CHAPTER- II
DATA AND METHODOLOGY

2.1 Introduction
The present research work is primarily intended to understand the level of food security and its association with the child health in a rural community setting in West Bengal. Demographic and health indicators in this state is comparatively better than many north and central Indian states, agricultural performance is also quite better and considered as a leading food grains producing state in India, nevertheless food security and malnutrition remains as an issue. The concept of ‘food security’ has been shifted from the national focus to household level focus during mid of 1980s, but there are very few studies in India which concentrate on the household level food security. It’s may be because of the scarcity of secondary data on this particular aspects. Most of the study in India measure food security based on the national or regional food availability and food stock pattern but it does not consider the household access to foods. National Sample Survey (NSS) is the only source of data which gives some vantage to measure on household level food security. NSS collects household’s food consumption and expenditure pattern as a part of consumption expenditure module. But studies that are based on NSS data measure household level food security either using calorie norm (i.e., comparing calorie intake and requirement at household level) or using food expenditure data. The main drawback of these measures is that they are unable to capture multidimensional and qualitative aspects of the household food security. Hence, the present study takes an opportunity to measure the household level food security in most comprehensive ways. Along with, this study tries to investigate the association between childhood malnutrition and household level food security. In order to fulfil the purpose of the study primary data is used, which is not only conceptualize the household food security but also beneficial in explaining the determinants of household food security and it’s association with childhood malnutrition.
2.2 Profile of the study area

2.2.1 West Bengal

The preliminary process involved in a field-based study is selection of study area. The present study was conducted in West Bengal. The rational to choose West Bengal is that nutrition and food security remains as a challenge despite better agricultural performance and improvement in many demographic indicators.

Geographically West Bengal is located in eastern part of India and is the nation’s fourth-most population state, with over 91 million of population. West Bengal is on the eastern bottleneck of India, stretching from the Himalayas in the north to Bay of Bengal in the south. It lies between $85^0\ E$ to $89^0\ E$ and $21^0\ N$ to $27^0\ N$. The state has a total area of 88,752 sq Km. West Bengal is bordered by three countries of Nepal, Bhutan and Bangladesh, and six Indian states of Odisha, Jharkhand, Bihar, Sikkim, and Assam. The capital of this state is Kolkata, a third-largest urban agglomeration and the third-largest city in India. West Bengal is consists of 3 divisions and 20 districts. Depending on soil and climatic variations, West Bengal can be divided into six broad divisions. These are: the hill region in the north; the terai and Teesta alluvial region of North Bengal; the laterectomy, red and gravelly undulating region in the west; the coastal alluvial region in the south; the gangetic alluvial region in the west; the vindhya alluvial region in the centre.

West Bengal is the fourth most populous state in India. As per 2011, West Bengal has population of 91,347,736, out of which 46,927,389 are male. West Bengal accounts 7.55 percent of India’s population. Almost 32 percent population in West Bengal are living in urban area whereas 68 percent are living in the villages of rural counter part. West Bengal shows a decadal growth of 13.84 percent in the last decade. About 77 percent of the India’s population are literate but there are gender disparity in the level of literacy. Nearly 83 percent of male population are literate while female literacy level is 71 percent. Literacy level of West Bengal has seen a bit of upward trend from 2001 to 2011. Highest level of literacy is found in the districts of Purba Medninipur (87 %); Kolkata (86 %); N 24 Parganas (84 %); Howrah (83 percent), and Hugli (81 percent). Sex-ratio of West Bengal is 950 female per 1000 male, which is better than the national average of 940 as per 2011 census. As concern to the child sex ratio (0-06 yrs), it is 956 female child per 1000 male child. West Bengal is the second most densely populated state in India. As per 2011, population density of West Bengal is 1,028 oer sq km which is much higher than the
national average of 382 per sq km. Most of the people are Bengalis, but Marwaris, Bihari and Oriya minorities are scattered throughout the state. Main official languages of West Bengal are Bengali and English.

Table 2.1 Socio-economic and demographic profile of West Bengal

<table>
<thead>
<tr>
<th>Demographic Profile</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>91,276,115</td>
</tr>
<tr>
<td>Male Population in percent</td>
<td>51.37%</td>
</tr>
<tr>
<td>Female Population in Percent</td>
<td>48.63%</td>
</tr>
<tr>
<td>Total Area (in sq km)</td>
<td>88,752</td>
</tr>
<tr>
<td>Percent of National Population</td>
<td>7.55%</td>
</tr>
<tr>
<td>Population Growth</td>
<td>13.84%</td>
</tr>
<tr>
<td>Percent of Urban Population</td>
<td>31.87%</td>
</tr>
<tr>
<td>Percent of Rural Population</td>
<td>68.13%</td>
</tr>
<tr>
<td>Literacy</td>
<td>77.08%</td>
</tr>
<tr>
<td>Male Literacy</td>
<td>81.69%</td>
</tr>
<tr>
<td>Female Literacy</td>
<td>66.57%</td>
</tr>
<tr>
<td>Sex Ratio</td>
<td>950</td>
</tr>
<tr>
<td>Child Sex Ratio (0-06 yr)</td>
<td>956</td>
</tr>
<tr>
<td>Population Density/ sq km</td>
<td>1,028</td>
</tr>
<tr>
<td>Total Fertility Rate</td>
<td>1.7</td>
</tr>
<tr>
<td>Infant Mortality Rate (per 1000 live birth)</td>
<td>32</td>
</tr>
<tr>
<td>Life Expectancy of Birth (in years)</td>
<td>64.9</td>
</tr>
</tbody>
</table>

Source: Census, SRS

2.2.2 Bankura district

Bankura District from West Bengal has been chosen for this study because it is one of the underdeveloped districts in West Bengal where most of the socio-demographic and development indicators are low compared to other parts of West Bengal. Nutrition is also a major challenge in the district. Nearly 46 percent under five children in this district is malnourished which is much higher than the state average. Bankura district is one of the seven districts of Burdwan Division in the Indian state of West Bengal. Bankura is located in the western part of the state and almost 230 km far way in western direction from the capital of the state. Geographically, Bankura district is bounded by latitudinal extent of 22° 38' N to 23° 38' N and longitudinal extent of 86° 36' E to 87° 46' E, covering a total geographical area of 6,882 sq.km. On the north and north-east the district is bounded by Bardhaman District, from which it is separated mostly by the Damodar River. On the south-east it is bounded by Hooghly district, on the south by Pachim Medinipur district.
and on the west by Purulia district. The district has been described as the “connecting link between the plains of Bengal on the east and Chota Nagpur Plateau on the west”. The area to the east and north-east are low lying alluvial plains. To the west the surface gradually rises, giving way to undulating country, interspersed with rocky hillocks. Most of the area of this district is covered with forest. The western part of the district has poor, ferruginous soil and hard beds of laterite with scrub jungles and sal woods. Most of the hills of this district are consist of outlier of the Chota Nagpur plateau and two are the famous-Biharinath and Susunia. The rivers of the area flow from the north-east to the south-west in course roughly parallel to one another. The important rivers are: Damodar, Dwarakeswar, Shilabati, Kangsabati, Sali, Gandheswari, Kukhra, Birai, Jaypanda and Bhairabbanki. Economically, Bankura is a backward district. In 2006 the Ministry of Panchayati Raj named Bankura one of the country’s 250 most backward districts.

As per 2011 census, Bankura district has a total population of 3,596,674 out of which 92 percent living in rural area. Population distribution is mostly scattered, having a population density of 523 people per sq.km. Average 70 percent of the total population is literate whereas 80 percent of male population and 60 percent of the female population are literate. In regards to sex ratio, it is 957 female per 1000 male which is little better than the national figure 940. The district is mainly agrarian economy based where 66 percent of the working population engaged in agriculture either as cultivators (31 percent) or as agricultural labour (35 percent).

2.3 Sample size

Total sample size for this study will be determined based on prevalence of child malnutrition in Bankura District. Second round of District Level Household Survey (2003-04) shows that 43 percent children of aged under five years are malnourished (underweight) in Bankura District. Total sample size for this study has been determined using the following formula:

\[
N = \frac{Z^2 \cdot p \cdot q}{d^2 \cdot r}
\]

\[
n = \frac{(1.96)^2 \cdot 0.43 \cdot 0.57}{(0.05)^2 \cdot 0.9}
\]

\[
= 418 \text{ or } 420
\]
Here,  
$n =$ the estimated sample size  
$Z =$ the $z$ value at 95% confidence level (e.g. 1.96 for a 95% confidence level)  
$d =$ the marginal error (i.e 0.05)  
$p =$ prevalence of malnutrition 43 percent  
r = response rate 90% (i.e 0.9)  

Hence, the estimated minimum required sample size for this study was 418. However, I have been able to collect information from 485 households, which is higher than the minimum required sample. Thus, the present study analyses a total sample of 485 households from rural Bankura of West Bengal.

2.4 Sample frame and selection of sample households  
The present study follows a cross-sectional study design. A multi-stage sampling procedure was applied to select the sample households. In first stage Community Development Blocks (CDB) were selected. Villages and sample households were selected in the second and third stage of the sampling respectively.

2.4.1 Selection of CDB  
Bankura District comprises with three administrative subdivisions (SD) – Bankura Sadar Sub-Division, Khatra Sub-Division and Bishnupur Sub-Division – and 22 Community Development Blocks (CDB). Out of 22 Community Development Blocks, two were selected randomly i.e Borjora Block and Sonamukhi Block. Borjora Block falls under Bankra Sadar subdivision and Sonamukhi Block falls under Bishnupur subdivision. These two blocks are quite diverse in terms of many developmental indicators such as percent of SC/ST population, literacy rate, percent of marginal workers etc. As total sample size was 420, it was decided that a minimum of 210 households to be collected from each block.

2.4.2 Selection of villages  
In second stage, villages were selected from these two Community Development Blocks. Form each block seven villages were selected on the basis of probability proportionate to
size (PPS) where size or number of households was considered for selection. Hence, a
total of 14 villages were selected from these two Community Development Blocks.

2.4.3 Estimation of number of households

In the last stage, number of households to be surveyed was estimated for each of the
village. As mentioned earlier, It was decided to survey a minimum of 210 households
from seven selected villages of each block. Thus, sample households from each village
were estimated following proportional allocation to the village size. Larger sample was
collected from bigger village and small sample was collected from smaller village.
Purposive sampling was used to select the households within the village, but with a
condition that household should have at least one child of aged six months to five years.
Though minimum sample for this study was estimated 420 households i.e 210 households
from each block. But I have been able to collect 236 households from Sonamukhi block
and 249 households from Borjora block, which heave my sample to a total of 485
households. Details of sampling frame is given as follow:-

Table 2.2 Sample villages and estimated sample households

<table>
<thead>
<tr>
<th>Block</th>
<th>Village</th>
<th>Total Households</th>
<th>Estimated Households</th>
<th>Surveyed Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sonamukhi</td>
<td>Samanta Bandi</td>
<td>27109</td>
<td>210</td>
<td>236</td>
</tr>
<tr>
<td></td>
<td>Jaynagar</td>
<td>78</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Alampur</td>
<td>216</td>
<td>42</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Basudebpur</td>
<td>96</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Maitya</td>
<td>69</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Ranga Matiya</td>
<td>495</td>
<td>97</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Nabagram</td>
<td>84</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>2. Borjora</td>
<td>Napara</td>
<td>382</td>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Paharpur</td>
<td>748</td>
<td>78</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Bamandih</td>
<td>482</td>
<td>50</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Purakonda</td>
<td>188</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Shitalpur</td>
<td>81</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Metia Narayanpur</td>
<td>74</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ashuria Madhabpur</td>
<td>52</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

Total            | 420            | 485               |
Fig 2.1 Location map showing distribution of sample villages, Bankura, West Bengal
2.5 Tools of data collection

Both quantitative and qualitative methods were applied to collect the information. Quantitative information was collected canvassing semi-structured questionnaire among sample households. Two different questionnaires were used – household questionnaire and child questionnaire. Household questionnaire was canvassed to any of the adult women member who is responsible for the preparation and distribution of food in the household. Child questioner was asked to mother of the child. In case of more than one children aged six months to five years present in the household, information was collected for youngest children only. In such case questioner was administrated to the mother of youngest child in the household. Qualitative information was collected using key-informants interview. A total of ten key-informants interviews had been conducted, out of which five key informants were selected from households, three were Sarpanch (Panchayat Pradhan), and two were ration dealer (owner of fair price shop).

2.5.1 Quantitative data

2.5.1.1 Household questionnaire

Household questionnaire has been consisting of eight sections, which are discussed as follows:

Section – I: Household roster

A household roster was prepared to collect the details demographic information of each of the individual of the household. Household roster records the information about relationship of household members with head of the household, residence status in home, age, sex, marital status, and level of education of each individual of the selected households. This section is useful to understand the overall demographic composition of the household.

Section- II: Household details

This section covers mainly socio-economic aspects of the households. It records information about household religious and caste status, migration of the household, type of house, type of family, use of cooking fuel, ownership on various consumer durable items, access to drinking water, type of toilet, sources of lighting etc. This section depicts the social and economic imprints of household.
Section- III: Household landholding and livestock

This section collects information about household’s access to land and livestock in the household. Information collected in the section include access to land- cultivated land, irrigated land, types of irrigation, types of crops produced in the household, food grains stock behaviours, access to loan for agriculture, livestock in the household etc.

Section-IV: Occupation and employment

This section mainly deals with the occupation and employment status of household members. This section collects information on nature and types of employment, mode and amount of payment, days of work in a year for each individual adult employed member in the household. It also records about child employment-types of work and mode of payments. Additionally, it also collects the household income from the remittance in the form of cash or kind.

Section – V: Participation in food based safety net programs

This section covers information on household participation and perceptions about various food based safety net programs. This section collects information about types of ration card in the household, access to PDS, interaction of ration dealer with household member, service quality of PDS, household access to ICDS and Mid-day-meal programme, Quality issue of service delivery, participation in MGNAREGA program, job security under this programme, and household’s perception about the benefits of food based safety net programmes.

Section- VI: Heath wellbeing and morbidity

This section collects the information of health wellbeing and morbidity among all members of households. Information was collected about both short-term and major morbidity. Short-term morbidities like fever, cough and diarrhoea were collected for one months reference period while major morbidities such as cataract, tuberculosis, hypertension, heart disease, high BP etc were collected for one year reference period. Other information such as treatment seeking behaviour, day’s loss due to morbidities were also asked along with the information of short-term and long-term morbidities. This section also collects information if there is any physically challenged or handicap persons in the household.

Section –VII: Household consumption and expenditure
This section records information of about consumption quantities and expenditure pattern on various food and non-food items. This section collects information of consumption and expenditure pattern about various food items (cereals, pulses, milk and milk product, sugar, salt, non-veg, vegetables, fruits, and other food items) for 30 days of reference period of the survey. Information collected are quantity consumed, price spend, and sources for each of the food items during 30 days of reference period. For non-food items, only expenditure were collected for one year of reference period. Non-food items include expenditure on education, medical expenses, clothing expenses, home appliances, and all others necessary non-food expenses.

**Section VIII: Household food security and coping strategies**

This section contains questions to capture the household food security condition and household coping behaviour at time of food shortage. Information was collected about the cyclic nature of food shortage, diets pattern in the households, and coping behaviours during food shortage. This section contains all the questions of 8 items Household Food Security Survey Module to capture the broad domain of food security status in the household. This module asked questions about anxiety of food shortage, experience of shortage of money to buy food, perception of household about quantity and quality of food, and instances of hunger in the household etc. This section also contains a set of questions to understand the coping behaviour of the household at time of food shortage. Questions were designed to capture both the consumption coping strategies and livelihood coping strategies.

**2.5.1.2 Child questionnaire**

This scheduled contains four sections, which contain information about the various aspects of child care, nutrition and health.

**Section I: Child demographic information**

This section mainly records demographic characteristics of the child. This section collects information on child sex, date of birth, birth order, birth weight, place of delivery, whether attended by a skill birth attended, place of delivery etc.

**Section II: Child feeding practice**

This section contains information about child feeding practices including complementary feeding. Information was collected about breast feeding practices, feeding of colorstum
milk, if child is feed colorstum milk immediately after birth, duration breast feeding, frequency of breast feeding. Apart from the complementary feeding, this section also collects information about diets of children in the last 24 hours.

**Section III: Child illness and child immunization**

Information on child illness and child immunization has been asked in this section. To understand the childhood illness, question was asked about the occurrence of fever and diarrhea in the last two weeks of survey. Questions were asked about the treatment seeking behaviour for this childhood illness. Information about immunization of the child has also been collected. This includes status of immunization (whether immunized or not), immunization against Polio, BCG, DPT, measles, and vitamin A. Information was recorded about the partials or full immunization and if immunized the numbers of immunization was also recorded.

**Section IV: Anthropometry measurement**

This section records information on anthropometric measurements of children and their mother. Information on height and weight of children and their mother was recorded in this section.

2.5.2 Qualitative data

2.5.2.1 Key informants interview

Key-informants interviews were carried out to get an insight on household perception in participating the food based safety net programs, how they cope the food insecurity condition, problem in accessing the PDS, role of PDS in improving food security-quality and quantity issue, and perception of ration dealer on the operation of PDS. For this study a total of ten key informants interviews were conducted, out of which five key-informants were selected from sample households, three were ration dealer and two were Panchyaet Pradhan (Sarpanch). Following major domains were covered:

Perception about food security at the household. What is the major concern for food security at household? How far can they maintain quantity and quality of food that they consumed?

What are the major sources of food? Are these sources sustain throughout the year?

What are the major sources of nutrition? Are they capable to choose nutritious foods for their diets? What determines the food selection of their food basket?
What determines food security at the household?
Perception of the household about the seasonal pattern of the food insecurity.
Perception and participation about food based safety net programs such as MGNREGA, Mid-day meal, PDS, ICDS etc.

What are the major coping strategies during the time of food shortage?
How far are government programs helpful for better coping mechanism during the time of food shortage?
Role of Panchayet during the time of emergency circumstance of food shortage.
Awareness about various government programs and benefits of the programs

Some additional and specific questions were asked while interviewing the ration dealers and panchayet pradhan.

Guide line of specific questions for Ration Dealers:-
Perception about customers/ beneficiaries behaviour.
What are the problems that they face in the effective operation of PDS?
What are the problem that they face in regular dispatch of commodities form godowns?

Guide line of specific questions asked to Sarpanch:-
Role of panchayet during the emergency of food shortage.
Fund allocation and fund distribution on development purpose.
Role of MGNREGA in improving the household food security.
If there is any social audit ?
Role of panchayet in improving the nutrition and health of their people.

2.6 Ethical issue
Participants were not misled about the benefit from the study, and neither false promise was made. Informed consent from the participants was taken before starting the interview, briefing about the contents of the questionnaire was provided. The participants had full liberty to leave the interview any moment they felt unwilling to answer the questions. Extra caution was taken while administering the sensitive questions, so as not to cause emotional damage to the responded. Utmost care was taken to keep the information gained from the respondent, confidential.
2.7. Data collection

2.7.1 Preparation of the field work

After completing the preparatory work for data collection (i.e., selection of study area and preparation of quantitative and qualitative tools for data collection) the final data collection was started. The survey was carried out during the months of December 2012 to March 2013. This period was best suited for the survey because of some reasons. First, this was the time of retreating monsoon and winter prevailed and hence considered a suitable whether for visiting villages and households. Second, this study area showed a monoculture practice, agriculture was mainly done during the kharip season (during monsoon time) and rabi cultivation was not very popular in this area due to scarcity of irrigation facility. So household members were expected to be at home in that time due to less demand of agricultural labour. Questioners were translated into local language (in Bengali) for the convenient purpose. Before starting the survey, several visits were made in the villages, and interacted with the village people and community leaders to get their support during the data collection.

2.7.2 Collection of anthropometric data

Anthropometry data was collected for the purpose of the study. Height, weight and age of the children and mothers were collected. For taking weight, digital weight machine was used to get accurate weight. Women and children were weighted twice and the average weight was entered as final to minimize error. The children who were less than two years of age were weight along with their mother. First, women hold their children and stood on the weight machine, later on the weight of the mother was subtracted and weight of the children was calculated. Information on height were taken for both mother and child. Mothers and child of age more than two years were measured against straight wall and then that height was measured with an inch tape. The children who were less than two years of age were measured in laying down position.

2.7.3 Difficulties faced during data collection

Overall, the experience of data collection was very good; however, I had to face some problems and difficulties, especially in the initial stage of the survey. It was little difficult
for me to engage myself with the community people initially. So building a good repute with the village people was a major challenge for me. That’s why, I had several visits to the villages and contracted with the people and community leaders, which helped me to get involved them in my study. Another problem arose during the time of conducting interview due to lengthiness of the questioner. I had to fill two questioners from each household that together lengthen to about 45 pages, which took session for almost 60 to 75 minutes to complete one household. Thus, it was very challenging task to conduct an interview with the respondent due to their reluctance to sit for such a longer period of time.

Most of the time respondents were much interested to inform their personal problems. Whenever they got a chance, they started to complaining about government, local politician, neighbours etc, which were irrelevant to my study. It was also difficult task to divert their conversation in the right track which were relevant with the study. Further, I found another problem during the interview. I found that respondents were hiding many information, particularly which were related to the land, income and household assets. Initially, I could not get that why they were suppressing these information, but later I found that they were thinking me as a governmental officials. So, I had to make them very clear that I was not a governmental person but I am a research student. Though in the beginning of the survey, I told them about myself and about the study but again I had to narrate them that this study will be used only for research purpose. Many times I had to record the information based on the observation.

Recall bias was an another problem that I faced while collecting the retrospective data. There were some section which required retrospective data, especially household’s consumption expenditure section, food security survey module, dietary diversity module, coping strategy model etc. But proper attention was given in these sections and respondents were thoroughly probed to get the correct answer. Apart from these, I also faced some other difficulties relating to the accessibility to the villages, food and other logistics. Even though I came across some of the difficulties and problems, at the end it was an excellent learning experience.

2.8. Data compilation

After obtaining data from field, data was edited and cleaned. Although pre-cautions were taken during the field and recognised problems were fixed at that time, still re-editing, data consistency check were done to maximize the quality of the data. At the time editing,
codes were assigned appropriately to open ended questions for need of data entry and analysis. Data compilation and entry was done using Cs Pro 4.0 package, which is developed by US census processing unit and is now being widely used for the processing of survey data. Analysis was done using STATA version 12 and SPSS version 20 softwares.

2.9. Data analysis

To fulfil the objectives of present study, appropriate uni-variate, bi-variate and multi-variate techniques were used. Apart from percentage distribution, mean and standard deviation (SD) were computed as per the requirement. Proper multi-variate techniques were applied in this study to understand the effect of independent or explanatory variables on the outcome variable. Appropriate statistical tests were applied to explore the statistical significance of association between two variables based on the nature of the data and requirement.

2.9.1 Multi-variate analysis

2.9.1.1 Binary logistic regression analysis

The binary regression analysis is useful when the outcome variable has only two categories (0 or 1), which are mutually exclusive. This model has advantage over the simple regression model partly because it is easy to interpret the result as it leads to a logit model that derives the relative likelihood of the occurrence of the event of interest. The basic form of logistic regression model, which yields the probability of occurring of an event, can be shown as:

\[
p = \frac{1}{1+e^{-z}} = \frac{e^z}{1+ e^z} \quad \text{....................(1)}
\]

Where, \( z \) is the predictor variable (linear combination of independent variables) and \( e \) is the base of natural logarithm. Thus, in a multivariate logistic regression, \( z \) will be a linear function of a set of predictor variables and could be written as:

\[
Z = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \ldots \ldots + b_kx_k
\]

Therefore, in a mutivariate logistic regression, the form of logistic function will be:
\[ p = \frac{1}{1 + e^{(b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots + b_k x_k)}} \]

In other word, the probability of non-occurrence of an event will be:

\[ 1 - p = \frac{1}{1 + e^{-z}} = \frac{e^{-z}}{1 + e^{-z}} \quad \ldots \ldots \quad (2) \]

From equation (1) and (2),

\[ \frac{1}{1 + p} = e^{-z} \]

The quantity, \( p/(1-p) \), is called the odds ratio of the occurring an event, denoted more concisely as \( \Omega \) (uppercase omega), and the quantity \( \log(p/(1-p)) \) is called the log odds or the logit of \( P \). Thus,

\[ \text{Odds} = \frac{1}{1+p} = \Omega = e^{(b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots + b_k x_k)} \]

\[ \text{Logit } P = \log \frac{1}{1+p} = \log \Omega = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots + b_k x_k \]

In the logistic regression, coefficient ‘\( b \)’ is the factor by which the odds changes with unit increase in independent variable. If ‘\( b \)’ is positive then odds ratio will increase, as this factor will be greater than one. Contrary to that, if ‘\( b \)’ is negative then the odds will decrease. When ‘\( b \)’ is 0, the factor exponential of ‘\( b \)’ equals to 1 and, therefore, the odds remain unchanged.

2.9.1.2 Multiple linear regression model

Multiple regression technique is an extension to the bi-variate linear regression model where dependent variables are continues in nature. The main advantage of using this model is that it allows more than one predictor variables in the model to estimate their effect on dependent variables. The general form of multiple linear regression model is:
\[ Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \ldots + \beta_k X_{ki} + \epsilon_i \]

Where \( k \) denotes the number of predictors and ‘i’ denotes the \( i^{th} \) member of the population.

One can interpret \( \beta_1 \) as an estimated effect of \( Y \) of one additional unit of \( X_1 \), holding \( X_2 \) \ldots \( X_k \) constant. Similarly, \( \beta_2 \) as the estimated effect on \( Y \) of one additional unit of \( X_2 \), holding \( X_1, X_3, \ldots, X_k \) constant.

### 2.9.1.3 Ordered logit regression model

Ordinal logistic regression is used when the depended variable is classified according to their order of magnitude such as ‘low’ ‘medium’ and ‘high’. One of the assumptions underlying ordered logistic regression is that the relationship between each pair of outcome groups is the same. In other words, ordered logistic regression assumes that the coefficients that describe the relationship between, say, the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories, etc. This is called the proportional odds assumption or the parallel regression assumption. Hence it is also called as the proportional odds model (McCullagh, 1980) Because the relationship between all pairs of groups is the same, there is only one set of coefficients (only one model). Thus ordered logit models are used to estimate relationship between an ordinal dependent variable and a set of independent variables.

In ordered logit, an underlying score is estimated as a linear function of the independent variables and a set of cut-points. The mathematical equation of this model can be defined in following way:

\[
\lambda_j(\tilde{x}) = \ln \left( \frac{\sum_j^i \Pr(y = j|\tilde{x})}{\sum_{j+1}^k \Pr(y = j|\tilde{x})} \right) = \alpha_j + (\beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p)
\]

Here,

\( j=1,2,\ldots, k-1 \)

\( y= \) response variable, \( \tilde{x} = \) vector of explanatory variables = \((x_1, x_2, \ldots, x_p)\)
2.9.2 Statistical Tests
Appropriate statistical tests were performed to tests the significance differences between and among the variables. Chi-square test was used to explore the statistical significance of association between two and more categorical variable. Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. T-test has been used to test the statistical significance in the difference in mean score (z-score) between two categorical independent variables. One-way analysis of variance (ANOVA) has been applied (F-test) to test the statistical significance in difference in mean score of more than two categorical independent variables.

2.10 Limitation of the study
This study contributes in conceptualizing the household food security in more comprehensive manner, going beyond to the calorie norm approach. It also tries to understand the association between child malnutrition and household food security status. Nevertheless, the present study suffers with some limitations. Being a cross-sectional nature, this study collects many information regarding household food security, coping strategies, consumption and expenditure pattern in retrospective ways which might have been affected by recall bias. Household food security might be in different forms such as – chronic, cyclic or seasonal. Seasonal variation of household food security may be better captured in a longitudinal study. A cross sectional study may not be an appropriate study design to capture the seasonal variation of household food security. This study also attempted to understand the association between household food security and childhood malnutrition. Childhood malnutrition in this study is measured using anthropometric indicators. Most of the anthropometric indicators reflect the long term deficiency of nutrition. But the present study measures household food security on short period of time (say last one year) which may not sufficient to capture the long-term nutritional changes among children. Further, the present study is based on only rural area, but it would have been a good attempt to study the rural-urban difference of food security in association with the childhood malnutrition.