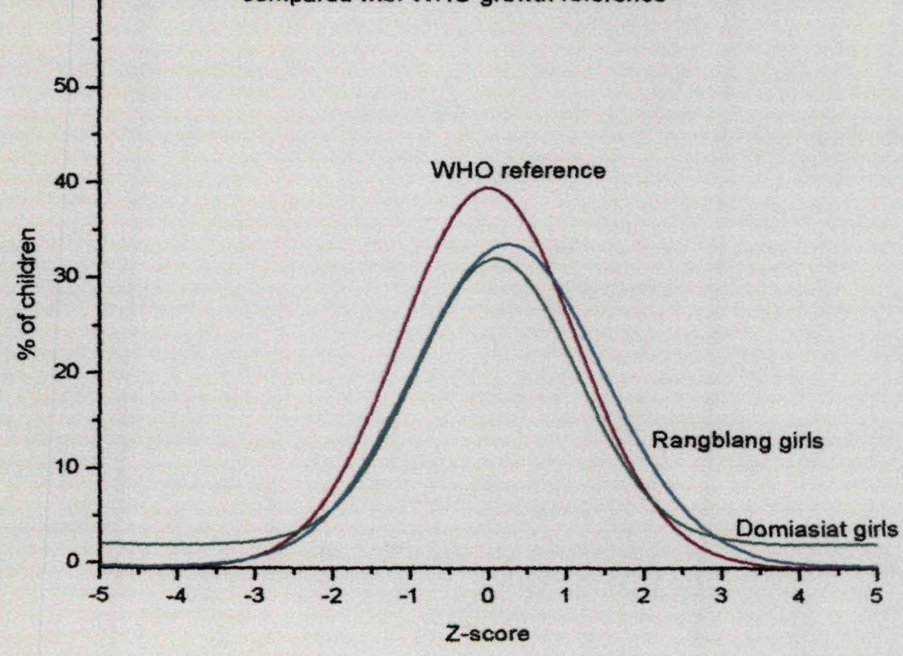
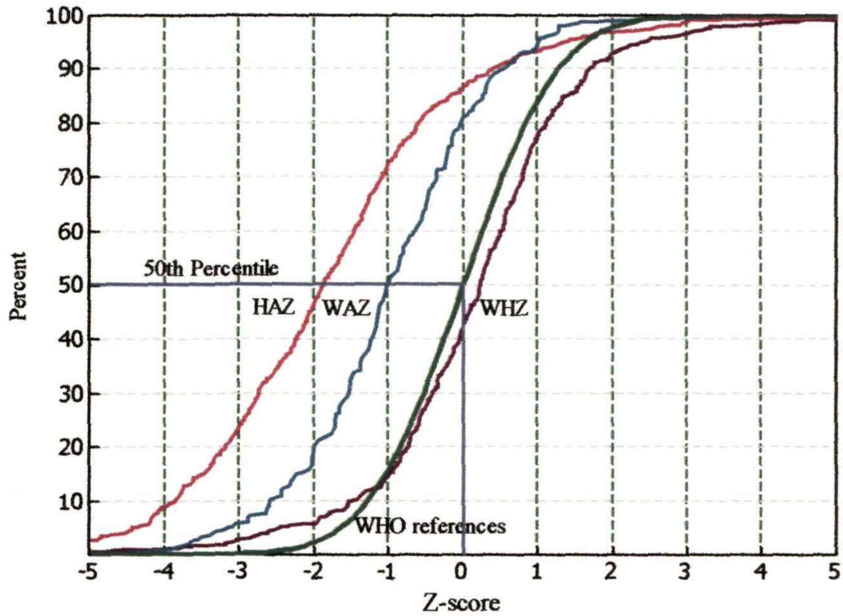


Table 5.10. Criteria for assessing severity of under-nutrition in a population*

Indicator	Prevalence (%)			
	Low	Moderate	High	Very high
Underweight	< 10	10.0 – 19.9	20.0 - 29.9	≥ 30.0
Stunting	< 20	20.0 – 29.9	30.0 - 39.9	≥ 40.0
Wasting	< 5	5.0 – 9.9	10.0 – 14.9	≥ 15.0

* As proposed by Gorstein *et al.*, (1994)

Figure 5.17. Overall cumulative distribution for WAZ, HAZ and WHZ scores*



*HAZ - Height-for-age Z-score, WAZ - Weight-for-age Z-score and WHZ - Weight-for-age Z-score

Summary on nutritional status

The present findings suggest that the prevalence of stunting is very high in both Domiasiat and Rangblang children, ranging between 40 to 52%. The prevalence of underweight ranges between 13% and 24%, whereas the prevalence of wasting is moderately low according to the classificatory criteria proposed by Gorstein *et al.* (1994) shown in **Table 5.10**. Pooling the data for both the sexes and areas of study, **Figure 5.17** shows that the cumulative prevalence of stunting (i.e., number of stunted children with less than or equal to -2 z-score as indicated by height-for-age) was about 50%, whereas the prevalence of underweight as indicated by weight-for-age z-score was about 20%. On the other hand, the prevalence of wasting as indicated by weight-for-height was about 5%. Therefore, stunting is the major nutritional problem in both the areas.

There are not enough statistical evidences to support the hypothesis of the differences in nutritional status between Domiasiat and Rangblang areas. However, the sex differences seemed to be statistically important especially in Rangblang area of study. Rangblang boys are more likely to have a greater risk of underweight and wasting compared to their female counterparts.

NUTRITIONAL STATUS AND BIOSOCIAL FACTORS

In this section, we deal with the correlation between nutritional status and certain socio-demographic factors, such as place of residence (Domiasiat and Rangblang areas), sex, family size, household income and maternal education. This is also in part to address one of the objectives of the present study. Odds ratios derived from the logistic regression analysis will be used to test the effects of socio-demographic factors. The nutritional status of children is dichotomized into two categories for all the three anthropometric indices, namely, weight-for-age, height-for-age and weight-for-height. For example, the nutritional status according to weight-for-age is classified into underweight and non-underweight groups. The socio-demographic factors mentioned above are considered as risk factors of the nutritional status. The findings are described as follows:

Table 5.11. Risk factors for underweight as indicated by odds ratios derived from logistic regression analysis

Parameters	N	Prevalence %)	Odds ratio (95% CI)	p-level
Model 1				
Residence				
Rangblang	251	47 (18.73)	-	-
Domiasiat	355	68 (19.15)	1.02 (0.68-1.55)	0.894
Sex				
Girls	286	50 (17.48)	-	-
Boys	320	65 (20.31)	1.20 (0.80-1.81)	0.375
Family size				
Small	75	15 (20.00)	-	-
Medium	345	64 (18.55)	0.84 (0.45-1.55)	0.578
Large	185	34 (18.38)	0.83 (0.43-1.62)	0.584
Income group				
High	86	7 (8.14)	-	-
Middle	203	40 (19.70)	2.77 (1.19-6.45)	**0.018**
Low	317	68 (21.45)	3.08 (1.36-6.99)	**0.007**
Maternal education				
Above Secondary	41	2 (4.88)	-	
Secondary	269	46 (17.10)	4.02 (0.94-17.25)	0.061
Primary	222	52 (23.42)	5.97 (1.39-25.54)	**0.016**
Illiterate	74	15 (20.27)	4.96 (1.07-22.89)	**0.040**
Model 2				
Income group				
High	86	7 (8.14)	-	-
Middle	203	40 (19.70)	2.61 (1.11-6.10)	**0.027**
Low	317	68 (21.45)	2.85 (1.25-6.48)	**0.013**
Maternal education				
Above Secondary	41	2 (4.88)	-	
Secondary	269	46 (17.10)	3.48 (0.81-15.05)	0.061
Primary	222	52 (23.42)	5.07 (1.17-21.90)	**0.030**
Illiterate	74	15 (20.27)	4.19 (0.90-19.56)	**0.040**

Note: Chi-square test for linear trend in respect of household income = 6.08, df =1, p<0.01)

Chi-square test for linear trend in respect of maternal education = 5.28, df =1, p<0.01)

Risk Factors of Underweight

Table 5.11 shows the risk factors of underweight in terms of odds ratios derived from two logistic regression models. In the first model, the unadjusted odds ratios with 95% confidence interval (CI) were computed separately for all the socio-demographic factors. The second model is concerned with those factors that have significant effects on underweight. It is seen from the Table that residence, sex and family size are not associated with underweight. The absence of significant relationship between nutritional status and place of residence as well as sex had also been shown in the previous analyses. However, household income and maternal education seemed to be important in regulating the weight status of children. In comparison with the high income group, the odds ratios for underweight are found to be 3.08 for low income group and 2.77 for middle income group. This indicates that children in the low and middle income groups had respectively about 3.08 and 2.77 times greater in risk of being underweight as compared to children in the high income group. The lower level of the confidence intervals (CI) are found to exceed 1 for both low (CI: 1.36-6.99, $p < 0.007$) and middle (CI: 1.19-6.45, $p < 0.018$) income groups. It is also found that the chi-square test for linear trend was 6.08 (df = 1, $p < 0.01$). Therefore, it suggests that underweight is not only associated with household income, but also decreases with increasing income level. As normally expected, it may be interpreted that low economic condition acts as a significant risk of being underweight among children.

Table 5.11 further shows that underweight is associated with maternal education according to the first model of logistic regression mentioned above. In comparison with children whose mothers are educated up to secondary level and above, the odds ratio was found to be 4.96, 5.97 and 4.02 for the illiterate, primary and secondary groups, respectively. It is significant for the illiterate (CI: 1.07-22.89, $p < 0.04$) and primary (CI: 1.39-25.54, $p < 0.02$) groups compared to the mothers with educational level of secondary and above. The chi-square test for linear trend was found to be highly significant (χ^2 for trend = 5.28, df = 1, $p < 0.02$). Therefore, it suggests that maternal education also plays a very important role in regulating the weight status of children in the present study. It is likely to decrease with the increasing educational level of the mothers.

Using the model 1, it is clear that underweight is associated with household income and maternal education. In model 2 of the logistic regression, we included both the variables to test their relative importance in patterning underweight of children. It is found that the effect of household income as indicated by the odds ratios is till significant even after adjusting for maternal education. The same is true with respect to maternal education. The odds ratios for illiterate and primary groups of mothers are still significant even after adjusting for household income. Therefore, we may conclude that both household income and maternal education are important in controlling underweight among children of Domiasiat and Rangblang areas.

Table 5.12. Risk factors for stunting as indicated by odds ratios derived from logistic regression analysis

Parameters	N	Prevalence %)	Odds ratio (95% CI)	p-level
Model 1				
Residence				
Domiasiat	355	150 (42.25)	-	-
Rangblang	251	124 (49.40)	1.33 (0.96-1.85)	0.082
Sex				
Boys	320	142 (44.37)	-	-
Girls	286	132 (46.15)	1.07 (0.78-1.48)	0.661
Family size				
Small	75	41 (54.67)	-	-
Medium	345	151 (43.77)	0.65 (0.39-1.07)	0.087
Large	185	81 (43.78)	0.65 (0.38-1.11)	0.112
Income group				
High	86	20 (23.26)	-	-
Middle	203	93 (45.81)	2.79 (1.58-4.94)	**0.001**
Low	317	161 (50.79)	3.41 (1.97-5.88)	**0.001**
Maternal education				
Above Secondary	41	14 (34.15)	-	
Secondary	269	106 (39.41)	1.25 (0.63-2.50)	0.520
Primary	222	115 (51.80)	2.07 (1.03-4.16)	**0.040**
Illiterate	74	39 (52.70)	2.15 (0.98-4.74)	0.060
Model 2				
Income group				
High	86	20 (23.26)	-	-
Middle	203	93 (45.81)	2.63 (1.48-4.67)	**0.001**
Low	317	161 (50.79)	3.15 (1.81-5.46)	**0.001**
Maternal education				
Above Secondary	41	14 (34.15)	-	
Secondary	269	106 (39.41)	1.01 (0.50-2.05)	0.897
Primary	222	115 (51.80)	1.63 (0.80-3.34)	0.334
Illiterate	74	39 (52.70)	1.68 (0.75-3.79)	0.208

Risk Factors of Stunting

Table 5.12 shows the risk factors of stunting in terms of odds ratios like in the case of underweight shown above. It is seen that, in the Model 1 of logistic regression, short stature or stunting is associated with only household income and maternal education. It is found that children in the low income groups had about 3.41 (CI: 1.97-5.88, $p < 0.001$) times greater in risk of being stunted as compared to children in the high income group. Similarly, the risk for children in the middle income group was about 2.79 (CI: 1.58-4.94, $p < 0.001$) times greater than those belonging to the high income group. The chi-square test for linear trend was found to be highly significant (χ^2 for trend = 17.13, df = 1, $p < 0.001$). Therefore, like underweight, it suggests that stunting in children of the present study is not only associated with household income, but also decreases with increasing income level. With respect to maternal education, **Table 5.12** shows that children of illiterate mothers had about 2.15 times greater in risk of being stunted as compared to their counterparts whose mothers are educated up to secondary and above. However, the lower value of the CI is less than 1 (CI: 0.98-4.74, $p < 0.060$), i.e., it is not statistically significant. Similarly, the difference between secondary and above secondary groups of maternal education is not statistically significant. However, the risk of being stunted was significantly greater among children of mothers with primary level of education compared to those with above secondary level of education (OR =2.07, CI: 1.03-4.16, $p < 0.04$). Thus, the role of maternal education in controlling stunting cannot be totally ruled out among children of the present study. It is also found that the chi-square test for linear trend was highly significant 9.71 (df = 1, $p < 0.001$). However, when both household income and maternal education were included in Model 2 of the logistic regression analysis, the effect of maternal education disappeared. Therefore, we may interpret that both household income and maternal education are significantly associated with stunting, but it is likely that household income is relatively more important.

Risk Factors of Wasting

The risk factors of wasting in terms of odds derived from logistic regression models are presented in **Table 5.13**. Unlike in the case of underweight and stunting, the effects of demographic and socioeconomic 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. Similarly, the role of maternal education cannot be totally ruled out in regulating wasting in the present population.

Table 5.13. Risk factors for wasting as indicated by odds ratios derived from logistic regression analysis

Parameters	N	Prevalence %)	Odds ratio (95% CI)	p-level
Model 1				
Residence				
Rangblang	251	10 (3.98)	-	-
Domiasiat	355	24 (6.76)	1.75 (0.82-3.72)	0.184
Sex				
Girls	286	13 (4.55)	-	-
Boys	320	21 (6.56)	1.48 (0.73-3.00)	0.284
Family size				
Small	75	6 (8.00)	-	-
Medium	345	15 (4.35)	0.52 (0.19-1.40)	0.195
Large	185	13 (7.03)	0.87 (0.32-2.38)	0.785
Income group				
High	86	4 (4.65)	-	-
Middle	203	15 (7.39)	1.02 (0.33-3.75)	0.975
Low	317	15 (4.73)	1.64 (0.53-5.08)	0.395
Maternal education				
Above Secondary	41	1 (2.44)	-	
Secondary	269	17 (6.32)	2.70 (0.35-20.84)	0.341
Primary	222	12 (5.41)	2.29 (0.29-18.08)	0.433
Illiterate	74	4 (5.41)	2.29 (0.25-21.61)	0.467

CHAPTER VI

NUTRITIONAL AND HEALTH STATUS OF ADULTS

In the present Chapter, we shall describe our findings on the health and nutritional status of the study population groups in terms of anthropometry, physiological characteristics and morbidity. Morbidity is defined in terms of self-reported illness, hypertension and anemia. Our design of study is to compare the Domiasiat and Rangblang areas in respect of these characteristics. We shall also look into the relationship between these characteristics and certain socioeconomic parameters in both the areas of study.

SOCIOECONOMIC BACKGROUND

Table 6.1 shows the percentage distribution of male and female participants according to background characteristics for both Domiasiat and Rangblang areas. It is seen that the age distribution of males and females is greater in lower age groups in both the sexes and areas of study. Most of them belonged to the aged group 25-45 years. It may be mentioned that the age group included in this study was from 18 to 60 years for both males and females. The proportion of illiterates is similar for both the sexes in both the areas of study. However, the number of illiterate samples seems to more in Rangblang than in Domiasiat. Most of the participants in this study had educational level between primary and secondary. The proportion of participants with higher secondary level of education is greater in Rangblang than in Domiasiat areas. Most of the participants belonged to the low income group ranging from 43% to 49% for Rangblang males and females, respectively. The proportion of participants in the high income group ranges from 16% for the Rangblang females to 21% for the Domiasiat males. In short, the number of participants belonging to the low income group is similar in both Domiasiat (46.44%) and Rangblang (46.65%) areas. It is also observed from **Table 6.1** that more than 50% of the participants in this study lived in a household of 5 to 8 individuals. The proportion of participants living in large family (more than 8 persons) varies from 22% for Rangblang females to 31% for Domiasiat females.

Table 6.1. Percentage distribution of males and females according to background characteristics

Background characteristics	Domiasiat				Rangblang			
	Males (N =212)		Females (N=238)		Males (N =172)		Females (N=216)	
	N	%	N	%	N	%	N	%
Age group (years)								
< 25	43	20.28	70	29.41	62	36.05	67	31.02
25-45	126	59.43	130	54.62	84	48.84	120	55.56
> 45	43	20.28	38	15.97	26	15.12	29	13.43
Education								
Illiterate	25	11.79	28	11.76	25	14.53	31	14.35
Primary	87	41.04	112	47.06	50	29.07	65	30.09
Secondary	87	41.04	95	39.92	63	36.63	97	44.91
Higher secondary & above	13	6.13	3	1.26	34	19.77	23	10.65
Income group								
Low	101	47.64	108	45.38	74	43.02	107	49.54
Middle	66	31.13	82	34.45	66	38.37	74	34.26
High	45	21.23	48	20.17	32	18.60	35	16.20
Family size								
Small (<4)	46	21.70	46	19.33	34	19.77	47	21.76
Middle (5-8)	107	50.47	119	50.00	90	52.33	121	56.02
Large (> 8)	59	27.83	73	30.67	48	27.91	48	22.22

ANTHROPOMETRIC CHARACTERS

Table 6.2 shows the means and standard deviations of anthropometric characters for Domiasiat and Rangblang males. It is seen that both Domiasiat and Rangblang males are similar in stature, but the former are significantly lighter than the latter. The Rangblang males had also greater skinfold thickness compared to the Domiasiat males. This is clearly reflected in other fat mass indicators such as body mass index (BMI), fat-mass index (FMI) and conicity index. Therefore, it is likely that the nutritional status is better in Rangblang males than in Domiasiat males. We shall describe this issue in the next section of this chapter. It may be noted here that the difference in waist circumference, as generally considered a substitute for BMI, is not statistically significant like it does with respect to BMI. This also suggests that BMI is more sensitive in detecting the nutritional status of the individuals.

Table 6.3 shows the means and standard deviations of anthropometric characters for females. Like in the case of males, the Rangblang females are significantly heavier than the Domiasiat females. They are also significantly greater in skinfold thicknesses, BMI and FMI. But they are significantly lower in conicity index, because this index is lower with increasing BMI. Nevertheless, the present findings shown in **Tables 6.2** and **6.3** clearly indicate that there are considerable differences between Domiasiat and Rangblang areas with respect to body dimensions and composition that are related to nutritional status. Therefore, our design of study to segregate the Domiasiat and Rangblang data seems to be well-fit as far as the present study is concerned. Accordingly, in the following sections, we shall present our data separately for both males and females in order to address the objectives of the present study.

Table 6.2: Anthropometric characters of Domiasiat and Rangblang males

Anthropometric characters	Domiasiat (n=212)		Rangblang (n = 172)		t-value
	Mean	SD	Mean	SD	
Anthropometric measurements					
Weight (Kg)	51.24	5.39	52.91	5.48	2.99*
Height (cm)	157.96	6.58	157.59	4.91	0.61
Sitting height (cm)	81.71	3.91	82.00	3.49	0.76
Hip circumference (cm)	83.33	6.43	82.02	6.51	1.98*
Waist circumference (cm)	76.83	7.65	76.61	7.56	0.29
Biceps (mm)	5.85	2.00	6.90	2.29	4.79**
Triceps (mm)	7.62	2.83	9.11	3.32	4.74**
Subscapular (mm)	9.82	3.42	12.46	3.70	7.25**
Sum of 3 skinfold thicknesses (mm)	23.30	7.75	28.47	8.78	6.13**
Anthropometric indices & ratios					
Body mass index (kg/m^2)	20.57	2.23	21.29	1.90	3.40**
Fat-free mass index (kg/m^2)	17.34	1.51	17.40	1.28	0.41
Fat-mass index (kg/m^2)	3.23	1.09	3.90	1.06	6.05**
Cormic index	0.52	0.02	0.52	0.02	1.29
Conicity index	1.24	0.11	1.22	0.11	2.08*
Waist-hip ratio	0.93	0.12	0.94	0.13	1.01

*p<0.05, **p<0.001

Table 6.3: Anthropometric characters of Domiasiat and Rangblang females

Anthropometric characters	Domiasiat (N=238)		Rangblang (N = 216)		t-value
	Mean	SD	Mean	SD	
Anthropometric measurements					
Weight (Kg)	45.26	5.77	46.57	6.17	2.33*
Height (cm)	147.66	6.57	147.71	4.90	0.09
Sitting height (cm)	76.59	4.14	77.08	2.82	1.46
Hip circumference (cm)	83.28	6.45	83.41	5.76	0.23
Waist circumference (cm)	77.35	9.31	78.03	9.39	0.77
Biceps (mm)	4.09	1.88	5.43	2.15	7.09**
Triceps (mm)	7.41	2.96	9.68	3.33	7.70**
Subscapular (mm)	9.41	3.79	13.13	4.22	9.88**
Sum of 3 skinfold thicknesses (mm)	20.91	7.92	28.24	8.59	9.46**
Anthropometric indices & ratios					
Body mass index (kg/m^2)	20.78	2.53	21.34	2.56	2.33*
Fat-free mass index (kg/m^2)	16.55	1.65	16.07	1.45	3.31**
Fat-mass index (kg/m^2)	4.23	1.42	5.27	1.42	7.81**
Cormic index	0.52	0.03	0.52	0.02	1.50
Conicity index	1.28	0.13	1.28	0.12	0.62
Waist-hip ratio	0.93	0.12	0.94	0.12	0.57

*p<0.05, **p<0.001

NUTRITIONAL STATUS

The nutritional status of participants in this study was assessed by using BMI, taking into consideration the cut-off points recommended for the Asia pacific region (WHO, 2000). As described in Chapter II, the WHO (1995) has recommended the BMI cut-offs of 25.0 kg/m^2 and 30.0 kg/m^2 for defining overweight and obesity, respectively. But there is considerable evidence that these cut-off values are not applicable across ethnic groups, especially among Asian populations. Accordingly, the new BMI cut-off points of 23·0 kg/m^2 and 25·0 kg/m^2 have been recommended for Asian populations (WHO, 2000) and other populations (WHO, 1995), respectively. In order to test the validity of these recommended cut-off points, we used the Receiver Operating Characteristic (ROC) curve analysis and the results are given in **Table 6.4** and **Figures 6.1-6.2.**

Table 6.4 shows sensitivity and specificity values according to selected threshold values of BMI against the reference PBF>25% for men and >30% for women derived from skinfold measurements. It is found that the BMI cut-off points of $\geq$ 22 and $\geq$23 kg/m^2 would be most appropriate for detecting obesity among males and females as shown in **Figure 6.1 and 6.2**, respectively. The area under the ROC curve (AUC) was slightly greater in males (AUC = 0.96, CI: 0.93-0.98, $p < 0.0001$) than in females (AUC = 0.94, CI: 0.91-0.96, $p < 0.0001$).

If the BMI cut-off point is increased up to $\geq$ 25 kg/m^2 against the reference PBF >25%, the rate of sensitivity or true positive rate in males decreased substantially from 92.68% to 34.20%, while the rate of specificity or false positive rate increased to 100%. Similarly, the positive predicted value in females increased from 86% for the BMI criterion of 23.01 $kg/\ m^2$ to 99% for the BMI criterion of 25 $kg/\ m^2$, and the negative predicted value decreased from about 87% to 99%. Therefore, so far as the nutritional status in the present population is concerned, the cut-off points recommended for the Asia-pacific regions (WHO, 2000) would be more appropriate than those international cut-off points recommended by the WHO (1995). However, it is also important to report the findings as per the international cut-off points for the purpose of comparative analysis. In the following sections, we shall look into the nutritional status of the adult males and females, taking into consideration both the recommended cut-off points.

Table 6.4: Sensitivity and specificity of BMI thresholds in detection of obesity against the PBF reference value of > 25% for males and > 30% for females

Parameters	Males	Females
Criterion value of BMI (kg/m^2)	22.4	23.01
Sensitivity (95% CI)	92.68 (80.1-98.5)	86.21(68.3-96.1)
Specificity (95% CI)	86.01 (81.9-89.5)	87.06 (83.5-90.1)
Area under the ROC curve (95% CI)	0.96 (0.93-0.98)	0.94 (0.91-0.96)
Positive predicted value	6.62	6.62
Negative predicted value	0.09	0.09
Criterion value of BMI (kg/m^2)	25.0	25.0
Sensitivity (95% CI)	34.20 (20.1-53.1)	68.97 (49.2-84.7)
Specificity (95% CI)	100.00 (98.9-100.0)	98.92 (97.3-99.6)

CI – Confidence interval

Figure 6.1. ROC curve of sensitivity and specificity for BMI of males against reference PBF (> 25)

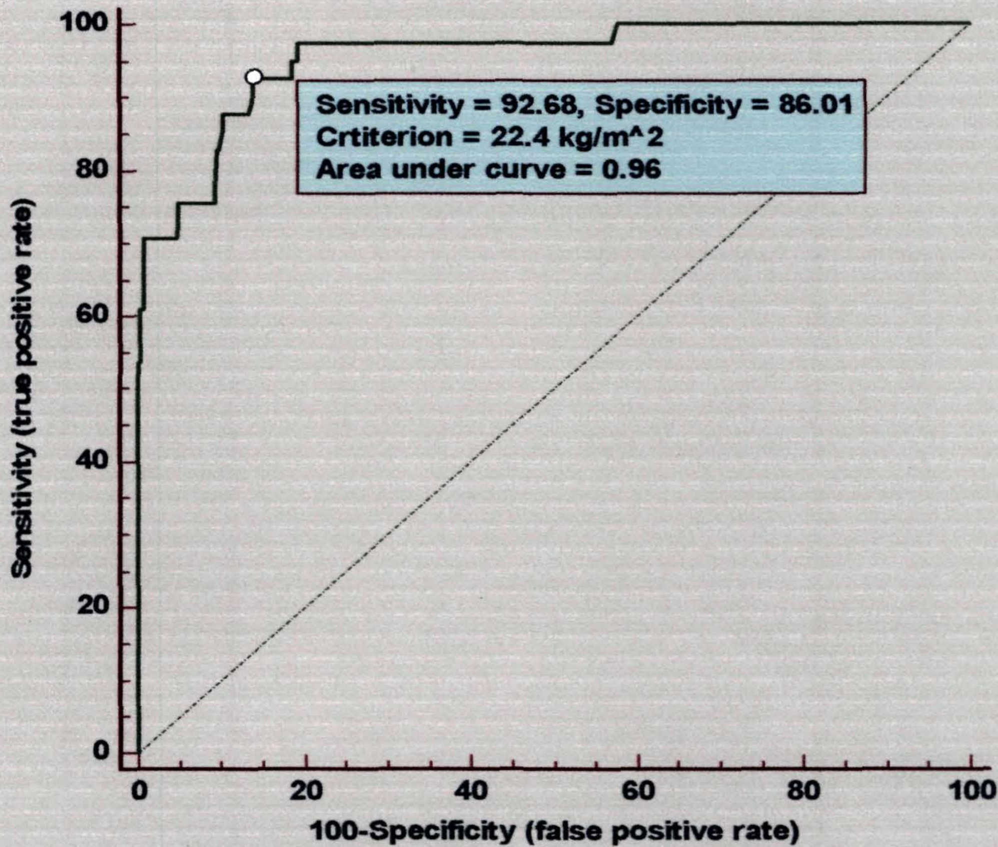
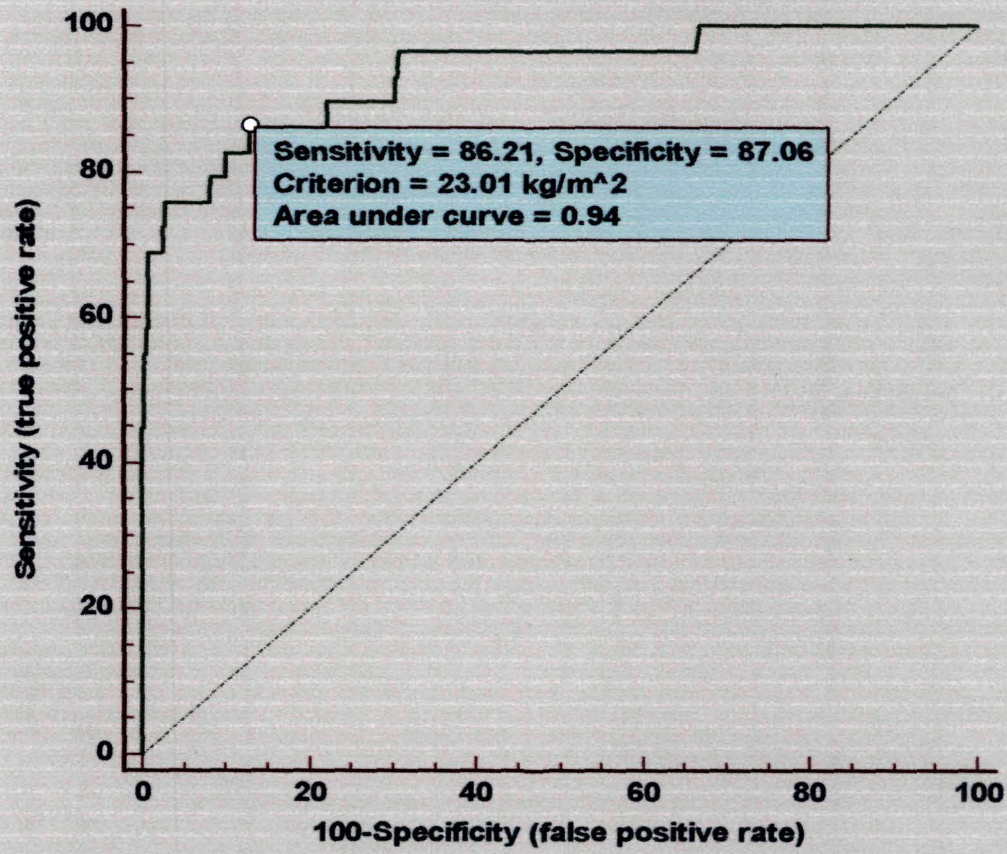


Figure 6.2. ROC curve of sensitivity and specificity for BMI of females against reference PBF (> 30)



Nutritional status according to BMI

Table 6.5 shows the nutritional status of participants according to BMI categories. It is found that about 12.26% and 84.91% of the Domiasiat males were in the categories of underweight and normal, respectively. In Rangblang males, these frequencies are 5.81% and 88.95%, respectively. The prevalence of underweight is significantly higher in Domiasiat than in Rangblang (χ^2 = 6.59, df = 1, p < 0.01). Similarly, the prevalence of underweight is higher in Domiasiat females (19.75%) than in Rangblang females (11.68%), and it is statistically significant (χ^2 = 5.67, df = 1, p < 0.01). It is further seen from **Table 6.5** that the prevalence of underweight is greater in females than in males in both Domiasiat (χ^2 = 4.62, df = 1, p < 0.05) and Rangblang (χ^2 = 3.87, df = 1, p < 0.04) areas. Thus, it is obvious that were differences between the sexes and the two areas of study with respect to the prevalence of underweight.

With respect to the prevalence of overweight and/or obesity, it is observed that are three aspects of differences, namely, (i) differences due to BMI cut-off points, (ii) Domiasiat and Rangblang differences, and (iii) sex differences. As mentioned above, the cut-off points recommended for the Asia-pacific regions (WHO, 2000) would be more appropriate in the present population than those international cut-off points recommended by the WHO (1995). However, we have presented our data according to international cut-off points (WHO, 1995) for not only for comparative purposes (WHO Consultation Group, 2004), but also for understanding the possible underestimation of the prevalence of overweight/obesity in the present population. This is important because many studies in India and other developing countries have paid more attention to the problem of undernutrition as compared to that of overnutrition. **Table 6.5** shows that the prevalence of overweight/obesity in Domiasiat females, for example, was 5.23% according to the international cut-off points, but it was about 17.44% according to the cut-off points recommended for the Asia-pacific regions (WHO, 2000). It shows that the difference in estimation of overweight and/or obesity is about 12.21 percentage points. This sort of underestimation of the prevalence of overweight and/or obesity holds true for both the sexes and areas of study. We shall further discuss this issue in chapter on discussion.

Table 6.5: Nutritional status according to BMI

Nutritional Status	Domiasiat		Rangblang	
	Number	%	Number	%
According to International Cut-offs (WHO, 1995)				
Males (n: Domiasiat = 212, Rangblang = 172)				
Underweight (< 18.5 kg/m^2)	26	12.26	10	5.81
Normal (18.5 – 24.9 kg/m^2)	180	84.91	153	88.95
Overweight and obesity (≥ 25 kg/m^2)	6	2.83	9	5.23
Females (n: Domiasiat = 238, Rangblang = 216)				
Underweight (< 18.5 kg/m^2)	47	19.75	25	11.57
Normal (18.5 – 24.9 kg/m^2)	182	76.47	175	81.02
Overweight and obesity (≥ 25 kg/m^2)	9	3.78	16	7.41
According to Asia Pacific Cut-offs (WHO, 2000)				
Males (n: Domiasiat = 212, Rangblang = 172)				
Underweight (< 18.5 kg/m^2)	26	12.26	10	5.81
Normal (18.5 – 22.9 kg/m^2)	163	76.89	132	76.74
Overweight and obesity (≥ 23 kg/m^2)	23	10.85	30	17.44
Females (n: Domiasiat = 238, Rangblang = 216)				
Underweight (< 18.5 kg/m^2)	47	19.75	25	11.57
Normal (18.5 – 22.9 kg/m^2)	154	60.92	146	67.59
Overweight and obesity (≥ 23 kg/m^2)	37	15.55	45	20.83

With respect to the differences between Domiasiat and Rangblang in overweight and/or obesity, **Table 6.5** shows that, unlike the prevalence of underweight, the prevalence of overweight is higher in Rangblang than in Domiasiat area, irrespective of cut-off points and sexes. According to the cut-off points recommended for the Asia-pacific regions (WHO, 2000), the prevalence of overweight was 10.85% and 17.44% in Domiasiat and Rangblang males, respectively. This difference between Domiasiat than Rangblang males is, however, not statistically significant (χ^2 = 3.46, df = 1, p > 0.05). In other words, although the prevalence of overweight appears to be greater in Domiasiat than Rangblang males, such differences may be due to sampling variation or chance errors. The same is true in the case of women, which is not significant (χ^2 = 2.14, df = 1, p > 0.05). With respect to sex differences, **Table 6.5** indicates that women had a greater prevalence of overweight than men in both Domiasiat and Rangblang areas. However, from the statistical point of view, the differences are not significant for both Domiasiat (χ^2 = 2.14, df = 1, p > 0.05) and Rangblang (χ^2 = 0.70, df = 1, p > 0.05).

Overall, the present analyses on nutritional status indicate that the prevalence of underweight is greater in Domiasiat than in Rangblang adults. This can also be seen from **Figures 6.3** and **6.4** for Domiasiat and Rangblang, respectively. The Figures show that the percentage distribution of persons below the BMI level of 19 kg/m^2 was much greater in Domiasiat than in Rangblang for both the sexes. On the other hand, it is likely that the prevalence of overweight and/or obesity was greater in Rangblang than in Domiasiat. It is seen from the figures that the percentage distribution of persons with BMI of ≥23 kg/m^2 is greater in Rangblang, especially in females. It was also observed that the prevalence of underweight is greater in females than in males for both the areas of study (**Figures 6.5.**

and 6.6). It can be seen from the figures that the percentage distribution of persons with BMI level of $\leq$19 kg/m^2 was much greater in females than in males in both the areas of study. On the other hand, it is likely that the prevalence of overweight and/or obesity was greater in females than in males. It is seen from the figures that the percentage distribution of persons with BMI of $\geq$23 kg/m^2 is greater in females, especially in Rangblang.

The study also indicates that the use of BMI cut-off points is very important for defining obesity or overweight. If we follow the cut-off points recommended for the Asia-pacific regions (WHO, 2000), the prevalence of overweight increases significantly for both the sexes and areas of study. However, the sex differences in the prevalence of overweight and/or obesity was not significant in both Domiasiat and Rangblang areas, although it appears to be greater in females than in males. The important implication here is that females are more likely to have a double burden of malnutrition.

Figure 6.3. Percentage distribution of adult males by BMI levels

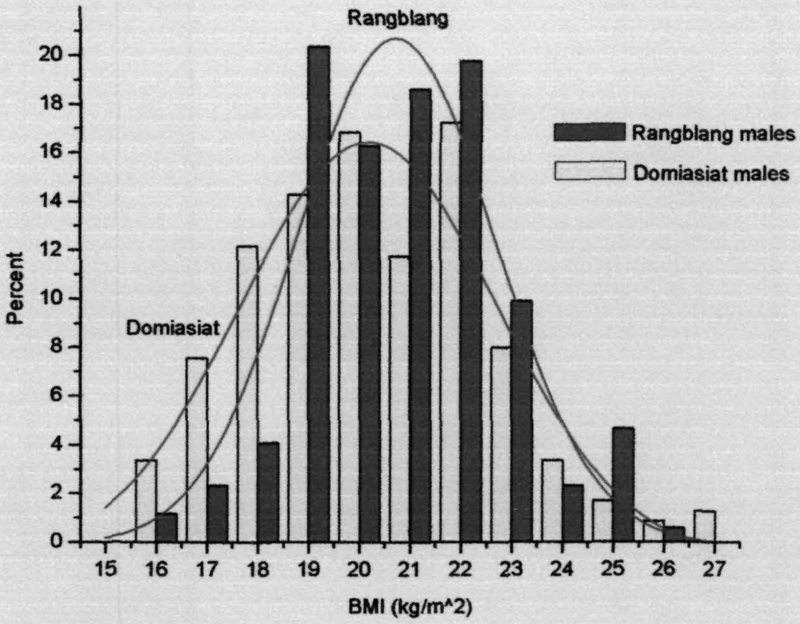


Figure 6.4. Percentage distribution of adult females by BMI levels

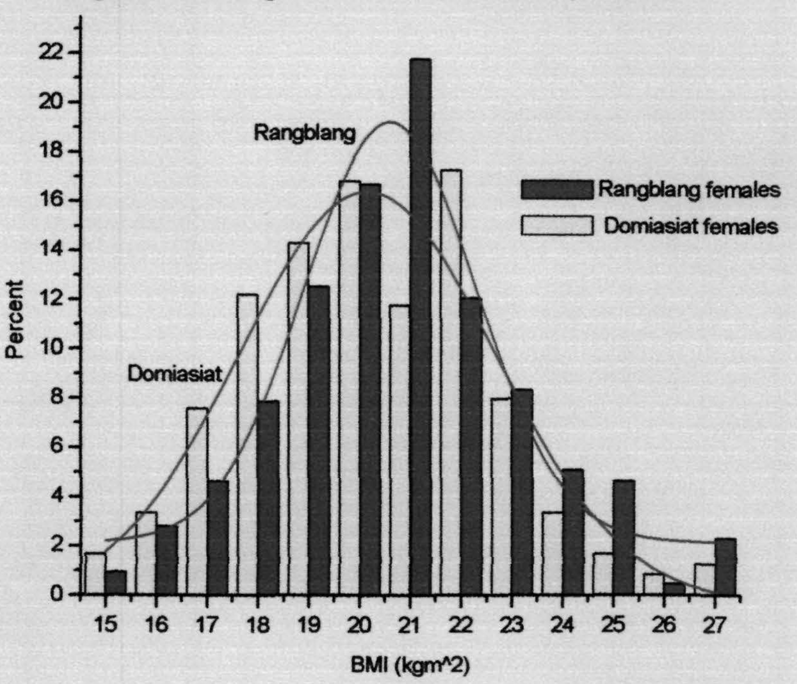


Figure 6.5. Percentage distribution of Domiasiat males and females by BMI levels

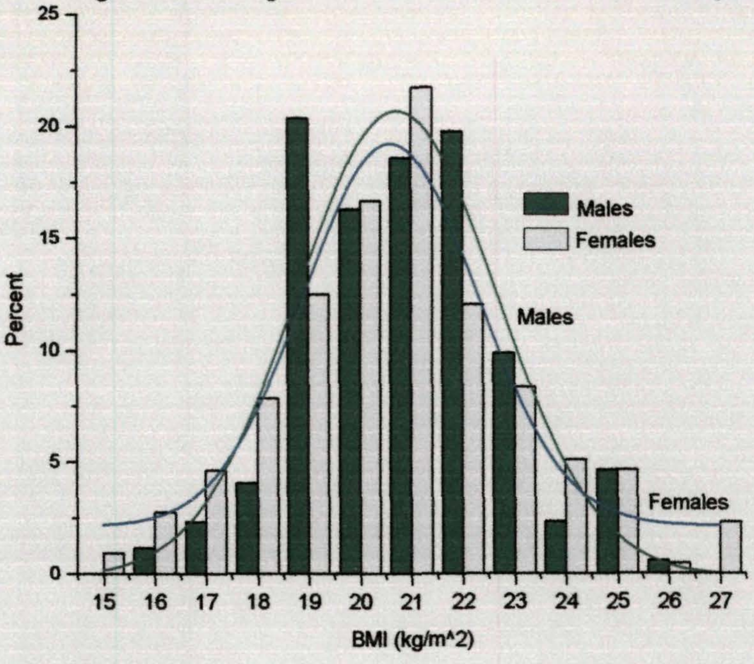
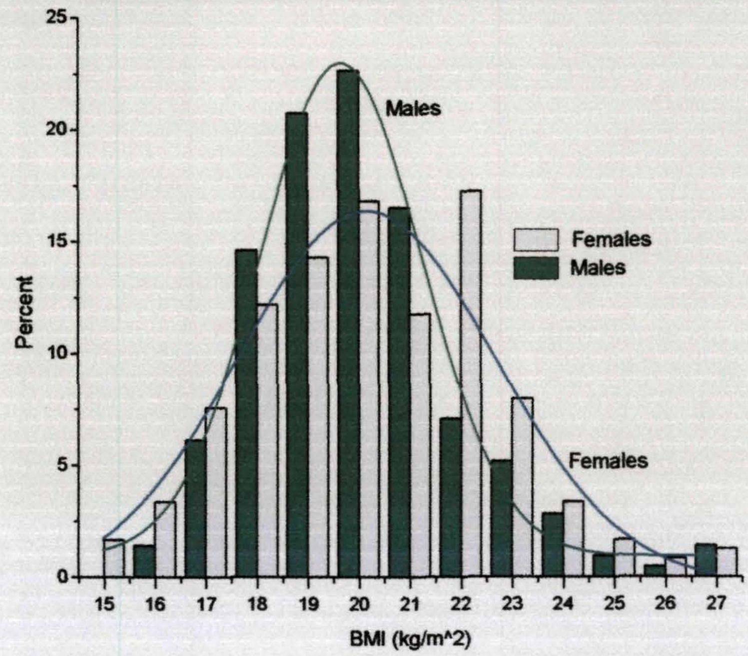


Figure 6.6. Percentage distribution of Rangblang males and females by BMI levels



BLOOD PRESSURE

In this section, we deal with blood pressure of the participants from both Domiasiat and Rangblang areas. The blood pressure is reported in terms of both systolic and diastolic pressure. We shall also look into the prevalence of hypertension in both the sexes and areas of study. Hypertension was defined as a systolic blood pressure ≥ 140 mm Hg, and/or diastolic blood pressure ≥ 90 mm Hg (WHO/ISH, 2003).

Table 6.6 shows the means and standard deviations of systolic and diastolic pressure for both males and females of the two areas of study. It is seen that the mean diastolic blood pressure is similar for both the sexes and areas of study. On the contrary, systolic blood pressure seems to be greater in males than in females, and the sex difference is statistically significant in Rangblang ($t = 2.85$, $p < 0.05$). Therefore, the present findings suggest that there are no clear differences in diastolic blood pressure between the sexes and areas of study. However, the systolic blood pressure seems to be greater in males than in females. In the next section we shall look into the relationship of blood pressure with other independent factors.

Table 6.6. Mean values of blood pressure in Domiasiat and Rangblang areas

Blood pressure and sex	Domiasiat			Rangblang			t-value
		Mean	SD		Mean	SD	
Diastolic blood pressure (mm, Hg)							
Males	208	77.32	10.31	157	77.59	11.04	0.24
Females	235	77.21	10.92	197	76.37	11.94	0.76
t-value	0.11, p > 0.05			0.99, p > 0.05			
Systolic blood pressure (mm, Hg)							
Males	208	119.29	13.84	157	121.16	16.11	1.19
Females	235	116.92	16.99	197	116.30	15.83	0.39
t-value	1.60, p > 0.05			2.85, p < 0.05			

Table 6.7. Prevalence of hypertension in Domiasiat and Rangblang areas

Sex	Domiasiat (n: M = 203, F = 235		Rangblang (n: M = 157, F = 197)		χ^2 - value
	Number	%	Number	%	
Males	30	14.78	31	19.75	1.82, $p > 0.05$
Females	39	16.60	27	13.71	0.69, $p > 0.05$
χ^2 - value	0.40, $p > 0.05$		2.33, $p > 0.05$		

Table 6.7 shows the prevalence of hypertension for both males and females of the two areas of study. Like in the case of mean values, the differences between Domiasiat and Rangblang are not clearly perceptible in the present study. It is seen that the Rangblang males had greater prevalence of hypertension than the Domiasiat males, whereas the Domiasiat females had greater prevalence of hypertension than their counterparts in Rangblang. Nevertheless, the chi-square test indicates that the sex and residence differences in the prevalence of hypertension are not statistically significant. Therefore, we may conclude that the prevalence of hypertension does not seem to be related to sex or place of residence.

HAEMOGLOBIN

Table 6.8 shows the means and standard deviation of hemoglobin level by sex and areas of study. As theoretically expected, the mean hemoglobin content is significantly higher in males than in females for all of the age groups. It may be mentioned here that the World Health Organization (WHO, 1968) has recommended a different cut-off point for adult males (13.0 g/dl) and females (12.0 g/dl) to screen anemia in a population. The present study confirms the importance of such a separate cut-off point for males and females. It may also be noted that we carried out hemoglobin test only among the non-pregnant women of the present study. **Table 6.8** further shows that the hemoglobin content is significantly greater in Rangblang than in Domiasiat. It holds true for both males and females. Therefore, unlike blood pressure, the differences between the sexes and areas of study are clearly perceptible in respect of hemoglobin content.

Table 6.8. Mean values of Hemoglobin content (g/dl) in Domiasiat and Rangblang areas

Sex	Domiasiat			Rangblang			t-value
	N	Mean	SD	N	Mean	SD	
Males	98	13.61	1.79	49	14.99	1.97	4.26**
Females	127	11.78	1.78	62	12.56	1.69	2.88*
t-value	7.63, $p < 0.001$			6.99, $p < 0.001$			

*p < 0.05, **p < 0.001

Table 6.9. Prevalence of Anemia in Domiasiat and Rangblang areas

Sex	Domiasiat (n: M = 98, F = 127		Rangblang (n: M = 49, F = 62)		χ^2 - value
	Number	%	Number	%	
Males	26	26.53	6	12.24	**3.91**, $p < 0.05$
Females	51	40.16	26	41.94	0.05, $p > 0.05$
χ^2 - value	**4.56**, $p < 0.05$		**11.76**, $p < 0.005$		

The prevalence of anemia is shown in **Table 6.9**. It is seen that the Domiasiat males are significantly greater than the Rangblang males in the prevalence of anemia ($\chi^2 = 3.91$, $p < 0.05$). However, the difference between these two areas of study is not significant in females ($\chi^2 = 3.91$, $p > 0.05$). With respect to the sex differences, it is found that females had greater prevalence of anemia in both Domiasiat ($\chi^2 = 4.56$, $p < 0.05$) and Rangblang ($\chi^2 = 11.76$, $p < 0.005$ areas of study. Therefore, we may conclude that the differences between the two areas of study are not clearly perceptible in females, but significant in males. On the other hand, females had greater prevalence of anemia than males in both Domiasiat and Rangblang areas.

SELF-REPORTED MORBIDITY

The frequency and percentage distribution of self- reported health problems of all women for both rural and urban areas during the last one is shown in **Table 6.10**. The self reported symptoms of morbidity are broadly classified into three groups (Sadana, 2000). **Cold and respiratory** include those symptoms such as cough, runny nose, fever, breathing problem, chest pain, sore throat, etc. **Intestinal disorders** include diarrhea, dysentery, worms, vomiting, and other self-reported problems of stomach pain. Self-reported symptoms of morbidity like headache, diabetes, hypertensions and other than the three categories above were included in the category of **Other health problems**.

Table 6.10. Self-reported health problems of all participants during the last one month before the survey

Self-reported health problems	Domiasiat (n: M=212, F=238)		Rangblang (n: M=172, F=216)		χ^2 - value
	Frequency	%	Frequency	%	
MALES					
Cold and respiratory disorders	47	22.17	7	4.07	25.74**
Intestinal disorders	28	13.21	5	2.91	12.83**
Others[a]	31	14.62	13	7.56	4.67*
Overall morbidity[b]	68	32.08	23	13.37	18.37**
FEMALES					
Cold and respiratory disorders	36	15.13	20	9.26	3.61*
Intestinal disorders	25	10.50	5	2.31	12.30**
Others[a]	35	14.71	18	8.33	4.46*
Overall morbidity[b]	67	28.15	37	17.13	7.79*
χ^2 for sex difference in overall morbidity	0.82, $p > 0.05$		1.03, $p > 0.05$		

[a]*Headache, diabetes, hypertension, etc.*

[b]*Based on the number of participants who experienced at least one type of health problem during the last one month prior to survey.*

*$p< 0.05$, $p< 0.001$

Table 6.10 shows that the prevalence of different types of morbidity is significantly higher in Domiasiat than in Rangblang areas. It is true for both males and females. The prevalence of overall morbidity (based on the number of participants who experienced at least one type of health problem during the last one month before the survey) is also higher in Domiasiat than in Rangblang areas. However, the sex differences in respect of the overall morbidity are not statistically significant for both the areas of study. Therefore, the present findings indicate that the prevalence of self-reported morbidity was higher in Domiasiat than in Rangblang, whereas the differences between the sexes were not statistically significant.

BIOSOCIAL CORRELATES

The findings presented so far in this chapter are basically descriptive in nature. It may be mentioned that one of the objectives of the present study is to understand how selected health indicators are associated with different biosocial factors. In this section, we shall look into this aspect with a view to addressing the objective of our study. In doing so, we used different models of the binary logistic regression analysis to understand how underweight, overweight, hypertension, anemia and morbidity are associated with different biosocial factors like, age, sex, household income, education, family size, and different anthropometric variables.

Underweight and Biosocial Correlates

Table 6.11 shows the coefficients of the logistic regression of underweight on independent factors. In model-1, we correlated each independent variable with underweight. It is found that underweight is significantly correlated with place of residence, i.e., it is higher in Domiasiat (coded as 1) than in Rangblang (coded as 2). It is also correlated with sex (males coded as 1 and females coded as 2), age ($B = 0.689 \pm 0.161$, $p < 0.01$), household income ($B = -0.163 \pm 0.077$, $p < 0.05$), education ($B = -0.349 \pm 0.127$, $p < 0.01$), morbidity ($B = 0.567 \pm 0.225$, $p < 0.01$) and waist-hip ratio ($B = -3.060 \pm 0.964$, $p < 0.01$). In model-2, we included only these variables that are significantly associated with underweight in order to understand their relative importance. It is found that the effect of household income, education and morbidity disappeared, i.e. only residence, age, sex and waist-hip ratio are significantly associated with underweight. This indicates that the effects of household income, education and morbidity are less important compared to those exerted by residence, age, sex and waist-hip ratio. In model-3, we included only residence, age, sex and waist-hip ratio. It is found that all of these four factors are significantly associated with underweight. Thus, it may be concluded that place of residence, age, sex and waist-hip ratio are relatively more important factors that influenced underweight among the participants in the present study. It is likely that household income, education and morbidity could influence underweight through these factors.

Table 6.11. Coefficients of the logistic regression of underweight on independent factors

Parameters	Coefficient of regression (B) and its standard error (SE)					
	Model-1		Model-2		Model-3	
	B	SE	B	SE	B	SE
Underweight						
1. Residence	**-0.636****	0.219	**-0.512***	0.229	**-0.582****	0.225
2. Sex	**0.567****	0.218	**0.651****	0.226	**0.670****	0.225
3. Age	**0.689****	0.161	**0.604****	0.168	**0.668****	0.163
4. Household income	**-0.163***	0.077	-0.026	0.144	-	-
5. Education	**-0.349****	0.127	-0.186	0.138	-	-
6. Family size	-0.067	0.151	-	-	-	-
7. Systolic BP	-0.012	0.007	-	-	-	-
8. Diastolic BP	-0.010	0.010	-	-	-	-
9. Hb level	-0.172	0.093	-	-	-	-
10. Morbidity	**0.567***	0.225	0.367	0.237	-	-
11. Conicity index	0.990	0.964	-	-	-	-
12. Waist-Hip ratio	**-3.060****	0.964	**-2.870****	1.004	**-2.992****	0.996

*p < 0.05, **p < 0.01

Model-1 includes morbidity and each independent variable

Model-2 includes residence, sex, age, household income, education, morbidity and waist-hip

ratio as covariates

Model-3 includes residence, sex, age, and waist-hip ratio as covariates

Table 6.12. Coefficients of the logistic regression of overweight on independent factors

Parameters	Coefficient of regression (B) and its standard error (SE)			
	Model-1		Model-2	
	B	SE	B	SE
Overweight				
1. Residence	**0.462***	0.190	**0.464****	0.192
2. Sex	0.305	0.192	-	-
3. Age	-0.083	0.143	-	-
4. Household income	-0.003	0.124	-	-
5. Education	-0.086	0.114	-	-
6. Family size	**0.269***	0.139	**0.304****	0.142
7. Systolic BP	0.011	0.006	-	-
8. Diastolic BP	0.013	0.009	-	-
9. Hb level	0.044	0.077	-	-
10. Morbidity	0.328	0.239	-	-
11. Conicity index	0.294	0.768	-	-
12. Waist-Hip ratio	**2.235****	0.736	**2.254****	0.746

*p < 0.05, **p < 0.01

Model-1 includes morbidity and each independent variable

Model-2 includes residence, family size and waist-hip ratio as covariates

Overweight and Biosocial Correlates

Table 6.11 shows the coefficients of the logistic regression of overweight on independent factors. Like in the case of underweight, we correlated in model-1 each independent variable with underweight. It is found that overweight is significantly correlated only with place of residence, family size and waist-hip ratio. In model-2, we included only these variables that are significantly associated with overweight in order to understand their relative importance. It is found that all the three variables are significantly associated with overweight. It is likely that the participants in Rangblang would have a greater risk of being overweight compared to those in Domiasiat. Similarly increased family size and waist-hip ratio are likely to be the risk factors of overweight among the participants of the present study.

Table 6.13. Coefficients of the logistic regression of hypertension on independent factors

Parameters	Coefficient of regression (B) and its standard error (SE)			
	Model-1		Model-2	
	B	SE	B	SE
Hypertension				
1. Residence	0.060	0.194	-	-
2. Sex	-0.107	0.194	-	-
3. Age	0.038	0.148	-	-
4. Household income	-0.235	0.131	-	-
5. Education	-0.030	0.117	-	-
6. Family size	0.209	0.142	-	-
7. BMI	0.279	0.182	-	-
8. Hb level	**0.168***	0.077	**0.175***	0.079
9. Fat mass index	**0.340***	0.124	**0.263***	0.108
10. Fat-free mass index	0.094	0.062	-	-
11. Conicity index	1.161	0.792	-	-
12. Waist-Hip ratio	0.376	0.781	-	-

*$p < 0.05$
Model-1 includes morbidity and each independent variable
Model-2 includes anemic status and fat-mass index as covariates

Hypertension and Biosocial Correlates

The relationship between hypertension and independent factors is given in **Table 6.13**. It is seen that, out of 12 independent factors, overweight is correlated only with hemoglobin level and fat-mass index. It is found that the effects of these independent factors are still significant even in model-2, i.e., only two of them were included in the regression analysis. Therefore, we may conclude that hemoglobin level and fat-mass index are the two important factors that are significantly associated with overweight among the participants in the present study.

Table 6.14. Coefficients of the logistic regression of anemia on independent factors

Parameters	Coefficient of regression (B) and its standard error (SE)					
	Model-1		Model-2		Model-3	
	B	SE	B	SE	B	SE
Anemia						
1. Residence	-0.250	0.252	-	-	-	-
2. Sex	**0.905****	0.249	**1.005****	0.316	**0.973****	0.261
3. Age	0.189	0.180	-	-	-	-
4. Household income	**-0.331****	0.152	**-0.441****	0.168	**-0.455****	0.163
5. Education	**-0.307****	0.139	-0.242	0.155	-	-
6. Family size	-0.135	0.168	-	-	-	-
7. Systolic BP	**-0.026****	0.008	**-0.027****	0.011	**-0.030****	0.008
8. Diastolic BP	**-0.026***	0.011	-0.003	0.016	-	-
9. BMI	**-0.180****	0.057	-0.159	0.120	-	-
10. Fat mass index	-0.079	0.089	-	-	-	-
11. Fat-free mass index	**-0.293****	0.079	-0.020	0.168	-	-
12. Conicity index	0.333	0.109	-	-	-	-
13. Waist-Hip ratio	1.382	0.122	-	-	-	-

*p < 0.05, **p < 0.01
Model-1 includes morbidity and each independent variable
Model-2 includes sex, household income, education, systolic BP, diastolic BP, BMI and fat-
mass index as covariates
Model-3 includes only sex, household income and systolic BP as covariates

Hemoglobin Content and Biosocial Correlates

Table 6.14 shows the coefficients of the logistic regression of anemia on independent factors. It is found that anemia is correlated with age, sex, household income, education, systolic and diastolic blood pressure, BMI, and fat-free mass index. In model-2, we included only these variables that are significantly associated with anemia in order to understand their relative importance. It is found that the effects of education, diastolic blood pressure, BMI and fat-free mass index disappeared. This shows that these factors are less important when compared to sex, household income and diastolic blood pressure in their effects on anemia. In model-3, we included in the regression analysis only sex, household income and systolic blood pressure. It is found that all these three independent variables are significantly associated with anemia. Thus, it may be concluded that anemic status in the present study is more related to sex, household income and systolic blood pressure compared to education, diastolic blood pressure, BMI and fat-free mass index.

Table 6.15. Coefficients of the logistic regression of morbidity during the last one month on independent factors

Parameters	Coefficient of regression (B) and its standard error (SE)					
	Model-1		Model-2		Model-3	
	B	SE	B	SE	B	SE
Overall Morbidity						
1. Residence	**-0.851****	0.174	**-0.647****	0.325	Removed	-
2. Sex	-0.044	0.164	-	-	-	-
3. Age	**0.302****	0.124	0.243	0.200	0.228	0.198
4. Household income	-0.182	0.110	-		-	-
5. Education	-0.139	0.099	-		-	-
6. Family size	-0.124	0.119	-		-	-
7. Hb level	**-0.144****	0.067	-0.094	0.073	**-0.142***	0.070
8. Systolic BP	-0.005	0.005	-	-	-	-
9. Diastolic BP	**-0.016***	0.008	-0.099	0.073	-	-
10. BMI	**-0.095****	0.037	-0.043	0.084	-0.067	0.083
11. Fat mass index	**-0.200****	0.063	0.126	0.144	-0.221	0.132
12. Fat-free mass index	-0.043	0.053	-	-	-	-
13. Conicity index	-0.368	0.663	-	-	-	-
14. Waist-Hip ratio	-1.215	0.695	-	-	-	-

*p < 0.05, **p < 0.01

Model-1 includes morbidity and each independent variable

Model-2 includes residence, age, Hb, diastolic BP, BMI and fat-mass index as covariates

Model-3 includes only age, Hb, diastolic BP, BMI and fat-mass index as covariates

Morbidity and Biosocial Correlates

Table 6.15 shows the coefficients of the logistic regression of overall morbidity on independent factors. It is found that place of residence, age, hemoglobin level, BMI and fat-mass index are significantly correlated with morbidity. In model-2, we included only these variables that are significantly associated with morbidity in order to understand their relative importance. It is found that only place of residence is significantly associated with morbidity. This indicates that the effects of residence outweighed the effects of all other variables included in model 2. In other words, the greater prevalence of self-reported morbidity in Domiasiat compared to Rangblang cannot be compared with the effects of other independent variables. Therefore, in model-3, we removed the effect of residence by including only age, hemoglobin level, BMI and fat-mass index. It is found that the effects of age, BMI and fat-mass index disappeared (i.e. only hemoglobin level is significantly associated with morbidity). When hemoglobin level is removed from the model, it is found that morbidity is significantly associated with fat-mass index ($B = -0.174 \pm 0.089$, $p < 0.05$). In this way, the relative effects of other variables can be found out with help of logistic regression analysis. However, it is clear that place of residence, hemoglobin level and fat-mass index are more related to morbidity compared to age and BMI among the participants in the present study.

OVERALL HEALTH STATUS

In view of the present findings, the question may arise as to what is the overall health status in the present population? The answer to this question may be difficult because it depends on the nature and types of health indicators taken under a given study. It is well known that human development index (HDI) is measured by taking the average of (1) life expectancy, (2) weighted average of functional literacy and combined elementary and secondary net enrolment rate, and (3) real per capita income. On the basis of the concept of HDI, we have also measured the population or overall health index in the present study by taking into consideration the average of infant mortality, reproductive wastage, proportions of children with underweight, stunting and wasting, and proportions of adults with underweight, overweight, self-reported morbidity, anemia and hypertension. Assuming that the ideal population health index as 1 and the least population health as 0, we calculated the overall health index (OHI) as follows:

On the basis of the concept of human development index (HDI), we have proposed a population or overall health index by taking into consideration the average of infant mortality, reproductive wastage, proportions of children with underweight, stunting and wasting, and proportions of adults with underweight, overweight, self-reported morbidity, anemia and hypertension. Assuming that the ideal population health index as 1 and the least population health as 0, we calculated the overall health index (OHI) as follows:

$$\mathbf{OHI = 1/7(H_{FD}) + 1/7(H_{IC}) + 1/7(H_{CM}) + 1/7(H_{AM}) + 1/7(H_{SM}) + 1/7(H_{HB}) + 1/7(H_{HP})}$$

Where, H_{FD} = 2/3(Still-birth index) + 1/3(Miscarriage index)

H_{IC} = 2/3(Infant mortality index) +1/3(Child mortality index)

H_{CM} = 3/6(Wasting index) +2/6(Underweight index) +1/6(Stunting index)

H_{AM} = 2/3(Adult underweight index) +1/3(Adult overweight index)

H_{SM} = Self-reported morbidity index

H_{HB} = Anemic index

H_{HP} = Hypertension index

Still-birth index = (1- Number of still-births per live-birth)

Miscarriage index = (1- Number spontaneous abortions per conception)

Infant mortality index = (1- Number of deaths before 1 year per live-birth)

Child mortality index = (1- Number of deaths between 1 and 4 years per live-birth)

Wasting Index = (1 - Proportion of wasted children)

Underweight index = (1 - Proportion of underweight children)

Stunting Index = (1 - Proportion of stunted children)

Adult underweight index = (1 – Proportion of underweight adults)

Adult overweight index = (1 – Proportion of overweight adults)

Self-reported morbidity index = (1 - Proportion of adults with at least one case of self-reported morbidity)

Anemic index = (1 - Proportion of adults with anemia)

Hypertension index = (1 Proportion of adults with hypertension)