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 between 1-4 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 ($\chi^2 = 0.32$, df = 1, $p > 0.05$). In short, the difference in sex ratio between Domiasiat and Rangblang areas is not statistically significant ($\chi^2 = 0.43$, 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 Poisson 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 still 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 5th percentile of the
WHO growth reference. Similarly, the body weight of both Domiasiat and Rangblang girls is above the 10th percentile of the WHO reference. However, the curve for Rangblang girls is below the 10th 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 5th percentile of the WHO growth reference from 2 to about 4.5 years of age. Thereafter, they are below the 5th percentile up to below 6 years of age.
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 of 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 ($\chi^2 = 5.57$, 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.

**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 ($\chi^2 = 0.62$, 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 ($\chi^2$ 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 ($\chi^2$ 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 ($\chi^2$ 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 ≥ 22 and ≥ 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 ≥ 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 ($\chi^2 =$
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/m² 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/m² 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:

\[ OHI = \frac{1}{7}(H_{FD}) + \frac{1}{7}(H_{IC}) + \frac{1}{7}(H_{CM}) + \frac{1}{7}(H_{AM}) + \frac{1}{7}(H_{SM}) + \frac{1}{7}(H_{HB}) + \frac{1}{7}(H_{HP}) \]

Where,

\[ H_{FD} = \frac{2}{3}(\text{Still-birth index}) + \frac{1}{3}(\text{Miscarriage index}) \]
\[ H_{IC} = \frac{2}{3}(\text{Infant mortality index}) + \frac{1}{3}(\text{Child mortality index}) \]
\[ H_{CM} = \frac{3}{6}(\text{Wasting index}) + \frac{2}{6}(\text{Underweight index}) + \frac{1}{6}(\text{Stunting index}) \]
\[ H_{AM} = \frac{2}{3}(\text{Adult underweight index}) + \frac{1}{3}(\text{Adult overweight index}) \]
\[ H_{SM} = \text{Self-reported morbidity index} \]
\[ H_{HB} = \text{Anemic index} \]
\[ H_{HP} = \text{Hypertension index} \]

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 5th and 10th 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 50th percentile of
the WHO reference population, it may be expected that the curves should at least lie
between 50th and 25th percentiles. When the growth curves fall away from the 25th
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.