Maternal Health and Maternal Mortality: A Study of Four Selected Districts of Assam

A thesis submitted to Indian Institute of Technology Guwahati
in partial fulfilment of the requirements for the degree of
Doctor of Philosophy

By

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Guwahati, India

2018

Dedicated to

My Parents

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Declaration

This thesis entitled **"Maternal Health and Maternal Mortality: A Study of Four Selected Districts of Assam"** submitted for the degree of Doctor of Philosophy has not been previously submitted for any other degree of this or any other university and is my original work.

In keeping with the general practice of reporting scientific observations, due acknowledgement has been made wherever the work described is based on the findings of other investigations.

IIT Guwahati
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Certificate

This is to certify that Miss Pranti Dutta has prepared the thesis entitled **"Maternal Health and Maternal Mortality: A Study of Four Selected Districts of Assam"** for the degree of Doctor of Philosophy at the Indian Institute of Technology Guwahati. The work was carried out under my supervision and in strict conformity with the rules laid down for the purpose. The thesis is the result of her investigations and has not been submitted either in whole or in part to any other university/ institution for a research degree.

IIT Guwahati
February, 2018

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Supervisor

Acknowledgements

I would like to express my sincere thanks to many teachers, friends and members of my family who provided me with support and advice while I was working on this thesis. At the outset, I would like to express gratitude to my supervisor, Dr. Bodhisattva Sengupta, for his sincere guidance, support, encouragement and kindness from the beginning till the end of my work. I am immensely grateful to him for his generous and constant effort in providing me with positive feedback on all my writings.

I do express my deep sense of gratitude to the members of my doctoral committee. I sincerely thank Prof. Saundarjya Borbora, Dr. Mrinal Kranti Dutta and Dr. Debarshi Das for their insightful comments, suggestions and encouragement. Their suggestions and comments have enriched my research from various perspectives. I would also like to express my sincere gratitude to Dr. Hiranya Kumar Nath, Dr. Rajshree Bedamatta and Sriparna Bandopadhyay for their helpful suggestions.

I am grateful to the Department of Humanities and Social Sciences (HSS), Indian Institute of Technology Guwahati (IITG) for providing me the opportunity to carry out my research. I am grateful to the office staff of Department of HSS, Bandana Khataniar, Parag Kalita and Durga Sarma for their kindness and ready administrative help. I would also like to take this opportunity to express my sincere thanks to the Ministry of Human Resource Development (MHRD) for providing me with fellowship assistance to conduct my research smoothly.

The IIT Guwahati Central Library (Lakshminath Bezbaroa Central Library) has been an asset with ample resources for the thesis. I also owe my thanks to the different libraries like Krishna Kanta Handique Library, Gauhati University, Omeo Kumar Das Institute of Social Change and Development, Guwahati, Indian Institute of Public Administration, Delhi, Institute of Human Development Delhi, International Institute for Population Science Mumbai, Indian Institute of Technology Mumbai, Tata Institute of Social Science Mumbai, Gokhale Institute of Politics and Economics, Pune, Jadavpur University, Kolkata, Indian Statistical Institute, Kolkata, Institute of Development Studies, Kolkata during the course of literature review.

I am extremely indebted to numerous people for their kind support, time and ready-help provided during my fieldwork in different districts of Assam namely- Kamrup, Dibrugarh, Sonitpur and Cachar. Without their help it would have been difficult to carry out my survey to collect data on maternal health. I would also like to thank village-heads, medical officers, ANMs and ASHA workers who extensively supported and cooperated during my field visits to different villages of Muhimari, Patgaon, Lepetakatta, Jazimukh, Kadamani, Sakamato, Motinagar and Silcoorie. I also sincerely thank NRHM-Assam for extending their helping hand in accessing data on maternal health.

I would also like to take this opportunity to acknowledge my family for their constant support who deserves more than words could express. I am extremely grateful to my parents and elder sister Dr. Rinti Dutta and Bother-in-Law Pranab Bhajani for their love and encouragement to work hard, stay focused and who have always been sources of inspiration in my life. I feel privileged to express my sincere thanks to my aunt Mrs. Gayatri Dutta and all family members for their sincere help, love and support throughout my research work.

Among my friends, special thanks go to Prerana Hazarika, Jimlee Saharia, Bikram Baruah, Anuj Athparia, Chandita Baruah, Deepa Gupta, Suparana Katyaini, Samarpita Basu, Rinshu Dwivedi for constantly encouraging me during my work. I must extend my special thanks to Bharat Konwar, Mahsina Rahman, Rajashree Bargohain, Munmi Saikia, Nirmala Devi, Sariful Rahman, Bhasker Pegu, Pankaj Kalita, Bhupen Mili, Mizingsa Daimary, Rakesh Soud, Suju Kumar Baglari, Hemanta Barman, Luke Horo, Baban Bayan, Halim Hussain, Rupan Boro, Jitu Tamuli and many others who were extremely cooperative throughout the study and provided me with moral support during the entire period.

Finally, I express my deepest acknowledgement to Aniruddha *(Ani)* for offering me his wonderful companionship, time and support and thorough encouragement during my work. I truly believe that without his constant care and understanding it would have been difficult for me to remain persistent and complete this thesis.

(Pranti Dutta)

February, 2018

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Abbreviations

Abbreviations	Explanations
AHS	Annual Health Survey
AIC	Akaike Information Criterion
ANC	Antenatal Care
ANM	Auxiliary Nurse Midwives
AHS	Annual Health Survey
ASHA	Accredited Social Health Activist
BPHC	Block Primary Health Centre
CBR	Crude Birth Rate
CDR	Crude Death Rate
CHC	Community Health Centre
DLHS	District Level Household and Facility Survey
EAG	Empowered Action Group
EmOC	Emergency Obstetric Care
ESS	Effective Sample Size
FOGSI	Federation of Obstetric and Gynecological Societies of India
FRUs	First Referral Units
HBM	Health Belief Model
HDR	Human Development Report
HPD	Highest Probability Density
IAY	Indira Awaas Yojana.
ICU	Intensive Care Unit
ICDS	Integrated Child Development Services
IMR	Infant Mortality Rate
JSY	Janani Suraksha Yojana
JSSK	Janani Shishu Suraksha Karyakram

MCH	Maternal and Child Health
MCMC	Monte Carlo Markov Chain
MDG	Millennium Development Goals
MMR	Maternal Mortality Ratio
NFHS	National Family Health Survey
NRHM	National Rural Health Mission
NSDP	Net State Domestic Product
OBC	Other Backward Class
OLS	Ordinary Least Squares
PCI	Per Capita Income
PHC	Primary Health Centre
RAMOS	Reproductive Age Mortality Survey
RCH	Reproductive And Child Health
SC	Scheduled Caste
SDG	Sustainable Development Goal
SRS	Sample Registration Sample
ST	Scheduled Tribe
TBA	Traditional Birth Attendants
VIF	Variance Inflation Factor
U5MR	Under Five-Mortality Rate
UNFPA	United Nations Fund for Population Activities
WHO	World Health Organization

Abstract

The thesis addresses factors associated with high maternal mortality in Indian state of Assam through examination at disaggregated level. Motivation for taking up this research is twofold. First, according to recent estimates of Sample Registration System (SRS) report 2013, Assam exhibits the highest Maternal Mortality Rate in India with 300 per 1, 00,000 live births. An adverse pregnancy has lifelong effects on women's health and her new-born as well. However, studies which have investigated the context-specific reasons behind such a dismal statistics are limited in both number and scope. To the best of our knowledge, this thesis attempts to fill up the gap in literature in a more comprehensive fashion. Second, in 2010, Planning Commission of India came up with a proposal of increasing government financing of health sector from 1 percent of GDP to at least 2.5 percent by the end of 12th Plan i.e. 2017. The fund is purported to be utilized for improving health care workforce, quality of care, governance and accountability. For effective and productive use of such enhanced funding, it is imperative to identify the sectors where public money should be spent to improve maternal health outcome. To this end, the thesis identifies certain barriers to maternal health seeking behavior at disaggregated level.

We provide a brief outline of the thesis here. Frist, a broad range of literature is reviewed to understand the relationship between prevailing maternal health scenario and reasons for higher maternal deaths, both at national and international levels. Given this background, the thesis first analyzes how well the secondary data (obtained from various Government sources) fits the literature. To provide answer to this research question, we use rank correlation and cluster analysis. Surprisingly, districts with better socioeconomic conditions and better availability of maternal care facilities have higher maternal mortality compared to the ones with lower level of socioeconomic variables and maternal care facilities. This shortcoming may result from the fact that, data were taken from different sources and years, given the paucity of quality secondary level data for this region. This also highlights the fact that, any meaningful research and policy prescription, at least in the context of Assam and North Eastern India, should not be based on secondary data sources alone.

Observation from field survey indicates that anemia is one of the major causes of maternal deaths in sample districts of Assam. Medically speaking, maternal anemia is the result of the

lower concentration of hemoglobin level in red blood cells. The evidence from the field shows that such lower hemoglobin level is due to dietary imbalance resulting from low hem product in daily dietary intake. Further, analysis based on regression model indicates that concentration of low hemoglobin level is significantly associated with literacy, land landownership and teagarden habitats. However, evidence in favor of literacy rate (in terms of level of significance) is a bit weak. In addition, maternal health seeking behavior is shaped by organizational factors such as non-availability of ambulance and non-availability of female health providers; cultural factors such as ignorance and hesitation; socioeconomic factors such as long queue at facilities, non-availability of persons at home to take care of pregnant women and heavy workloads.

Based on the findings, one of the major implications is that policymaker should consider context-specific identification of factors affecting maternal health. For example, according to our results, food-based approach might be effective and preventive measures to reduce iron bioavailability (rather than supplements). Heath promotion action needs to encourage people to seek medical help, ensuring availability of physical infrastructure and female health providers. In addition, community level awareness of maternal problems, tracking, monitoring of pregnant women are needed to enhance maternal health seeking behavior of the population.

Results of the thesis have been published in various forms in:

Edited Book Volume:

1. Dutta, P. 2017. "Maternal Anemia: A Village Level Empirical Observation in Assam" in *Issues of Health and Healthcare in India: A Special Reference to North Eastern Region* (ed) by U K De, M. Pal, P. Bharati and Manoranjan Pal. Springer, Singapore, ISBN 978-981-10-6103-5, PP. 97-108.

Conference Proceeding:

2. **Dutta, P.** and Sengupta, B. 2017. "Socioeconomic Determinants of Maternal Anemia: A Disaggregated Level Analysis from Assam, India" of 3rd *International Conference of Public Health* (ICOPH), by TIIKM, Sri Lanka, ISSN: 2324-6735, PP.71-87.

CHAPTER I

INTRODUCTION

1.1. Background of the Study:

1.1.1. Women's Health and Maternal Mortality:

World Health Organization (WHO) defines the term '*maternal health'* as health of women during pregnancy, childbirth and postpartum period. Improving maternal health acts as an indicator of development measure reflecting the status to access the health institutions, skilled health personnel, women empowerment, education, nutrition, social status and socio-economic development of the society (Johnson, 2010). Recent statistics of WHO (2013) show that HIV/ AIDS is the leading cause of death worldwide, whereas, maternal deaths are second largest contributor to the global disease burden of women at their reproductive age. Maternal death is the worst outcome of maternal health problems, which is defined as

> *"The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes."*
>
> (WHO, 2010)

Around the world, about 830 women die from pregnancy and childbirth-related complications (WHO, 2016) on a daily basis. In addition, developing countries contributed to over 99 percent of all maternal deaths worldwide (*ibid*). The Sub-Saharan Africa (546 per 100,000 live births) suffers from highest Maternal Mortality Ratio (MMR) followed by Oceania (187) (WHO, 2015). At country level, India (15 percent) and Nigeria (19 percent) accounted for one-third of all global maternal deaths (*ibid*). Such a high figure remains as a paradox since most (around 80 percent) of the maternal deaths are due to well-researched and preventable causes (UNICEF, 2008; Goldie et al., 2010; Shija et al., 2011) and there are successive international commitments to cut down maternal mortality. The most recent and well-publicized of those, the Millennium Development Goal (MDGs) of 2000 committed MMR to be cut by 75 percent between the years 1990-2015 (Neiburg, 2012). Its successor,

the Sustainable Development Goal (SDGs) 2015, attempted to reduce of MMR[1] to 70 per 1, 00,000 live births by 2030 (UNDP, 2015). There have been significant improvements in some of the MDG/SDG goals such as reduction of poverty and hunger, access to clean drinking water facilities, provisions of electricity and roads. These achievements fall short in cases of reduction in gender inequality, child mortality and access to adequate sanitation or eliminate open defecation (U N, 2015).

Reduction of maternal mortality directly targets the survival probability of almost 49.5 percent (World Bank, 2015) of humanity. One could argue (like a Kantian, e.g. White, 2011) that such statistics itself is an important reason for such intervention. However, since modern economics (both in theory and policies) is rooted in consequential philosophy of Utilitarianism, arguments based on efficiency grounds to defend interventions to target maternal health are not hard to find. Apart from saving the life of a mother, improvement of maternal health is crucial for the survival of newborn as well as elder children (Powers & Maddux, 2013). It is observed that infants whose mothers have died during her childbirth have more risk of dying in their first year of birth than those of mothers who remain alive (UNICEF, 2007). According to Koblinsky (1995), 14 perinatal deaths (i.e. deaths of a foetus or death of an infant in the first week of life) occur each year for every one maternal death in developing countries. Further, a child's nutritional status is highly associated with mother's nutritional health status during her pregnancy (Derbyshire, 2011). Low weight, nutritional deficiency or anemia during pregnancy of the mother can lead to low birth weight and under-nutrition to her children, which contributes to more than one-third of child deaths (UNICEF, 2009). Thus, current state of maternal health directly or indirectly conditions future status of public health.[2]

During 2015, MMR in developing region was almost 20 times more than that of developed regions. In Sub-Saharan Africa, the ratio is almost 45 (WHO, 2015). According to UNFPA (2005), an Afghan woman is 600 times likely to die during childbirth than an American

[1] Number of maternal death per 100000 live births. See other related definitions in Chapter II.

[2] Victora et al., (2008) focuses on long-term effect of maternal health, while Black et al., (2013) demonstrates short-term consequences, especially in low and middle-income countries. It is also being recognized that other aspects of future human capital are directly linked with current human capital *of the mother*. See, for example, Rozenswig and Wolpin, 1994.

woman. Such global disparities reflect not only resource constraints, but the societal attitude towards women/ maternal health.

In any disease, cure occurs through multiple phases. One has to identify a health problem, decide to seek medical advice, consult a (qualified) doctor and follow up the treatment over the prescribed time period. Maternal complications are unique to women, and, in this respect, solution and cure of such complications are linked with factors like income, education, customs and beliefs, power status of the patient within society and family, as well as actual or perceived quality of healthcare services. In presence of adverse structural conditions, pregnant women cannot imagine to seek care or use maternal healthcare services (Chamberlain et al., 2007). In view of the above observation, incidence of maternal mortality within a society reflects how well the society counters pre-existing gender biases. On the other hand, recognition and mitigation of gender-related discrimination, institutionalizing women's agency in seeking medical care as well as fertility decisions form an integral part of human rights promotion (Moss, 2002; WHO, 2013). Hence, maternal mortality is not only a key indicator of overall health of a population, but it provides an indirect commentary on the status of women and gender equality.[3] In this way, reduction of maternal mortality becomes a human rights issue.

In recent years, the central role of women in Economic Development has been stressed with increasing frequency within international development and donor agencies: so much so that one could observe almost parallel and simultaneous international efforts of narrowing the gender gap as well as promoting maternal health. Till late 1970s, the issue of maternal health was not a matter of concern in the world public health system. In many developing countries, maternal health statistics were either non-existent or incomplete. During 1977, only 66 countries out of 162 provided data on maternal mortality (Van Lerberghe & De Brouwere, 2001). World Health Organization had introduced Maternal and Child Health (MCH) programme during 1950's. The stress was on- technical supports such as training of midwives, integrating maternal health care with general health service, building of separate

[3] Database for Family Planning and Reproductive Health Indicators (2015).

administrative divisions etc.[4] Rosenfield & Deborah (1985) have pointed out that MCH programme stressed more on child health, neglecting the aspects of women's health and safe delivery.[5] Alma-Ata Declaration of 1978 (WHO) first included Maternal Health Care including family planning as a basic component of primary health care (Thaddeus & Maine, 1994). In the wider discourse on development, it came to be recognized around the same time that the process of Economic Development, as it is commonly understood, may leave women outside the ambit of it (e.g. Boserup, 1970). Such considerations generated the Women in Development (WID) movement during the early to mid-1970's, with successive conferences for women (1975 Mexico City, 1980 Copenhagen, 1985 Nairobi and 1995, Beijing) stressing on women's health as an area of concern. In 1987, the Safe Motherhood Initiative (promoted by the World Bank, WHO and UNFPA) emphasized improved referral system, availability of Emergency Obstetric Care Facilities (EmOC)[6] at health institutions, regular antenatal check-ups and delivery with skilled birth attendants etc. At the same time, the campaign also declared equity for women as a pillar of safe motherhood. This twin, and somewhat inseparable objectives of reduction in gender gap and improving maternal health finally culminated in the Millennium Development Goals (Goal 3 seeks to promote Gender Equality while Goal 5 explicitly targets MMR) and its successor, Sustainable Development Goals (Goal 3.1 stresses reduction of MMR[7], while Goal 5 targets Gender equity and empowerment). Bolstering the discourse on maternal health and maternal mortality through issues of gender equity and women-centric development thus consolidates women's right to health.

[4] See Chapter II, section 2.1.4 "Maternal health: getting priority in health sector".
[5] That is, the MCH program treated maternal health as a subset of child health.
[6] EmOC is a package of facilities which include both basic and comprehensive components. Basic EmOC- Treatment for sepsis, eclampsia, obstructed labour, incomplete miscarriage, Post-abortion care. Comprehensive EmOC: along with above listed services it includes- caesarean section, anesthesia, safe blood transfusion (RAISE, 2007).
[7] As well as "universal access to sexual and reproductive health-care services, including family planning, information and education, and the integration of reproductive health into national strategies and programmes"

1.2. Statement of the Problem:

Recent estimates of Sample Registration System (SRS) 2013, the Indian state of Assam experienced highest Maternal Mortality Ratio (MMR) in India with 300 per 1, 00,000 live births. Since 1997-98, Assam has always been one of the top (above the 3rd quartile) states with MMR. The details on outliers are presented in Table 1.A. However, studies that have investigated the context-specific reasons behind such dismal statistics are limited in number. Secondly, the key recommendation of the High-Level Expert Group (HLEG) on Universal Health Coverage (Planning Commission of India, 2010) is that Government should increase public expenditure on health sector from 1.2 percent of GDP to at least 2.5 percent by the end of 12th Plan i.e. 2017 and to a at least 3 percent of GDP by 2022 (Thakur, 2011). The fund is purported to be utilized for improving health care workforce, quality of care, governance and accountability. For effective and productive use of such enhanced funding, it is imperative to identify the sectors (in the context of maternal health) where public money should be spent. The current literature largely focuses on utilization of maternal health care services using data from various National Family Health Survey (hereafter NFHS) and District Level Household Survey (hereafter DLHS) reports (Mahapatro, 2012; Gogoi et al., 2014; Singh et al., 2014; Rawat et Al., 2015). Such studies do not address the broader scope of health seeking behavior in the context of community. The present study is undertaken to contribute in such areas.

1.3. Objectives of the Study:

The objective of the study is to investigate the problems of high maternal mortality in Assam. Based on this, we propose three sub-objectives

1. Analysis of maternal mortality at district level based on secondary data.
2. Socioeconomic determinants of maternal complications at micro level.
3. Factors conditioning demand for reproductive health care at micro level.

1.4. Data Sources and Methodology:

The present study is based on both secondary and primary data sources. Secondary data have been collected from various reports of the Sample Registration System (SRS) and National Family Health Survey (NFHS). For district level data, the recent publications of Family Welfare Statistics in India, Annual Health Survey 2010-11, Assam Human Development Report 2014, National Rural Health Mission (NRHM), Statistical Handbook of Assam (various years), Census 2011 and reports of District Level Household Survey (DLHS) are used. Facility Survey of Public Health Institutions in Assam during 2007-08 and District Level Household and Facility Survey 2012-13 are used for comparing availability of health care services.

Data on district wise maternal mortality and live births of Assam during the period of 2011 to 2014 has been collected from NRHM regional office as well as the official website of NRHM, Assam. Apart from these, various information (leaflets of various programs and policy regarding maternal health) has been collected from Directorate of Health Services of Assam, the National Rural Health Mission Regional Office and the Census Regional Office, Guwahati.

To collect primary data, the field study was carried out in eight villages of four districts in Assam. Multistage sampling has been used to identify the sample villages. At first, by using stratified sampling methods, districts under all four Administrative Divisions of Assam have arranged from highest to lowest based on maternal mortality ratio for the period April 2013 and March 2014. The highest maternal deaths reported in districts from each of the Administrative Divisions are identified as Dibrugarh (413.3103), Kamrup (230.1539), Sonitpur (297.3435) and Cachar (516.6315) that comes under Upper Assam Division, Lower Assam Division, North Assam Division and Hills & Barak Valley respectively.[8] From each sample district, one Block Primary Health Center (BPHC) which reported highest maternal deaths was selected viz. Barbaruah (86), Chhaygaon (96), Biswanath Chariali (14) and Sonai (10) from Dibrugarh, Kamrup, Sonitpur and Cachar respectively. As per advice of Block

[8] Note that, two of these districts are above the state average and two are below it.

Level Medical Officer, purposively two villages[9] from each BPHC (total 8 villages) have been identified accordingly. These villages are Janzimukh and Lepetkatta Tea Estate from Barbaruah (Dibrugarh district), Muhimari and Patgaon from Chhaygaon (Kamrup district), Kadamoni and Sakumato Tea Estate from Biswanath Chariali (Sonitpur district) and Motinagar and Silcoorie Tea Estate from Sonai (Cachar district).

The following subjects were chosen for interview through a structured questionnaire

a) Currently pregnant women;
b) Mothers who have children aged 0-24 months.
c) Members of families who have experienced of maternal death(s).

Snowball sampling method (which is used when the desired sample characteristic is rare) is applied to identify the sample household in each sample village (the details of snowball sampling is outlined in Chapter IV). 169 households were selected for the field survey. Household survey was conducted during the period from October 2014 to February 2015 with reference period of 365 days preceding the date of the survey. In addition, a simultaneous survey also was conducted in all Block Primary Health Centers with Medical Officers and ANMs of the respective villages in order to understand the available maternal health care facilities and human resources at health institutions and their perspectives on prevailing maternal health status among women as a provider point of view.

Data from secondary sources and field surveys are analyzed using appropriate statistical tools. The proximate determinants of district level maternal mortality in Assam (Chapter 3) have been examined using cluster analysis with one-way ANOVA methods. Factors behind maternal complications at micro level (Chapter 5) are examined through testing for independence of attributes (e.g. Pearson's Chi-Square Test) as well as OLS regression. In addition, to identify barriers of maternal health seeking behavior (Chapter 6), we use a Bayesian logistic regression to fit the data. The methodology, in detail, is discussed in the respective chapters.

[9] Which reported highest maternal death/complication.

1.5. Layout of the Chapters:

The present thesis contains seven chapters including the present one.

Chapter II reviews definitions, approaches, concepts, magnitudes and significance of maternal mortality. This chapter discusses different strategies used in both developed and developing countries to improve maternal health outcomes. It also covers conceptual framework of demand for maternal care. Further, it discusses factors affecting maternal mortality at national level in order to have a better understanding of existing policy interventions. Therefore, this chapter provides the background of maternal health as well as maternal mortality to identify the scope for further research in Assam.

Chapter III focuses on maternal health scenario of Assam. After a theoretical analysis of factors which cause maternal complications, it also attempts to figure out to what extent such theoretical factors fit with recorded macro data at the district level. The problem with secondary sources of data justifies to the necessity of field visit.

Chapter IV contains discussion of field selection, data collection and a broad profile of sample villages with background characteristics of sample units. Subsequent chapters are based on the field survey.

Chapter V examines the determinants of maternal complication (which lead to high-risk pregnancy) at micro level.

Chapter VI presents an analysis of the barriers of maternal health seeking behavior from formal health care institutions, given the sample.

Chapter VII provides a summary of major findings, policy implications and future scope of the research.

Appendix

Table 1.A: ***Maternal Mortality Ratio in India in Selected States with Outliers (Per 1, 00,000 Live Births)***

States/Years	Assam	Bihar	Kerala	Rajasthan	Tamil Nadu	Uttar Pradesh	West Bengal	India	Q_1 (India)	Q_3 (India)
1997-98	**568**	531	150	**508**	131	**606**	303	398	226.5	549.5
1999-01	398	400	149	**501**	167	**539**	218	327	192.5	450.5
2001-03	**490**	371	110	445	134	**517**	194	301	164	467.5
2004-06	**480**	312	95	388	111	**440**	141	254	126	414
2007-09	**390**	261	81	318	97	**359**	145	212	121	338.5
2010-12	**328**	219	66	255	90	**292**	117	178	103.5	273.5
2011-13	**300**	208	61	244	79	**285**	113	167	96	264.5

Source: Registrar General of India, Ministry of Home Affairs (SRS Bulletins)

Note: Q_1 is the first quartile (25 percentile); Q_3 is the third quartile (75 percentile)

CHAPTER II

Maternal Health in Perspective

In this chapter, we first provide a brief account of relevant concepts and measurement issues. Next, a brief overview of literature is done (a) to review the status of maternal health in the contemporary era, (b) examine its significance to the public health system and (c) to explore the factors which lead to adverse maternal outcome across the world and national level.

The rest of the chapter is organized in three sections. Section 2.1 discusses the issues of maternal health. In Section 2.2, factors behind maternal mortality are discussed. Section 2.3 concludes the whole discussion of the present chapter.

2.1. Issues of Maternal Health

2.1.1. Definitions:

Since 1970's, several changes have been made in the definition of maternal death. In 1979, the International Classification of Diseases Ninth Revision (ICD-9) first included the term **maternal death** to be interpreted as death of a pregnant woman within a time-frame of 42 days at the end of the pregnancy period. However, earlier interpretation of such death was said to occur anytime within one year at the end of the pregnancy. The **indirect obstetric causes of maternal death** are the second inclusion. Indirect obstetric causes of maternal death result from pre-existing diseases, or those which developed during pregnancy and which was not due to direct obstetric causes, however, it was aggravated by the physiological effects of pregnancy such as malaria, anemia and cardiovascular diseases, lack of timely and appropriate treatment (Nour, 2008). **Direct causes** are defined by deaths resulting from obstetric complications of the pregnant state such as hemorrhage, sepsis, eclampsia, obstructed labour and complications of abortion; from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above (Lewis & Drife, 2004). During 1999, the International Classification of Diseases Tenth Revision (ICD-

10) included concepts to the existing definition of maternal death that was forwarded by WHO-**Pregnancy related deaths,** as above, are defined as death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death. **Late maternal death** are those deaths of a woman from direct or indirect obstetric causes more than 42 days but less than one year after termination of pregnancy.

The conventional definition of **Maternal Mortality Ratio** (MMR) is the ratio of the number of maternal deaths during a given period per 1, 00,000 live births while **maternal mortality rate** is the number of maternal deaths during a given period per 1, 00,000 women of reproductive age (WHO, 2010).

2.1.2. Measuring Maternal Mortality:

Measurement issues receive a top priority in any Development programme, for correct measurement reduces bias in reporting and is an indispensible tool for policy evaluation. Gradual modification and improvement have been made in methods of estimations and approaches that are used in measuring maternal mortality in different countries for the years 1995, 2000 and 2005. The World Health Organization (WHO) report of 1990 (published in 1996) has developed the worldwide concern about the issues of maternal mortality and women and child health as well. The report has further increased the methodological and conceptual understanding of maternal health issues to figure out the weakness of different measurement approaches of maternal mortality.

The vital registration system theoretically, tracks all events of death and birth, and is purported to be the most comprehensive method of measuring maternal death. A number of approaches have been used to estimate maternal death by WHO/UNICEF, in countries that do not have vital registration system. In this context, the *large-scale household survey* is one of the prominent methodologies (Ahmed et al., 2014). However, it requires large sample sizes and is extensive and time consuming. *Sisterhood method* is generally considered (Graham et al., 1989) cost effective as it needs smaller sample sizes than large-scale survey because each of the respondents can provide information on a number of sisters. This

method obtains information on maternal mortality by interviewing the sample of respondents about the survival of their siblings. The main disadvantage of the method is that it does not provide current estimates and also accuracy relies on strong cultural ties between siblings. A third way of measuring maternal mortality is the *Reproductive Age Mortality Survey* (RAMOS). To identify all deaths, this approach uses the multiple sources of information such as civil registers, health facility records, survey/census of households or key informants with direct questionnaire (not sisterhood). However, this method is time consuming and expensive in nature.

During 1990's, WHO and UNICEF developed a new approach where maternal mortality is adjusted to account for under-reporting and misclassification. In essence, the method consists of regress an indicator of maternal mortality on certain predictors which are intuitive in nature and almost universal data is available. The model is estimated using available country level data, and then used to predict out-of-sample indicator for maternal mortality for countries where maternal deaths data is not readily available. The predicted values are then compared with existing data gathered from other sources (UNICEF, 1996). In 1990 estimates, two independent variables were-general fertility rates and proportions of births that are assisted by trained persons.

In 1995 estimates treated *Proportion Maternal among Deaths of Females of Reproductive Age* (PMDF) as dependent variable. Other major methodological differences in estimation of 1995 as compared to 1990s are - countries were classified based on the time and quality of available maternal mortality data. Values for an independent variable were carefully reviewed country-by-country (AbouZahr & Tessa, 2001).

The approach during 2000 used WHO classification of countries according to the completeness of vital registration. To remove HIV- related deaths from deaths of women of reproductive age, this approach calculated maternal deaths from model-based PMDFs rather than deaths from the United Nations projections (that were used in 1995 estimates). In 2000 estimates, the absolute number of maternal death has slightly increased from 515,000 in 1995 to 529,000 in 2000 while the global MMR during the same time frame has remained unchanged at 400 per 100,000 live births (AbouZahr & Tessa, 2004).

Finally, the recent 2005 approach, added the definition of *life time risk of maternal deaths*[10] that accounts the other causes of deaths of female during their reproductive period. Estimates made by this approach have slightly increased to 536,000 as compared to 529,000 in 2000. Finally, the report pitched for improvement of civil registration systems for the data accuracy rather than indirect methods which have their own weakness (Say et al., 2007).

To sum up, a comprehensive civil or vital registration system is the most reliable way for measuring maternal mortality. However, in many countries, such reporting systems are weak, so maternal death or causes of death are underreported or may not be reported at all. In such countries, a number of indirect methods are applied, each with their own pros and cons. In absence of any data, even an imperfect estimate has to do the job. This is the guiding philosophy of these alternative approaches.

The succeeding discussion will include the magnitudes of maternal deaths and historical analysis of maternal mortality in getting priority in health sector worldwide and India as well.

2.1.3. Magnitudes of Maternal Deaths in India:

In Chapter I (section 1.1.1), we have already discussed the recent statistics of WHO on maternal deaths across globe, regional and at country level, that indicating the magnitude and concerns for maternal mortality worldwide. In India, Rawal (2003) notes that estimate of maternal mortality were very speculative till 1990's. The first WHO-UNICEF measures came in 1999. National Family Health Survey (NFHS)-I estimate soon followed, which relied on the large scale household survey method. Estimates of Sample Registration System (SRS) report shows that MMR in India has dropped from 398 per 100000 live births (1997-98) to 167 per 100000 live births (2011-13). Despite this, the magnitude of success is not that high in global comparison. Between 1990 and 2015, India succeeded to reduce the

[10] Lifetime risk of maternal deaths: The probability of risk of dying from maternal causes during a women's reproductive lifespan.

number of maternal deaths, but lags behind to achieve MDG 5 (Table 2.1.A). If we look at the state level estimates, we can find high variation in maternal deaths. As seen from Table 2.2.A, highest number of maternal deaths have occurred in states like- Assam, Rajasthan, Uttar Pradesh (as compared to Kerala, Tamil Nadu) which stresses need for further research on maternity service for the well-being of women at the reproductive age. Women between the age group of 15-35 are more vulnerable, as pregnancy and childbirth are the leading cause of maternal death and morbidity. In this regard, prevalent adolescent pregnancy (15-19) is another major concern that contributes substantially to these deaths (Graczyk, 2007).

These estimates depict only the magnitude of maternal deaths which resulted from pregnancy related complications. WHO (2004) contended that counting the death of pregnant women in developing countries is not enough to understand and identify the deeper cause of women's death during their reproductive age. Numbers do not tell the actual story of suffering and reasons behind women death at their reproductive age and what can be done to prevent such deaths.

It is very crucial to address the severity and magnitude of maternal deaths and lifelong morbidities of women due to pregnancy related complications because of three major reasons. Firstly, maternal deaths are not as common as death caused by other high-burden disorders (like HIV/ AIDS, malaria). Secondly, accurate measurement of maternal death is technically difficult. Finally, intervention to prevent maternal mortality is not as simple as some specific diseases (several children's diseases) that are preventable by vaccination. Additionally, maternal victims being a part of disadvantaged and vulnerable section of the society may have little political power. These are the challenges to draw attention of the policymakers' (Shiffman & Smith, 2007). The following section attempts to delineate historical analysis of maternal mortality at a global level.

2.1.4. Maternal Mortality: Getting Priority in Healthcare Sector

Historically, maternal mortality was not a subject of public discourse up to the late 1970s. In many developing countries, maternal health statistics were rare to get and incomplete in

nature. Most of the deaths happened at home or on the way to hospitals for which the issues of maternal health were underreported. Lack of disciplinary inquiry and unavailability of data were the main barriers for taking an active action to tackle the problems of maternal health. Even more, donor agencies and planners did also emphasize on child health rather than lives of mothers (Shiffman & Smith, 2007).

During the 1950s, WHO identified maternal health as an area of action and eventually, introduced Maternal and Child Health (MCH) programme. However, the issue gained its importance in the mid-1960s, when international agencies started funding the MCH programme in the developing countries. Thereafter, by the 1970s, the issue of maternal health was influenced by family planning movement. Subsequently, the World Population Conference in Bucharest in 1974 raised the prioritization for MCH and further, UNICEF and USAID started to focus on this programme (Global Health Watch, 2011).

The MCH programme gave more emphasis on child health than maternal health. During the implementation of MCH programme, differences between issues of maternal and infant health remained fuzzy (Rosenfield & Deborah, 1985). Human rights and development priorities of women were taken into consideration by development agencies, through lights on women reproductive health in the late 1970s and mid-1980s. Consequently, the Safe Motherhood Conference was held in Nairobi, Kenya in 1987 which highlighted the emergency and magnitudes of maternal deaths. It revealed that nearly 99 percent of maternal deaths are mostly in developing countries, that pose great challenges to reduce maternal mortality worldwide (UNICEF, 2008).

Apart from the Safe Motherhood Conference, various summits and important conferences were held at different point of time namely, the International Conference on Population and Development (1994); the Fourth World Conference on Women (1995); Millennium Development Goals (2000); Children's Summit (2002), Sustainable Development Goals (2015) etc. The main objective was to readdress the women reproductive health and identification of fiscal space for government intervention in order to widen the health care facilities to meet the demands of mothers.

Ranjan and Stones (2004) have extensively discussed the historical development of maternity care in independent India. After the recommendation of first Health Survey and Development Committee in 1948, Government of India set up Maternity and Child Health Bureaus in states. The office invested in training of health personnel, administration of maternity and child welfare services at the state and local level. During the First Five Years Plan, maternity and child welfare services were expanded to the backward areas. In the 2nd Five Year Plan these services were made integral part of primary health services. Further, these services have gained their priority in the National Health Policy both for the year 1983 and 2000. However, as noted earlier, these programmes emphasized more on child health component than the maternal health component: the emphasis was more on 'clean' deliveries than 'safe' deliveries. In India, maternal health component received major attention for first time during 1990s when Government of India launched the Child Survival and Safe Motherhood Programme which includes universal essential obstetric care services; early detection of complications through regular check-ups as well as community awareness and finally the emergency obstetric care services. During 1977, there was major paradigm shift took place in the delivery of maternal and child health services with the introduction of the reproductive and child health approach for the implementation of the National Family Welfare Programme.

Since the health of mothers and newborn is directly related, safe motherhood programme should need to pay attention to both the mother and the newborn as what affects the mother, accordingly affects the newborn too. The magnitude and historical analysis of maternal mortality in getting priorities in healthcare system reveals the importance of interventions to save the lives of mothers and reducing the risk of pregnancy during their reproductive age. A good understanding of influencing factors of maternal mortality and morbidity is much needed since identification of risk factors can help to initiate appropriate interventions and proper channelization of constraint resources. But before we can discuss any strategy, we must know the factors which are responsible for maternal mortality at the national level.

2.2. Factors Behind Maternal Mortality: A Brief Review

2.2.1. Production of Health:

The framework of health encompasses health system as a meta-entity which includes all the activities that promote, restore and maintain good health. However, the conceptual framework of current work only addresses issues related to maternal health, the focus of which is to improve women's health during her reproductive age, reducing maternal deaths and ensure quality care of mothers and her newborn.

Health production function analysis was pioneered by Grossman (1972a, 1972b). He made direct applications of consumer theory to demand for health and healthcare. Grossman perceives health as a capital stock, which can be increased with investment on health. Consumers demand health for two reasons- as a consumption commodity, since health is a direct source of utility (it makes the consumer feel better) as well as an investment commodity which determines the amount of time available for work, quality of leisure and money earnings. In Grossman model, a health production function links health (of a pregnant woman, in the current context) with inputs like medical care, socio-economic status such as level of income, education, health knowledge, nutrition and government interventions etc. (Grossman, *ibid*; Culyer & Newhouse, 2000; Kverndokk, 2000; Goodman & Currie, 2010).

In more simple sense, health, as a durable good, can be produced by an individual using various "inputs". In terms of a conceptual equation

Maternal Health = H (medical care, time, other health inputs)

Maternal health status, that is, the left-hand side of the variable can be measured through the magnitude of mortality, morbidity and quality of life of pregnant women during her childbearing period. The right hand side of the equation includes the demand for medical care (measured by, say, willingness to visit and/or an actual visit to seek medical care, the amount spent on medical care etc.), time i.e. availability of time for standing in long queue

in health facilities, work, earnings; other factors may include the supply side variables (proxy for quality and organization of medical services), geography, the level of pollution etc.

Demand for medical care is influenced by two major factors- patient specific factors that include health status (HS), demographic characteristic (DC), economic standing (ES). The second is the physician related factors (PF) as they determine the amount of health care utilization both as a provider of medical services and advisers to their patient. This can be expressed as:

Medical care= M (HS, DC, ES, PF)

Ceteris paribus, demand for medical care depends on the health status: presumably, people who are sick will demand more treatment. However, with sickness (and associated morbidity), patients have to spend more money for treatments and hence consumption of medical care diminishes in terms of quantity (less visit to doctor) or quality (seeking treatment from a quake rather than a qualified doctor). As a policy implication, insurance facility should stimulate demand for medical care. However, moral hazard problem may pose a challenge to policymakers as insured patients may use more medical facilities compared to those having no insurance. Second, availability of insurance may change the preferences for acute care instead of preventive care.

Demographic characteristics are proxies for cultural attitude towards health care. They may also capture social and other forms of exclusion.

Quality of medical care services can affect the demand for healthcare. Higher quality care services may reduce the need for repeated visits. It is also observed that in many developing countries lower utilization rates of these services are observed despite availability of insurance or government subsidies because of poor quality, lack of supply as well as the non-pecuniary cost of consuming medical services (Jack, 1999)

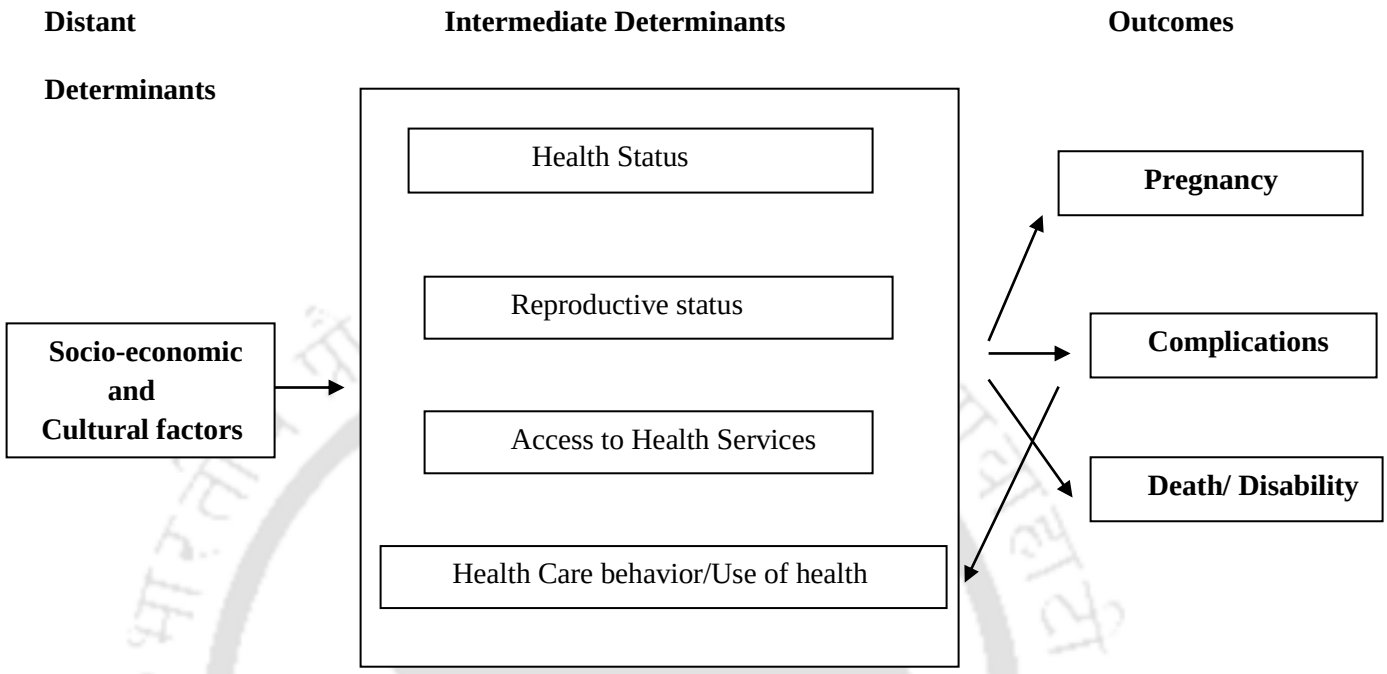
Factors that stimulate demand for healthcare can be divided into two groups. First, there is a need to improve medical services such as improving quality, referral patterns, lowering the

price of drugs and waiting time (will stimulate demand for persons who are sick). Second, knowledge of healthcare need and service providers, improved transport infrastructure etc. All these factors are important in determining demand towards accessing and utilization of healthcare sector (Ensor & Cooper, 2004). In this regard, a study on obstetric choices in Bangladesh (Barkat, Helali et al., 1995 reported in Piet-Pelon, Rob et al., 1999) found that major reasons behind not seeking medical help by women in case of obstetric emergencies are: distance to healthcare facility, lack of knowledge about when to seek medical help and other socio-cultural reasons rather than quality and availability of services.

The *three-delay model* developed by Thaddeus and Maine (1994) provides an alternative to focus on the factors that may contribute to delay in preventing maternal deaths. This framework deals with three types of delay: delay in decision to seek care, delay in reaching medical facility and delay in receiving adequate treatment. The first delay may be caused by socioeconomic as well as cultural factors: ability to recognize maternal complications, gender status, economic and educational status of patient within the household as well as of the household within the neighborhood. The second delay is related to identifying and reaching appropriate health facilities which depend on distance to the facility, transportation conditions, cost of medial fees, opportunity cost of seeking treatment, lack of awareness of existing services etc. Finally, the third delay is associated with quality of services: effectiveness of treatment and satisfaction of the received service. For example: the factors might include: staff attitude, availability of drugs, skilled health personnel, blood transfusion facility and/or other equipment, status of referral system etc. (Thaddeus & Maine, 1994).

Maine (1991) developed a framework for determinants of maternal mortality refereeing maternal death as the ultimate outcome. There are five sets of intermediate determinate and socio-economic and cultural backgrounds that result in poor maternal health outcome that is depicted in the following framework (Figure 2.3)

Figure 2.3: Analytical Model of Maternal Mortality



In studies of maternal mortality, this framework has emphasized the relative importance of different factors from distant variables to outcome in relation to complicated pregnancy and even deaths and disability. Their analysis shows that increased educational and social status of women are less likely to have an effect on maternal mortality unless provision of well-functioning family planning, abortion facility, labor and delivery services are made (McCarthy and Maine, 1992).

However, it can be noticed that, factors responsible for maternal mortality as well as policy implications suggested by these alternative approaches (production function, three-delay model, Maine's model) are not very different from each other. In the next section, we will try to provide a brief description of the factors and their importance.

Based on the discussion above, we can figure out certain determinants of maternal health. These determinants can be grouped into three sections: income/wealth, medical facilities and other social factors.

Income/Wealth: Income refers to money receipt by the individual from all sources including capital assets, labour, services and property. Income is (supposed to be) positively correlated with health outcomes (Case, 2001; Engel et al., 2009). Lower levels of income may result in poor health indicators like higher mortality, morbidity and less access to health care facilities due to lower social status, financial problem, early marriage and lack of basic necessities like housing, nutritional foods, safe drinking water, sanitation etc. High out-of-pocket expenditure (including cost of transportation or medicine) implies that a patient below a cut off level of income are unable to visit medical clinic for regular check-ups and avail institutional delivery. These factors contribute to the fact that lower income households face high risk of maternal deaths during childbirth (McCarthy & Maine, 1992; Nagahawatte & Goldenberg, 2008; Paruzzolo et al., 2010; Finlayson & Downe, 2013). Engel et al., (2009) and Finlayson & Downe (2013) highlighted that higher income individuals have greater access to health care facilities as well as health insurance.[11]

Female Education/Literacy: Female literacy is one of the significant determinants of reducing maternal deaths (McCarthy & Maine, 1992; Egmond, 2004; McAlister & Baskett, 2006; Islam, 2009). A study from Sub-Saharan Africa by Alvarez et al., (2009) argued that education and efficient and effective health system have a significant correlation with maternal deaths. They found an inverse relationship between maternal mortality and coverage of prenatal care, skilled birth attendants, access to safe water, education and government expenditure on health. A study was done by Pillaiet al., (2013) to examine the dynamic relationship between female literacy and maternal mortality in developing countries, found that changes in the rate of female literacy and rate of maternal mortality are negatively related. In other words, high female literacy results in declining rate of maternal mortality. A country like Sri Lanka has more than 80 percent of female literacy rate and MMR is only 60 per 100,000 live births. Similarly, the highest female literacy rate in India is Kerala (92 percent), a state with lowest maternal mortality ratio of 66 per 1, 00,000 live births. Literate women are more likely to have decision-making power over her age of marriage, birth spacing, use of contraceptives, financial security and seek proper healthcare

[11] The literature on income elasticities of medical care (starting from Rosset and Huang 1973) at both macro and/or micro level *unanimously* reveal that the elasticity is greater than zero. The debate is whether health care is a luxury or necessity, i.e. magnitude of the elasticity. Moreover, poor agents are more price responsive than rich agents.

before and during their pregnancy (McCarthy & Maine, 1992). The level of education is significantly linked with maternal health outcome in light of its effect on women's social status, fertility, access to healthcare and particularly women empowerment in taking decision. Maternal mortality tends to be higher in countries where female literacy rate is lower (McAlister & Baskett, 2006). Jain (2012) studied in major states of India about the relationship between female literacy and mortality rates of IMR and MMR. The study found that female literacy makes women aware about nutritional requirement during pregnancy that helps in preventing low birth weight, anemia, and hemorrhage. Additionally, literacy makes women to understand the importance of antenatal care as well as post-natal care and can identify the obstetric problems at times. A good educational background helps women understand the importance of higher and lower fertility and use of contraceptive that leads to a fewer complication during pregnancy. Educated women are also highly aware of the maternal healthcare services and they can demand and seek proper healthcare before and during pregnancy. Educated women are more likely to have financial security and can take timely decision for their better health (McCarthy & Maine, 1992). Thus, it also results in higher utilization of maternal healthcare services.

Age of Marriage: Age of marriage is an influential factor in determining women's health status. Marriage at early age results in the adverse and risky pregnancy; poor knowledge of nutritional diet and use of family planning methods; number of birth order and lack of decision-making power for the well-being of her family, child and herself as well. Low age of marriage is associated with low educational level and weak health that do not allow her to engage in economic activities that limits her decision-making power at home. Further, this also leads to financial constraints which result in lack of purchasing power to maintain a proper diet which causes nutritional anemia among pregnant women. A study was done by Singh (2012) in eight Empowered Action Group (EAG) states of India to investigate the effect of lifestyle behaviors on women's anemia level, showed that women in the age group of 15-19 years are more likely to be anemic. Similarly, a study by Biswas and Baruah (2014) in Boko-Bongaon Block in Kamrup, Assam showed that low age of pregnant women is significantly associated with prevalence of anemia. Girls with early age of marriage are more likely to suffer from anemia due to lack of adequate nutrition as they require nutrition over and above the nutritional demand for their adolescent growth.

Additionally, younger women are more responsible for high fertility and have no decision-making power about using contraception within their family. As a result, childbearing with shorter birth spacing makes women more vulnerable to anemia during their childbearing age (Kavitha, 2010).

Disadvantaged Group of Society: Social exclusion and the associated deprivation have many dimensions. It is possible that patients belonging to a certain group of people do not have access to social resources and deprived overtly or covertly. Such social exclusions are not limited to developed regions alone. For example, Ameh and Broyeck (2008) observed that in the context of UK, ethnic minorities or immigrants are more likely to suffer adverse effects of pregnancy. Blume (2015) reported that in the US, maternal mortality among blacks is more than twice than that of white women. In Developing countries, same trend is observed. Goland et al., (2013) and Yuan et al., (2013) showed that ethnic minorities are at disadvantaged position respectively, in Vietnam and China.[12]

In Indian context, social stratification includes Scheduled Caste (SC), Scheduled Tribe (ST) and Other Backward Class (OBC). The classification is based on different traditions, economic status, marginalization, geographical isolation, backwardness and social exclusion from the rest of the society (Nayar, 2007; Mukherjee et al., 2011; Sanneving et al., 2013). One-quarter of the population in India is accounted as ST and SC in together (Mukherjee et al., 2011). National Family Health Survey III report shows that among the pregnant women who receive any antenatal care (national average 77.1 percent), the corresponding figure is lowest among patients belonging to ST (70.5 percent) and SC (74.2 percent). Similarly, institutional delivery is 17.7 percent and 32.9 percent among ST and SC respectively while, the women not belonging to ST, SC, and OBC category accounts for 51.0 percent. The ST and SC women are highly anemic about 44.8 percent and 39.3 percent respectively, compared to 37.0 percent of others. Mukherjee et al., (2011) argued that although Kerala is one of the best performing states in the health sector, there is caste-based inequality in household health expenditure. For instance, Basu et al., (2004) have shown some major

[12] We have to be careful here. It could be the case that ethnic minorities are poor, and hence their demand for health is low. On the other hand, broad-based, egalitarian health system (UK or the communist countries) may counter the income effect. The fact that ethnic minorities fare worse even in those countries may be an indication of the fact that social exclusion, rather than income/wealth exclusion, is a major factor.

constraint for acceptance of family planning among tribal villages of West Bengal. Maiti et al., (2005) have found that tribal women in Jharkhand lag behind in socio-economic, demographic and health parameters compared to non-tribal. The study also revealed that malnutrition and prevalence of anemia are higher as well as utilization of maternal health care services are low among tribal women. The study of Nayar (2007) on linkages between caste and some selected health indicators based on National Family Health Survey II data, found that there are considerable differences between different caste groups regarding prevalence of anemia. Agrawal (2013) explored the health and nutritional disadvantaged among tribal women and children in comparison to non-tribal women. The study (based in Orissa, India) found that anemia and under nutrition are high among tribal women and children than non-tribal women and children. Hence, disadvantaged group of the society is an important predictor variable to determine the utilization of maternity care for improving the maternal health outcome.

Medical and Human Resource: Studies in Egypt and Jamaica have shown that better quality of care is more important to meet the demand for healthcare services and birth outcomes (Peabody et al.,1998; Hong et al., 2006). If the quality of services is not adequate, no stimulation can increase the demand for such services (Shevell & Malone, 2003). Olsen et al., 2005 have stressed on availalability of better and adequate qualified human resources to provide medical facilities.

Shiffman (2000) has analyzed what kind of intervention will be appropriate to reduce maternal mortality in resource poor country. A similar study was done earlier by John Caldwell (1986) where he has made the argument that wealth is not a critical determinant for reducing mortality as he found that per capita income in countries like Latin America, Vietnam, Cuba and Costa Rica had the lowest correlation with both infant mortality and life expectancies at birth. Caldwell concluded that poor countries could transit their mortality with changes in political and social priorities. However, Shiffman has readdressed and discussed that the health perspective argued for appropriate health intervention for reduction of maternal mortality. Several interventions, for example, antenatal care, family planning services, safe abortions, trained medical attendants at delivery, emergency obstetric care services etc. are critical to maternal mortality reduction. Delivery in well-equipped medical

institutions and the availability of comprehensive emergency obstetric care is essential to reduce maternal mortality.

Along with the medical facilities, availability of human resources is another determining factor to improve maternal health outcome. One of the major components of NRHM is *Accredited Social Health Activist* (ASHA) at the village level. The ASHA workers assigned to a particular village are selected from the village itself. They are trained to work as health activists at the community level creating awareness and participation of public health institutions. They motivate the pregnant women for antenatal care and institutional delivery. Apart from that, ANMs and ASHA workers are entrusted with immunization, maternity care, family planning services, record keeping, health education etc. (Malik, 2009). Hence, they are the key field level functionary of the entire reproductive and child health programmes (Mavalankar & Vora, 2008).

To understand the factors that influenced maternal mortality, various literatures on global interventions and strategies to reduce incidence of maternal deaths are discussed in the following section.

2.2.2. Review on Factors Influencing Maternal Mortality

a. Strategies to Reduce Maternal Mortality-Across Globe and National Level:

There are many success stories on the reduction of maternal mortality around the world. Many resource poor countries have reduced their number of maternal deaths to a significant level. The following discussion will encompass the strategies to improve the status of maternal health in different countries from different corner of the world and India as well.

In the global arena, Sweden had been able to reduce maternal mortality by improving the obstetric care with the help of doctors and midwives during the 19th century. From 1900 onwards, Sweden had an annual maternal mortality of 230 per 100,000 live births, while the rate for England and Wales was 440 per 100,000 live births. The success of the Sweden

public health facilities were primarily caused by medical technology and provision of good public healthcare. It also included the role of midwives and doctors in maternity care along with the proper involvement of the larger population in setting public health policy for reproductive and maternal care (Högberg, 2004).

Loudon (2000) traced out maternal health status of Western World during the mid-19th century to mid-1930s. In North-western Europe, through 1890 to 1900, the presence of well-trained midwives and use of antiseptics in home deliveries declined the maternal mortality. Till the 1830s, the rate of maternal mortality was high among the upper social classes who were more likely to deliver at hospitals and suffer from unnecessary surgical interference by a physician as compared to the poorer sections, who relied on home delivery by trained midwives. However, the major cause of sharp decline in maternal mortality during the mid-1930s was the introduction of better obstetric care. In developed countries, the high maternal mortality was not associated with malnutrition and adverse socio-economic conditions. The quality of obstetric care at delivery was very strong determinants of levels of maternal mortality. During 1954, USA sharp declined of its maternal death to 60 per 100,000 live births through improvement of techniques namely, antibiotics, transfusions, and caesareans that are made available to the majority of women. Decreasing trend of maternal mortality in industrialized countries between 1930 to 1970, is the consequence of willingness of decision makers to take responsibility for the professionalization of delivery care, making modern obstetric care available to population and accountable for addressing maternal health in an effective way. It is seen that when these preconditions were met, the same trend of reduction in maternal mortality have occurred in country whether it be poor (Sri Lanka) or wealthier (Malaysia, Thailand) (Van and Brouwere, 2001).

Similarly, developing countries like Peru, Kenya and Sri Lanka have made a successful journey through Right Based Approach to Maternal Health to reduce maternal mortality. Sri Lanka has dramatically reduced the maternal mortality ratio by 50 percent every 6 to 11 years. The key to the success of Sri Lanka can be traced as expansions of a collective package of health and social services to reach the poor. Secondly, the universal coverage and availability of information gives boost to the evaluation and takes active action towards the improvement of the maternal health (UNICEF, 2008). Likewise, Peru and Kenya have

succeeded in reducing maternal mortality through various initiatives like workshop, awareness programmes on women's rights to their maternal health among community members. Nepal also has been a successful case in reducing maternal mortality in recent decades. Survey data from 1996 to 2006 indicates that substantial decline in fertility and high coverage of family planning measures are the major reasons for the improvement in maternal deaths in the recent years. It is also observed that Bangladesh, Pakistan and other Asian countries have significantly shifted in maternal health with expanding family planning care and safe abortion in a wide range (Pant, 2008).

Shiffman (2000) has pointed that according to wealth perspective, a good living standard and better-nourished mother have lower risk of dying during childbirths. Better food and sufficient iron intake result in lower prevalence of anemia thus lowering the probabilities of hemorrhage. Apart from that, empowerment perspective is concerned with improvement of the status of women in the society. It is critical to reduce maternal mortality because, higher status of women, may lead to more priority from policymakers for improving their health than the conventional case. Secondly, when the lives of women are valued, then women are more likely to have access to education and have more choices for seeking medical care and trained medical personnel to assist them during their delivery. Critical determinants of maternal mortality are (1) the availability and use of maternal care services according to the health perspective; (2) economic development and the accumulation of material resources according to the wealth perspective; and (3) position of women in society according to the empowerment perspective. Moreover, the introduction of antibiotics, blood transfusions, and legal safe abortion may also have been important for declining maternal deaths than that of socioeconomic changes. Finally, Shiffman has argued that education of women, seeking and accessing of appropriate medical care services are critical determinant to reduce maternal deaths in poor countries. Along with that, political and social will at national and international level is also necessary to overcome the problem of maternal mortality.

Resource constraint is not the reason for backwardness of health sector, rather it is the rate of utilization of the facilities that really matter. In this context, Panikar (1979) discussed the Kerala health sector that achieved a significant success to provide healthcare services. In

several states with GNP per capita several times higher than that of the State Domestic Product (SDP) per capita of Kerala, the general and infant mortality rates are also higher. Regarding mortality rates, there are no significant differences between rural and urban areas in Kerala. Panikar (1979) also showed that Kerala is one of the economically less developed states with less SDP, as compared to Haryana, Maharashtra and Punjab. However, the spending on medical and public health care is higher than the better off states like Gujarat, Tamil Nadu and West Bengal, which have relatively lower health status. The rate of utilization of the facilities is governed by the accessibility of the institutions; their spatial distributions and health consciousness of patients etc. The success of Kerala on health system seems to lie largely in given equal emphasis to preventive and promotive as well as curative medicine. Moreover, a high proportion of deliveries are conducted in hospitals or other institutions. Education is one of the significant factors that contribute a lot to the better health status in Kerala. It created a high degree of awareness of health problems and better utilization of facilities. Kutty (2000) discussed the historical success of Kerala health sector. He has pointed out that the major factor behind the improvement of Kerala health sector is the active role of state government which has been a key factor in the expansion of healthcare facilities because factors outside the health field such as growing incomes, improvement of literacy and population aging all that contributed to this trend. Thus, from the analysis of different strategies to reduce in maternal mortality, it is observed that the magnitude of maternal deaths can be avoided with better provision of maternal healthcare services and universal access to maternal care globally (UNDP, 2015).

Different studies have found that the problem of hemorrhage can be tackled through strengthening the demand for EmOC and increasing awareness about the postpartum bleeding as a danger sign. EmOC is a package of medical interventions for care of women and newborn during pregnancy, delivery and postpartum period. It is found to be an essential service to reduce maternal death worldwide (Paxton et al., 2005; RAISE, 2007). EmOC includes basic and comprehensive facilities.[13] Some recent studies have identified a range of influential factors that lead to the death of pregnant women during childbirths. For

[13] Basic EmOC- Treatment for sepsis, eclampsia, obstructed labour, incomplete miscarriage, Post-abortion care. Comprehensive EmOC: along with above listed services it includes- caesarean section, anesthesia, safe blood transfusion (Source: RAISE Fact Sheet, 2007)

instance, accessibility of obstetric care, medical intervention and socio- economic conditions (Sundari, 1992; Motashaw, 1997; Shariff & Sing, 2002; Rawal 2003; Pandy 2003; Radhkar & Parasuraman 2007). A significant contribution of National Rural Health Mission (NRHM) is to reduce maternal mortality through First Referral Units (FRUs) at the national level. NRHM was launched by the government of India to strengthen the healthcare system with numbers of innovative ideas during the period of 2005. Improving maternal health is one of the key priorities for which numbers of changes have been taken place in maternity care services. Reports of National Family Health Survey (NFHS) III (2005-06) reveal that an institutional delivery has increased by 7 percentage points between NFHS II (1998-99) and NFHS III (2005-06). However, the report also pointed out that half of the deliveries still take place at home and most of them are not assisted by health personnel. Another important element of NRHM is the engagement of *Accredited Social Health Activist* (ASHA) worker for encouraging pregnant women for antenatal care and raising awareness for immunization and nutritional diet for better health. Antenatal care helps to identify the problem during pregnancy at the early stage, which helps the Auxiliary Nurse Midwives (ANM) in referring the pregnant women in advance for appropriate care (Padmanaban et al., 2009).

To ensure quality reproductive healthcare services, NRHM has also strengthened the health infrastructure by upgrading all existing community health institutions to address the problem of maternal mortality in rural areas. It has upgraded the Community Health Center (CHCs) to First Referral Units (FRUs) to provide referral services to the pregnant women for 24 hours obstetric emergency at the time of complications and safe abortion services to extend the coverage in rural areas. According to Guidelines for Operationalising FRUs, an existing hospital facility can be regarded as fully functional FRUs only if it is equipped to provide 24-hour emergency obstetric and newborn care, aside from other emergency services that any public hospital is required to provide. Three critical determinants of facility are declared as FRUs: availability of surgical interventions, newborn care and blood storage facilities on a 24-hour basis (GOI, 2004).

It is observed that Emergency Obstetric Care (EmOC) services and access to safe abortion has stronger relationship with maternal mortality than antenatal care and skilled birth attendants (Paxton et al., 2005). It can prevent the direct causes of maternal deaths, for

example, hemorrhage during pregnancy, timely treatment of pregnancy complications, increasing access to safe abortion services etc. which can be regarded as lifesaving interventions (Otolorin et al., 2015; Sikder et al., 2015). Emergency obstetric care is the key to reducing maternal mortality and it does not claim for high cost. Further, improvement in quantity and quality of service supply can have greater effect on maternal health outcome (Jowett, 2000). Two key factors were identified to improve maternal health status namely, proper medical attention and care during pregnancy which depends on three critical factors like- adequacy of maternity care services, efficiency and quality of these services and universal access to these services (Ranjan, 2004). Paxton et al., (2005) did a comprehensive study on effectiveness of EmOC in relation to maternal mortality which showed that in Malaysia and Sri Lanka, the dramatic reduction of MMR is the result of trained physicians and midwives assisted by required physical infrastructure and equipment for effective functioning. However, it is also observed that EmOC facilities are not sufficiently available in numbers both in countries with high and moderate levels of MMR and on the basis of the provisions of maternity services, majority of the EmOC are not able to qualify as basic EmOC facilities (Paxton et al., 2006). Similarly, it is also observed that the necessary infrastructure that is required for effectiveness of the traditional approaches of the comprehensive obstetric care is seriously lacking in major parts of India (Ranjan & Stones, 2004).

b. Factors Influencing: Different Regions and India:

In 1943, Government of India established the Bhore Committee for the purpose of conducting an extensive survey on the present status of health condition and organization in British India and to recommend for future development. Duggal (2005) has observed that the committee has emphasized on development of Primary Health Center (PHCs) for better and adequate provisions of health services to rural areas. This report provided significant remarks on maternal health in Colonial era, critically highlighting the inadequate number of midwives and nursing stuff. In addition, it also noticed the prevalence of early marriage, malnutrition, poverty; low-literacy and other socio-economic conditions to have a major impact on maternal health.

Motashaw (1997) in his study on root causes of maternal mortality discussed that female literacy rate has a huge impact on the use of contraceptives. In India, female literacy rate is 29 percent and contraceptive prevalence only 34 percent. However, the female literacy rate in Malaysia is 65 percent and the contraceptive prevalence is 54 percent. Likewise, in Singapore literacy rate is greater than 80 percent, and contraceptive prevalence is 74 percent. Therefore, female education should get its priority for improvement of maternal health. Similar study done by Shariff and Singh (2002) in rural India, found that education and availability of information significantly increased the utilization of prenatal, child delivery and postnatal health care.

Along with the educational attainment, declining rate of mortality may include a set of predictor variables such as income levels, access to health services, access to safe water and sanitation facilities, educational level of husband and other family members etc. (Desai & Alva, 1998). Further, research on effects of education on mortality show little effect of educated mothers on reducing mortality. For instance, Preston and Haines (1991) argued that educated mother can do little in reducing mortality if the other social and economic resources are absent in the society such as shortage of water and fuel to boil water for maintaining hygienic practices. A similar study by Kunstadter (1995) showed the decline of mortality among Hmong in Thailand without concurrent improvements in education. A study in Nepal by Simkahada et al., (2010) has concluded that health promotion and the educational interventional programme should target women, husband, family members and at the community level in order to improve the access to health care services. In many times, decision on seeking health care services is taken by husband, mother-in-law and other family members of pregnant women. A similar outcome was observed in the study from Ghana (Ganle et al., 2015) that intervention should be taken beyond individual women to target husbands and mother-in-lows particularly. The power dynamics at the household level, number of studies in Ghana found that religious beliefs, cultural norms and different stakeholders at multiple levels play an important role in decision making in seeking maternal healthcare than the individual childbearing women alone.

In contrast to female education, Sundari (1992) has reviewed that the maternal health problem is the consequence of inaccessibility of essential health information to the women.

Reduction of maternal death requires fundamental changes not only in resource allocation but also in the structure of the healthcare delivery system, for example: lack of live-saving equipment, personnel and expertise for referral services. Additionally, she pointed some failure of health care delivery systems that are contributing to the poor maternal outcome: the lack of equipment, personnel, and long waiting etc. Rawal (2003) also pointed out that, investment in secondary level rural hospitals is more important than the changes in policymakers and health professionals. Similarly, community level development is not possible only through education but it is necessary to develop a mechanism for delivery of emergency obstetric health care service for women to get quality care. Ranjan (2004) has identified two groups of factors that influence the maternal health such as in one hand, it includes factors of social, economic and cultural and on the other hand, it accounts for availability and accessibility of quality obstetric care services. He has also pointed out that it is essential to strengthen midwifery through infrastructure development and appropriate human development programmes. He has argued that improvement of availability and accessibility of quality care can compensate the adverse effects of exogenous factors such as social, economic and cultural. Radkar and Parasuraman (2007) have also argued that maternal death can be prevented with the intervention of obstetric care to women through the public health system. Secondly, early marriage and inadequate child spacing are major risk factors in Indian maternity health care services. The study also showed that 18 percent of total maternal deaths are observed among the age group of 15 to 19 years.

Studies of Royston & Armstrong (1989), Thaddeus & Nangalia (2004) and Sibley et al., (2005) have identified that the socio-economic factors are the strong determinants of higher risk of death during childbirth. The social and cultural factors influence the decision of seeking care during childbirth and postpartum period. The social status of a woman is largely associated with the level of education attainment and their personal income/wealth. The risk of death during childbirth is more among the poor and disadvantaged group of women than that of affluent ones (McCarthy & Maine, 1992). The burden of high out-of-pocket expenses for reproductive healthcare is a major cause of poor maternal health outcome among South Asian countries, including India (Upreti, 2008). Evidence shows that the risk of maternal death is greater in the poorest than the richest groups (Paruzzolo et al.,

2010). With a limited access to financial resources, it is very difficult for a woman to go for a medical visit during pregnancy, which is associated with the cost of transport, extra payment for medicines etc. (Finlayson & Downe, 2013).

Islam (2009) pointed out that increasing women's status, education, trained traditional birth attendants, mobilizing community were less likely to have an effect on maternal mortality unless improvements in family planning, abortion and delivery services were done. It is also pointed out three most important strategies for improvement of maternal health status- first, national health authorities need to revisit the structure and content of maternal and newborn health programs; second, they need to plan the scaling up of services within a health system that is able to respond to current needs; and third, need of political commitment to universal coverage of maternal and newborn health services.

Kumar (2010) has discussed various issues on maternal health in India. Insufficiently skilled manpower as well as non- availability of resources (equipment, drugs) causes bottlenecks in service delivery. Further, a study was done by UNICEF during 2008 on the quality of care showed that only 2 percent of health facilities in Orissa could provide effective obstetric care while in Tamil Nadu, around 50 percent of health facilities provided skilled birth attendance, postnatal care, and emergency obstetric. The case study on Tamil Nadu also reveals that political priority and constituent policies have been the major sources of improvement in its maternity services.

Talwar (1993) has conducted hospital-based study at New Delhi for the period of 1983-85. He found that maternal mortality is higher among women in the age group of 35 years as compared to 20-24 years. Maternal death is higher among those who have birth interval of two years or less in comparison to birth interval of three years or more than that. Maternal death is more in rural areas than that of urban as they mostly come to the hospital in the critical condition for delivery. Anemia is considered as high-risk factor leading to the death. Hence, there is urgent need of women's awareness about anemic conditions and improvement of antenatal care as basic healthcare services. Another hospital-based study done by Rajaram et al., (1995) in South India has analyzed maternal mortality deaths over the period of five years. They showed that majority of deaths were accounted as direct

obstetric causes while most of the mothers (40 percent) had not received any treatment before reaching referral hospital and about 57.7 percent of patients had to travel more than 60 Km. Such results show the urgent need of improving maternal health care services at the community level.

A pilot survey conducted by Ministry of Health and Family welfare in some selected states namely- Uttar Pradesh, Uttaranchal, Maharashtra, Karnataka and Delhi slum for three years reference period from March 2000 to April 2003 shows major causes of maternal deaths mostly occurred due to post-partum septicemia and anemia. It is also observed that postnatal death (70 percent) is higher than antenatal deaths (24 percent). 45 percent of deliveries were conducted by untrained Traditional Birth Attendants (TBAs). The study also revealed that more than 60 percent of deaths occur among ST, SC and OBCs households as compared to others (Pandey, 2003).

c. Factors Influencing: Assam and Northeast India:

India's Northeast consists of eight states namely Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Regarding maternal health status of Assam and other states of North Eastern Region in India, Singh et al., (2000) showed that in Arunachal Pradesh, Mizoram and Meghalaya more than 70 percent of women participate in decision about their own health care; in Assam this percentage is only 65.1 percent. Knowledge of family planning is found to be highest in Sikkim with 88.0 percent followed by Manipur 80.8 percent whereas Assam 60.8 percent which is slightly higher than the national level of 59.9 percent. The problem of Anemia is highest among women of Assam (69.7 percent) followed by Meghalaya (63.3 percent), Arunachal Pradesh (62.5 percent) and Sikkim (61.1 percent). These figures are higher than the national figure of 51.8 percent. Similarly use of family planning among married couples except for Manipur (59.6 percent) is very low in Nagaland (24.2 percent), and in Assam (26.6 percent) compared to national level (42.0 percent). Jain and Gupta (2005) found that full ANC and postnatal care is only received by 15 of women and safe delivery by only 24 percent of women. They also pointed

that a majority of such women belong to lower standard of living low literacy rate and work in rural background. Further, they found vaginal bleeding and swelling as most common maternal complications among higher birth order and working women. Chakrabarti and Chaudhari (2007) found that education of both women and husband is a major determinant of better utilization of maternal and antenatal care among north-eastern states. Second, women's occupations, freedom and husband's economic condition are found to be strong determinants of utilization level.

Anemia is largely associated with a vulnerable group of women due to lack of proper quality care and nutritional deficiency that causes a higher risk of maternal and infant mortality in the region (Gogoi, 2011; Sharma et al., 2012). Assam is the highest tea producing state in the country, accounting for 20 percent of tea garden labour community of the total state population where around 50 percent of total tea plantation workforces are women (Saikia, 2008). The socio-economic backgrounds of tea labourers have great impact on the maternal health of female workers. Illiteracy and early marriage are major causes of high fertility of these women. The average fertility level was 5.2 among female tea garden workers which is much higher than the national level 2.4 (in Assam 2.4) as per Sample Registration System 2011 (Das & Goswami, 2004). Generally, women who have many children are more prone to death or pregnancy complications as compared to that of other women. In this context, family-planning services are one of the proposed ways to reduce maternal mortality (Rosenfield & Maine, 1985). Various researchers have found that teagarden workers are not aware of family planning services. Due to shyness and lack of family support, women do not share their problems with doctors and ASHA workers. They even prefer to go for traditional home based care rather than going to hospitals (Hazarika, 2012; Sorathia, 2012). A number of studies have addressed the health problems of teagarden labourers and found high prevalence of undernutrition and anemia among labourers of tea community of Assam. For instance, Medhi et al., (2006) carried out their study on some randomly selected gardens of Dibrugarh district of Assam and their finding shows high magnitude of nutritional problems like 60 percent of children were underweight and adults were seen with thinness (nearly 70 percent) as well. Apart from that, the problem of anemia was also found widespread among female tea labourers. Lack of education severally influences maternal health awareness and

health-seeking behaviors among teagarden workers. Another study conducted by Das et al. (2012) in tea gardens of Assam, identified anemia as a major problem among female teagarden workers. There is acute need of iron and folic acid as a supplementation to them. Moreover, female teagarden workers continue to engage in hard jobs even during their pregnancy and postnatal period that cause harm both for mother and newborn (Borah, 2013).

2.3. Conclusions:

In this chapter, a wide range of relevant literature on maternal health has been reviewed. We began by relevant definitions. The different approaches to measure maternal mortality were discussed. We then reviewed theoretical literature concerning determinants of maternal mortality. One can think about two broad determinants/ strategies. First, maternal mortality can be reduced by investing/ advancing quality health care with easy access. Second, given the status of health care facilities, maternal mortality can also be reduced through utilization of these facilities to their full potential. A number of socioeconomic factors: like income and wealth, women's status on the family and society, ignorance etc. contributes to such usage. Based on this, we discuss how the current literature has identified the determinants under various country/ region specific contexts and whether any strategy/ interventions can be derived from there. This is done in two phases. First, we review the literature and evidence for different regions and India Second, our focus is on North-eastern region of India including Assam.

As identified by existing literature, lower utilization of maternal care (compared to national average) and prevalence of anemia during pregnancy continues to characterise Assam. The review of previous literature helps to summarize the background of maternal health and identify the scope for further research in Assam since it has highest maternal deaths across India. It is clear from the review of studies that context specific factors of maternal mortality have not been largely discussed in the state of Assam.

Next chapter is prepared to address the district level analysis on maternal health scenario of Assam.

Appendix

Table 2.1. A: ***Comparison of 1990 and 2015 Maternal Mortality Ratio across World***

Regions	Year	
	1990	**2015**
Developed regions	23	12
Developing Regions	430	239
Sub-Saharan Africa	987	546
Eastern Asia	95	27
Southern Asia	538	176
Latin America	124	60
South-Eastern Asia	320	180
India	556	174

Source: WHO, UNICEF, UNFPA and The World Bank estimates (1990-2015)

Table 2.2.A: ***Maternal Mortality Ratio in India in Selected States (Per 1, 00,000 Live Births)***

States	1997-98	1999-01	2001-03	2004-06	2007-09	2010-12	2011-13
Assam	568	398	490	480	390	328	300
Bihar	531	400	371	312	261	219	208
Kerala	150	149	110	95	81	66	61
Rajasthan	508	501	445	388	318	255	244
Tamil Nadu	131	167	134	111	97	90	79
Uttar Pradesh	606	539	517	440	359	292	285
West Bengal	303	218	194	141	145	117	113
India	398	327	301	254	212	178	167

Source: Registrar General of India, Ministry of Home Affairs (SRS Bulletins)

CHAPTER III

Maternal Health Scenario of Assam

3.1. Background Characteristics: Assam

3.1.1. Location, Demography and State Economy:

Assam is the largest economy in North East India. As per Census 2011, Assam covers an area of about 2.4 percent of the country's total geographical area. Total population of Assam is 31,169, 27 being 2.58 percent of the population of India. The population density of Assam is about 397 per square km. 86 percent of total population in the state lives in rural area (*ibid*). Literacy rate of the state is 73.18 percent: male literacy rate being 78.81 percent and that of female 67.27 percent. Assam consists of 27 districts, 56 sub-divisions and 145 revenue circles.

Per Capita Income (PCI) of the state is Rs. 49,480.00 at current prices for the year 2014-15 (GOI, 2015). Growth rate of Net State Domestic Product (NSDP), at 2004-05 prices is 15.9 percent during the year 2013-14 and the state's per capita NSDP growth rate is registered as 14.5 percent against the national growth rate of 9.6 percent in 2013-14 (GOA, 2013-14). 69 percent of the population relies on agriculture and its allied activities for their livelihood. Although agriculture sector is a major source of employment, its share in NSDP is declining over the years and expected to reach the level of 16.5 percent in 2014-15 from 21.7 percent in 2004-05 (GOA, 2014-15). Similarly, industrial sector also recorded a decline from 27.54 percent of NSDP in 2004-05 to 23 percent of NSDP in 2014-15. At the same time, the contribution of service sector to state economy has increased and expected to increase from 46.9 percent to 56.8 percent (*ibid*).

3.1.2. Current Healthcare System- Structure and Scenario of Assam:

a. Current Health Status:

As per the latest Sample Registration System (SRS) data for the year 2006-10, life expectancy of male and female in Assam are 61 years and 63.2 years respectively, which is lower than the national level i.e., male (64.6 years) and female (67.7 years) (GOA, 2014). As per Annual Health Survey 2010-11, Crude Birth Rate (CBR) and Crude Death Rate (CDR) are 21.9 and 7.2 respectively, which are slightly higher than the national average of 21.8 and 7.1 respectively. Infant Mortality Rate (IMR) (60) and the Under Five-Mortality Rate (U5MR) (78) are higher than the national level (44 and 55 respectively) in the same reference period. Data from National Family Health Survey reports (NFHS I to IV) show child vaccination have increased within the time period (1992-93 to 2015-16), but the percentage of children receiving all vaccination in Assam (47.1 percent) is far less than the national level (62.0 percent).

b. Health System Structure:

The overall organizational structure of rural health care system in Assam is similar to the structure followed across India. It is developed as a three tier system consisting of Community Health Centers (CHCs), Primary Health Centers (PHCs) and Sub-Center (SCs). The hierarchy of health institution is presented in figure 3.1.A, where Block Primary Health Center is a higher level institution to monitor the functioning of CHCs, PHCs and Sub-Center.

Sub-Center is the most peripheral and first contract point between Primary Health Care system and the community (IPHS, 2012; NRHM, 2012). According to Indian Public Health Standards (IPHS) guidelines 2012, one *Sub-Center* should be established for population of 5000 in plain areas and for 3000 in hilly areas. *Sub-Centers* are mainly responsible for services related to maternal and child health, family welfare, nutrition, immunization and control of communicable diseases. In other words, the assignment includes- preventive,

promotive, curative and referral services. Secondly, *Primary Health Centers* is the first contact point between village community and medical officer. It acts as a referral unit for six Sub-Centers. It has 4 - 6 beds for patients. The activities of PHC involve curative, preventive, promotive and family welfare services. *Community Health Centers* act as referral for every four PHCs. As per the minimum norms of Indian Public Health Standards *(IPHS)*, CHCs are required to have medical specialist, equipped with sophisticated diagnostic facilities and 30 in-door beds.

Based on the present healthcare structure and current health status particular for Assam, the following discussion attempts to understand the trend of maternal deaths and maternal illness among pregnant women in the state.

3.2. Trend of Maternal Deaths and Maternal Illness in Assam:

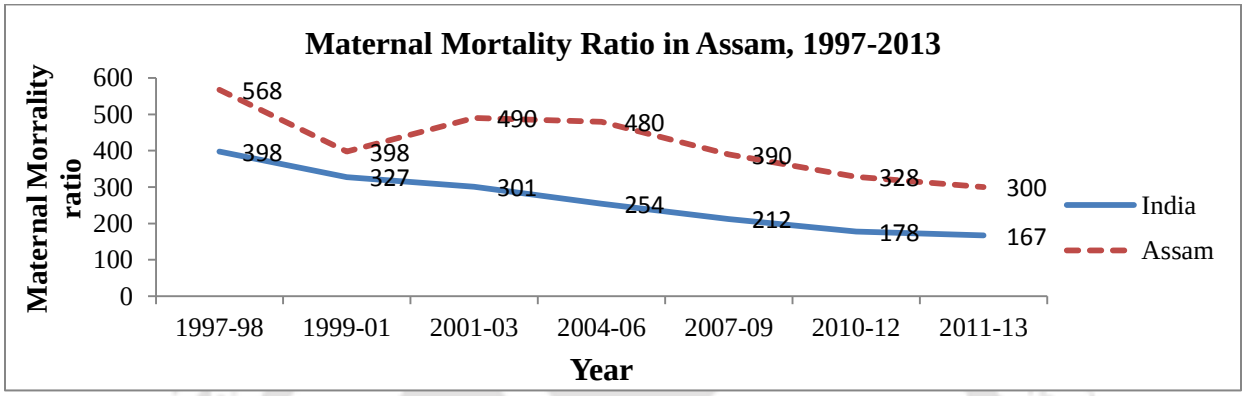
As per the *Sample Registration System (*SRS*), Registrar-General of India* (RGI-SRS) 2011-2013, Maternal Mortality Ratio (MMR) in Assam is 300 per 1,00,000 live births, which is highest in India (all India statistics is 167 deaths).[14] Table 3.1.A provides a comparative observation on the performance of outcome indicator of maternal health based on the report of National Family Health Survey (NFHS) III between Assam as well as India.[15] In Assam, the performance indicators of maternal health such as receiving antenatal care (70.7 percent) and postnatal care (16 percent) are lower than the national level (76.4 and 41.2 percent respectively). In addition, the mean age of marriage is 19 years as compared 21 years at the national level and a larger number of home deliveries (78 percent) as compared to national level (52.4 percent) result in poor maternal health outcome.

The reports of SRS for various years provide a historical trend of MMR in Assam[16], showing subsequent improvement in reduction of MMR from 568 to 300 per 100,000 live

[14] To provide a perspective, Kerala has maternal mortality ratio of 61 per 100,000 live births (SRS 2011-13).
[15] As the full report of NFHS IV for Assam is not available (only fact sheet available), we consider NFHS III estimates are the latest one.
[16] Here, SRS has provided the MMR of Assam for the year 2013. However, in our following discussion on district level MMR, we have estimated it from available NRHM official data for the year 2013-14.

births during the periods of 1997-2013. At the national level for the same reference period, it has decreased from 398 to 167 per 100,000 live births (Table 3.2.A).

Figure 3.2: ***Trend of Maternal Mortality Ratio in Assam from 1997-2013***



Source: Registrar General of India, Ministry of Home Affairs (SRS Bulletin)

Figure 3.2 provides the declining trend of maternal mortality ratio from 1997 to 2013.[17] There was a sharp decline in MMR of Assam during the period of 1999-2001, which is lower than the period of implementation of National Rural Health Mission programme (2005). According to Deka (2014), this is due to effective promotion and awareness of Reproductive and Child Health (RCH) programmes. Such initiatives are *Mahila Samridhi Yojana* (1993), *Indira Mahila Yojana* (1995), *Balika Samridhi Yojana* (1997), *Integrated Child Development Schemes III (1999)* (NSSO, 2014). Jeo et al., (2015) also argued that the sharp reduction of MMR by highlighting that the first and second phases of the Reproductive and Child Health (RCH) programmes (1997-2005 and 2005 onwards) focused on reducing MMR through various vertical programmes.[18] However, figure also depicts a subsequent increase in MMR after 1999-2001. It may be the case that Sample Registration System (SRS) has undertaken a special survey of deaths based on the 10th revision of the

[17]Until 1997, the indirect estimates of maternal mortality were unable to establish reliably the levels, trends and differences in maternal deaths (Maternal Mortality in India:1997-2003 Trends, Causes and Risk Factors, SRS 2006).

[18] Vertical programme can be defined as a set of activities that has specific and defined objective to provide primary health care services such as antenatal care, family planning services, vaccinations etc. (Caimcross, Peries, & Cutts, 1997; Elzinga, 2005).

International Classification of Diseases (ICD-10) in the period of 2001-2003, which is an improved form of Verbal Autopsy. The new method is known as Representative, Re-Sampled, Routine Household Interview of Mortality with Medical Evaluation (RHIME). The new estimate is better in terms of coverage, reporting and quality of data collection (SRS, 2006).

Annual Health Survey (AHS) 2011 has classified 23 districts of Assam (as per Census 2001) into four Administrative Divisions.[19] [20] As per AHS second updation of Bulletins 2012-13, Upper Assam Division recorded the highest maternal mortality ratio (404) followed by Hills and Barak Valley Divisions (281), Lower Assam Divisions (254) and North Assam Divisions (251). Table 3.3.A provides a comparative statistics of MMR at Administrative Divisions between the period 2010-11 and 2012-13. It is observed that out of four Administrative Divisions, Hills and Barak Valley, Lower Assam and North Assam Division have enjoyed a reduction in MMR to less than 300 in 2012-13 from 2010-11, while Upper Assam Division still has the highest MMR of more than 400 during the same reference period.

Apart from the trend, age distribution of female death due to the maternal cause reflects the maternal health status of women. According to SRS 2010, female mortality between the age group of 15-24 years is higher than that of the male death rate in Assam (Table 3.4.A). Official data from Census of Death in India (2001-03) showed that maternally related conditions within the age group of 15-34 are more prone to female death other than the diseases and infections (Table 3.5.A). Further, in Table 3.6.A, the latest report of the Census of Death in India statistics (2005-06) show that communicable, maternal, prenatal and nutritional conditions are the main cause of female deaths (53.7 percent) as compared to

[19]Assam has four administrative divisions up to 2015:
Upper Assam Division includes- Tinsukia, Dibrugarh, Sibsagar, Jorhat, Golaghat.
Lower Assam Division includes-Kokrajhar, Dhubri, Goalpara, Darrang, Bongaigaon, Barpeta, Kamrup, Nalbari.
North Assam Division includes-Marigaon, Nagaon, Sonitpur, Lakhimpur, Dhemaji.
Hills and Barak Valley Divisions includes-KarbiAnglong, North Cachar Hills, Cachar, Karimganj, Hailakandi.
Source: Annual Health Survey (AHS) 2010-11

[20] Although four new districts were created during 2004, AHS (2010-11) considered 23 districts of Assam as per 2001 Census. However, in the present study, district level analysis in section 3.5, I consider these four districts namely Chirang, Udalguri, Baksa and Kamrup (M); I have maternal related data on 27 districts collected from NRHM office of Assam.

male deaths (47.3 percent) in the Empowered Action Group (EAG)[21] states and Assam than the other states. SRS report 2010-12 shows that at national level, maternal deaths are higher among the age group 20-34 years as compared to non-maternal deaths (Table 3.7.A). According to Annual Health Survey (2010-11), maternal deaths are highest (112-117) among women in the 20-29 age groups in Assam (Table 3.8.A) (AHS, 2012). Such age distribution of female deaths shows the magnitude of female deaths during their childbearing period. Further, young mothers are more prone to death due to maternal related causes rather than non-maternal deaths.

However, there have been no significant changes in medical causes of maternal mortality over time (GOI, 2014). The official data of SRS 2001-2003 revealed that hemorrhage contributed 37 percent among other direct causes of maternal deaths (sepsis, hypertensive disorders, obstructed labour, abortion and others) in the states of Empowered Action Group (EAG) including Assam (Table 3.9). Hemorrhage can be defined as "blood loss > 1500 ml; decrease in hemoglobin > 4 g/dL or acute transfusion requirement > 4 units within 24 hours of delivery" (Shevell & Malone, 2003; Amelia & Andrew, 2005; Callum & Barrett, 2007). These two definitions of hemorrhage encompass both *antepartum* i.e. bleeding occurring after 24 weeks of gestation and before childbirth and *postpartum* i.e. hemorrhage occurs during 24 hours to six weeks after childbirth. Postpartum hemorrhage is the more common type of maternal hemorrhage problem which contributes about 25 percent and 17 percent of all maternal deaths in developing countries and developed countries respectively (Sheiner, 2011). Delivery at home without trained birth attendants, accentuates the problem of blood loss. Further, lack of decision-making power within family either for financial conditions or for religious/cultural belief, may prolong suffering (Tsu, 1993; McCormick et al., 2002).

Apart from direct causes of maternal mortality, a large proportion of maternal death occurs due to indirect causes like anemia (GOI, 2015). The incidence of severe anemia may aggravate the condition of hemorrhage as women already suffering from anemia cannot tolerate the excessive blood loss after their delivery. According to WHO estimates, anemia

[21] Empowered Action Group was set up to facilitate preparation of area specific programmes in selected socioeconomically backward states of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttaranchal and Uttar Pradesh as well as Assam which has lagged behind in demographic transition (GOI, 2001).

is a major contributor to the death of women during reproductive age (Brabin et al., 2001). It is directly and indirectly accountable for 40 percent of maternal deaths in India (Kalaivani, 2009). It increases the probability of maternal deaths and high-risk pregnancy during childbirth, responsible for stillbirth as well as poor birth weight and infant mortality (Noronha et al., 2012). Incidence of anemia among pregnant women varies according to socio-economic conditions, lifestyles and health seeking behaviors across different cultures (Lone et al., 2004). However, National Family Health Survey (NFHS) IV has shown that 46 percent of women are anemic in Assam which is lower than the national average of 53 percent.

Table 3.10.A depicts the data from District Level Household and Facility Survey (DLHS) report III (2007-2008) about any Antenatal Care (ANC) received by pregnant women, complications during pregnancy and seeking treatment for pregnancy complication in Assam. The table reveals that about 60.2 percent of women of Assam had faced complications during thier pregnancy (vs. at national level 61 percent). Further, according to DLHS III, nearly 67.8 percent of women in Assam have suffered from at least one delivery complication (vis-à-vis 35 percent at national level). These complications are manifested through obstructed labour (55.8 percent), prolonged labour (28.9 percent) and excessive bleeding (15.6 percent) while at national level reported as 69 percent, 35 percent and 15 percent respectively. In such situations, women may need urgent medical help and life-saving interventions such as drugs and Intensive Care Unit (ICU).

Antenatal care and institutional births can provide safeguards to both mother and infant in case of such emergencies. However, in Assam, only 45 percent of pregnant women sought treatment during pregnancy (DLHS III) (vs. at national level 55 percent). The DLHS III report also reveals that nearly 28 percent of women in Assam did not receive any Antenatal Care (ANC) during their pregnancy period (vs. at national level 25 percent), while only 16 percent of mothers had received postnatal care (vs. at national level 49 percent). Further, utilization of antenatal checkup is high among urban dwellers (89.2 percent), educated groups with at least 10 years and above schooling (91.6 percent) and high-income earners (95.8 percent). The national level statistic shows that 87.1 percent, 94.5 percent and 93.6 percent respectively for the same. Similarly, the proportion of Hindu women who received

ANC is high 79.3 percent (vs. at national level 75.1 percent) as compared to Muslim 66.6 percent (vs. at national level 74.6 percent) and Christian women 63.3 percent (vs. at national level 75 percent). Likewise, only 69.7 percent of Scheduled Tribe women received ANC (vs. at national level 65.9 percent) while it is high among women belonging to Scheduled Caste and Other Backward Class as 79.8 percent (vs. at national level 72.7 percent) and 81.9 percent (vs. at national level 74.7 percent) respectively.

In the case of institutional births, the report found that 22 percent of delivery took place at health institutions (vs. at national level 47 percent). Occurrence of institutional delivery is higher, in urban setup, among wealthy family, and among women who have received 10 or more years of education. Use of contraceptive among married women of 15-49 years of age groups is only 57 percent, whereas only 48 percent of contraceptives used as modern method of family planning in the state. However, there is disparity in usage of contraception as utilization is higher among the urban women (66 percent) as compared to rural women (55 percent).

Based on the above discussion, it is clear that the trend of maternal mortality has been declining in the subsequent years. At the same time, utilization of maternal health care services is very low in the state compared to the national average. In such cases, Government initiatives are needed to encourage women for utilization of reproductive care and facilities, probably at subsidized cost. In what follows we discuss various national and state government schemes on maternal health which are currently operational in Assam.

3.3. Operational Schemes on Maternal Health:

A number of schemes and programmes are implemented by the Government at both state and national levels to ensure effective intervention for improving maternal health status. The key strategy is to provide antenatal and postnatal care including cash assistance, Iron and Folic Acid supplementation and free of cost nutritional food to all pregnant women from poor background.

a. State Programmes:

Government has introduced The *Mamoni Scheme* in 2008 to provide *"Nutritional Food to Pregnant Women"* for the welfare of mother and child health. It is a conditional cash transfer programme. It provides monetary assistance of Rs. 1000 (in two instalments) to every pregnant woman during her pregnancy. The first instalment of Rs. 500 is provided during 2nd ANC check-up and the other instalment of Rs. 500 is given in her 3rd ANC check-up. This scheme includes three antenatal check-ups and motivating the expecting mother for institutional delivery in nearby health institution.

Mamta Scheme was introduced during 2010 to ensure post-delivery hospital stay of 48 hours of the mother and the newborn. At the time of discharge after the recommended hours, a "Mamta kit" is provided to mother that containing baby powder, baby oil, mosquito net etc. This scheme provides an incentive for adequate post-natal care to mother and the baby.

In order to combat anemia several schemes were implemented under National Rural Health Mission during 2012-2013. Along with the *National Iron Plus Initiatives*, Assam Government has introduced *Mission Tejaswee* during 2014-15. The purpose of these schemes is to meet the challenge of high incidence of anemia in various age groups. Under these schemes, IFA tablets are distributed among children including age group of 6 months to 5 years, adolescent girls and boys, pregnant and lactating mothers and women in reproductive age groups.

Additionally, Government has also introduced ambulance service like *Adoroni Service* (2012). Under this scheme, pregnant women get free transport facility to the health institutions for their delivery and similarly, drop-home facility is provided when the mother and the infant are discharged from hospital.

b. National Schemes:

Janani Suraksha Yojana (JSY) is a safe motherhood intervention under National Rural Health Mission launched during 2005 for promoting institutional delivery among pregnant women living under Below Poverty Line (BPL). It provides cash assistance with delivery

and post-delivery care. Under this scheme, for delivery in government hospital and accredited hospitals, mother will get Rs. 1400 in rural areas and Rs. 1000 in urban areas. Further, *Janani Shishu Suraksha Karyakram* (JSSK) was launched in 2011 for providing care to pregnant women, sick newborn and free delivery including caesarean section and free treatment in public health institutions viz. drugs, diet, diagnostics, blood transfusion if required.

Another important strategy of Government of India was to introduce *Accredited Social Health Activists* (ASHA), who acts as a community worker to bridge the gap between health personnel and village women. The general norm under the guideline of NRHM programmes is that one ASHA worker per 1000 population. The purpose of the ASHA worker is to monitor the pregnant women as well as encourage her for antenatal care and delivery in government hospital. They are supposed to provide important information regarding family planning methods and nutritional diet for better health of the mothers and her newborn to villagers. Along with that, government has also taken the initiative to distribute nutritional foods among mothers, adolescent girls, children up to age of 0-6 years and pregnant women through *Anganwadi Centers*[22] in both rural and urban areas.

Government of India has also introduced *Mobile Medical Unit* (MMU) in 2007. MMU is mobile vehicle with a team of doctors and other medical staff. It is fully equipped with the latest medical equipment and medicines to delivery of health-care services in rural and remote areas.

Government has taken up some initiatives at state and national level to reach the pregnant women in order to reduce maternal mortality and improve reproductive health of women as well. However, utilization of maternal health care is determined by immediate environment of an individual.[23]

[22] The Integrated Child Development Service Scheme (ICDS) is one of the Government initiatives to provide healthcare, nutrition and education services to the children below six years including the pregnant women and lactating mothers. For effective implementation of this programme, Anganwadi center are the focal component where Anganwadi Workers (AWW) deliver the services in close coordination with ANM and ASHA workers of that locality. For example: they jointly organize health camps, conduct health education and awareness programs, home-visit, delivering care during pregnancy and delivery etc. (UNICEF, 2011; Paul et al., 2013).

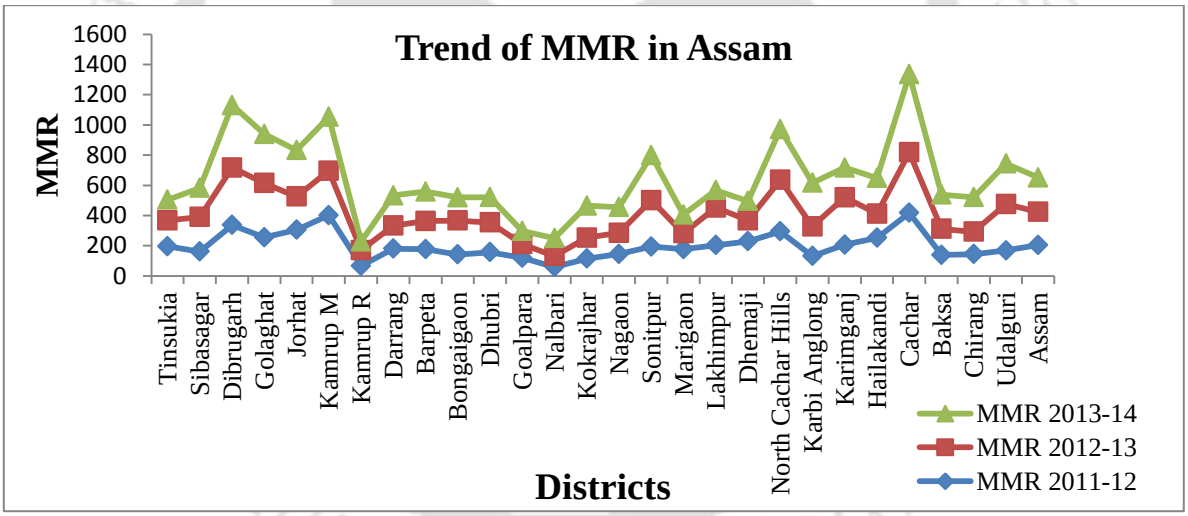
[23] For further elaboration see Chapter V and Chapter VI.

3.4. Maternal Healthcare in Assam: A District Level Analysis

3.4.1. Trend and Socio-Demographic Factors of MMR

The trend of maternal mortality ratio of Assam at district level during 2011-12 to 2013-14 reveals that MMR has increased throughout the years (Figure 3.4). The estimation of district wise MMR demonstrates that out of 27 districts of Assam (as per 2011 Census), Cachar district has the highest MMR (516.63 per 1, 00,000 live births) for the year 2013-14. The details about the districts wise MMR is presented in Table 3.11.A. The statistics shows that districts of Upper Assam as well as Hills & Barak Valley Divisions are more prone to maternal deaths than that of other two Divisions.

Figure 3.4: Trend of Maternal Mortality Ratio in Assam during 2011-12 to 2013-14



Source: Author's estimation

Our task, in this chapter is to formulate a preliminary framework to find out the proximate causes of maternal mortality at the district level- based on secondary level data sourced from various government reports. The variables (factors) are based on our theoretical analysis in chapter 2 (Section 2.2). Consequently, there are two levels of analysis: we need to look at MMR both as an outcome of socioeconomic as well as maternal care facilities. These are taken separately.

Our analysis is done through two stages. Given the paucity of data, regression results may not be reliable. As a result, we have resorted to various non-parametric exploratory data analysis. First, district wise rank correlation coefficient on MMR and explanatory variables are computed. Second, as a complementary approach, we have undertaken a cluster analysis to establish appropriate categorization of districts.

Cluster analysis is a tool to understand the objects within a group to be similar to one another and different from the objects in other groups. Cluster analysis can be defined as a classification of similar units into homogenous entities that can be used to data reduction, data exploration and prediction based on groups (Dilts et al., 1995). The greater the similarity within a group and the greater the difference between groups, is more distinct the clustering (Everitt et al., 2011). Given the groups, we used Analysis of Variance (ANOVA) to compare means from independent groups. Further, we have used different sources of data. First, to investigate the relation between MMR and the socioeconomic factors, we have used 27 districts (as per 2011 Census); however, for maternal care facilities we have used only 23 districts as the latest report of DLHS- IV provides data only for 23 districts of Assam (as per 2001 Census).

3.4.2. Sources of Data:

As already mentioned, we do not have unified source of data. Data has been collected from various years of reports of NRHM, Statistical Handbook, District Level Household Survey, Assam Human Development Report, Census reports, Annual Health Survey report and Facility Survey of Public Health Institution. Data on per capita income is taken from Human Development Report Assam, 2014; age of marriage from District Level Household Survey 2007-08, female literacy rate, percentage of ST and SC population to the total population are based on 2011 Census. The details are presented in Table 3.12.A.

Data on live births are collected from National Rural Health Mission, Department of Health and Family Welfare, Government of Assam. Likewise, maternal deaths are collected from

maternal deaths reporting system that is available in official website of NRHM, Assam. The descriptive statistics of socioeconomic variables are presented in Table 3.13.

Table 3.13.: ***Descriptive Statistics of all Socioeconomic Variables*** **(Obs. 27)**

Parameters	Variable	Mean	Std. Dev.	Min	Max
Maternal Mortality Ratio	MMR	224.398	105.7702	57.7701	516.631
Per Capita Income	PCI	24351.56	9501.21	16632	63444
Female literacy	Flt	67.16074	7.223902	54.26	85.82
Age of Marriage	AoM	20.91852	0.976665	19.1	23.2
Scheduled Caste	SC	6.937556	3.322034	2.026	15.254
Scheduled Tribe	ST	16.91385	19.00966	0.105	70.921

3.4.3. Spearman's Rank Correlation Analysis of Socioeconomic Variables:

Data related to MMR and socioeconomic variables are collected from different secondary sources. The number of observations is small (<30). For this reason, instead of customary regression analysis, we try to provide some alternative tools for pattern recognition. In such case, Spearman's correlation is appropriate analysis to examine the association between two variables.[24] Spearman's correlation is a non-parametric test that is used to measure whether two variables are correlated or whether one variable increases, the other variable tends to increase or decrease (Mcdonald, 2008). A spearman's correlation between MMR and socioeconomic variables is presented in Table 3.14.

Table 3.14: ***Results of Spearman's Correlation: Independent Variables with Consideration of MMR*** **(Obs. 27)**

Variables	Rho	Significance (p-value)
Per capita Income	0.1923	0.33
Female literacy	0.2405	0.22
Age of Marriage	0.2355	0.23
Scheduled Caste	-0.0174	0.93
Scheduled Tribe	0.0543	0.78

Source: Author's estimation

[24] Spearman's rank correlation (ρ) is simply the Pearson correlation calculated on the rank of a bivariate distribution (X_1, X_2). Unlike Pearson correlation, distribution of ρ does not depend on how X_i's are distributed. The null hypothesis is the X_i's are mutually independent (Conover, 1999, pp 314-16).

In Table 3.14, Spearman's Rho shows a relationship between MMR with predictor variables like per capita income, female literacy, age of marriage, SC and ST population. However, relationship between MMR and socioeconomic variables are not statistically significant.

In the following section, we undertake a cluster analysis to identify the structures within the data. However, it does not have any test of significance. For that, one-way ANOVA is considered to compare the group mean.

3.4.4. Cluster Analysis:

To complement the results based on rank correlation, cluster analysis is employed to determine the group of districts based on maternal mortality ratio. Presence of a smaller number of observations, agglomerative hierarchical clustering method[25] has been applied to form a cluster of similar districts with unique characteristics. Further, Ward's linkage clustering with squared Euclidean distance is used in the present cluster analysis. Ward's linkage clustering is chosen as this algorithm attempts to minimize the Sum of Squares (SS) of any two clusters. In order to decide the number of clusters, present study uses the Duda–Hart stopping-rule i.e. number of cluster is one with the largest Je (2)/Je (1) values that corresponds to a low pseudo-T-squared value.[26] The detail of number of clusters is presented in Table 3.15, which indicates that four-group solutions are the most distinct from this hierarchical cluster analysis. The smallest pseudo T-squared value is 9.99 and highest Je (2)/Je (1) is 0.3753. Further, one-way ANOVA with omnibus statistical significant testing

[25] It is a stepwise algorithm which merged two most similar objects.

[26] Pseudo-T-squared quantifies the difference between two clusters that are merged at a given step. Duda–Hart Je (2)/ Je (1) has an associated to Pseudo- T-squared value. A large Je (2)/ Je (1) value and small Pseudo-T-squared value indicate distinct clustering.
Duda-Hart (JE (2)/JE (1)) index itself is simply the sum of the sum of squares in the two clusters, divided by the sum of squares in the combined cluster.
In other words, Suppose, the combined cluster C has mean $\bar{x}_C$. Then

$$JE(1) = \sum_{x \in C} (x_i - \bar{x}_C)^2$$

If we split it up into two clusters, lest say c_1 and c_2, we define JE(2) as

$$JE(2) = \sum_{x \in C_1} \left(x_i - \bar{x}_{c_1}\right)^2 + \sum_{x \in C_2} \left(x_i - \bar{x}_{c_2}\right)^2$$

DuDa Hart and Stork (2001)

using univariate analysis of variance is used in order to compare the means between clusters to show both the clusters are statistically different on the parameter that has used.

Table 3.15: ***Number of Clusters Based on Duda/ Hart Stopping-Rule***

Number of Clusters	Duda/ Hart	
	Je(2)/Je(1)	pseudo T-squared
1	0.3191	53.36
2	0.3068	15.81
3	0.2881	39.54
4	**0.3753**	**9.99**
5	0.3412	15.45
6	0.1154	15.34
7	0.1328	39.17
8	0.1437	35.75
9	0.1782	9.23
10	0.0985	9.15

Out of 27 districts of Assam, four clusters of districts have been formed consisting of ten districts in cluster 1 and eight districts in Cluster 2 and Cluster 3 and one district in Cluster 4.[27] The details of clusters with respective mean values of variables that are related to maternal mortality ratio are presented in Table 3.16.A.

The mean variances between the four-clustered districts are shown in Table 3.17. Cluster 3 and Cluster 4 districts have comparatively better per capita income, female literacy rate, age of marriage than Cluster 1 and Cluster 2 districts. Additionally, Cluster 4 district has higher concentration of SC population and Cluster 3 districts have higher ST population than the Cluster 1 and Cluster 2 districts. In addition, Cluster 3 and Cluster 4 districts have higher MMR with comparatively better socio-economic parameters compared to Cluster 1 and Cluster 2 districts. The result is surprising.

[27]Cluster 1 is composed of Bongaigaon, Dhemaji, Dhubri, Goalpara, Kamrup (R), Lakhimpur, Marigaon, Nagaon, Nalbari, Tinsukia; Cluster 2 consists of Baksa, Barpeta Chirang, Darrang, Hailakandi Karimganj, Kokrajhar Sibsagar Cluster 3 includes Dibrugarh, Golaghat, Jorhat, Kamrup (M), Karbi Anglong, North Cachar Hills, Sonitpur and Udalguri. Cluster 4 consists of Cachar.

The one-way ANOVA results reveal that there are significant differences among four Clusters at p=0.034, p=0.096 and p=0.000 with respect to per capita income, age of marriage and maternal mortality ratio respectively.

Table 3.17: ***Mean Variance of Clustered Districts in Assam***

Variables	Cluster 1 (n=10) Mean (SD)	Cluster 2 (n=8) Mean (SD)	Cluster 3 (n=8) Mean (SD)	Cluster 4 (n=1) Mean (SD)
PCI	22472.91*	20697.32	34378.12	23052.00
	(3511.42)	(5621.12)	(15983.21)	(0)
Flt	66.39	64.49	72.52	74.62
	(4.95)	(6.76)	(9.61)	(0)
AoM	20.78*	20.40	21.58	21.20
	(1.21)	(0.73)	(0.52)	(0)
SCPOP	7.52	7.59	6.05	15.25
	(2.99)	(3.29)	(2.16)	(0)
STPOP	13.70	18.38	20.75	1.01
	(13.71)	(18.13)	(21.32)	(0)
MMR	123.09*	212.77	325.18	516.63
	(38.75)	(16.87)	(43.33)	(0)

Source: Estimated
Note: One way ANOVA
***** Significantly different from cluster 1 and cluster 2

3.4.5. Discussion

Therefore, the present analysis reveals that somewhat paradoxically, higher maternal deaths are more likely to be concentrated in districts with better socio-economic parameters. Such a result is consistent with the analysis what Alauddin (1986) found in context of Bangladesh. This study considered three socioeconomic variables in relation to MMR- family's economic solvency, land ownership status and mother's educational attainment. The correlation results show that maternal mortality is highest with solvent families than families that have experienced hardship. MMR is positively related with families owning more than two acres of land compared to less than two acres of land; similarly, MMR is highest among mothers with secondary level education than mother's with no education or merely literate. Thus, the result revealed that the relationship between maternal mortality and socioeconomic variables are puzzling and challenging to the conventional expectation of inverse relationship of better socioeconomic conditions with maternal mortality. A recent

study on trends in infant and child mortality and malnutrition levels in India by Srinivasan (2016) found that best performing districts in terms of supplementary nutrition index are the worst performing district in child malnutrition and vice-versa. This study revealed that there are other factors affecting malnutrition other than the supplementary feeding and other services provided by ICDS program. Therefore, the present cluster analysis provides a ground to reveal the unaddressed factors associated with higher maternal mortality at micro level focusing more on enabling factors of an individual.

In addition to the analysis of socio-demographic factors associated with MMR at district level, we take up an overview of availability of maternal health care facilities at district level in the state.

3.5. Availability of Maternal Care Facilities at District Level

As per the Rural Health Statistics 2014-15, there are 25 civil hospitals, 13 Sub-Divisional Civil Hospitals, 151 CHCs, 1014 PHCs, 40 First Referral Units (FRUs) and 4621 Sub Center in Assam. The Rural Health Statistics 2014-15 also reported that number of functioning health institutions have increased in the state between the period 2005 to 2015 (Desai & Alva, 1998). Details of health institutions in Assam are presented in Table 3.18.A. However, there is still a shortfall of health center in the state as of 2015, for example, Sub-Center by 21 percent and CHCs by 37 percent as compared to national level shortfalls (20 percent and 32 percent respectively) (GOI, 2014-15).[28] Table 3.19.A shows the district-wise availability of Sub-Center, CHCs and PHCs in Assam based on the recent report of District Level Household and Facility Survey (DLHS) 2012-13.

Facilities available at health institutions are another key element for healthcare services. Data shows that there is an acute deficit[29] at Sub-Center viz. own Government building (2830), two ANMs (2898), electricity (3390), water supply (4426), flush toilet (2752), labour table (4343) (GOA, 2007). In case of human resources in the health institutions,

[28]The shortfall has been calculated by difference between the requirement of infrastructure as per prescribed norms on the basis of provisional rural population from Census, 2011 and the availability of physical infrastructure in position (GOI, 2014-15).

[29] Deficit is measured by difference between total number of center and availability of different type of facility (GOA, 2007).

CHCs provide specialized medical care of Surgeons, Obstetric and Gynecologists, Physicians and Pediatricians. However, it is observed that only 36.99 percent PHCs have lady doctors, while the shortfall of specialists including Surgeons, Obstetric and Gynecologists, Physicians and Pediatricians at CHCs is 483 in the state as of 2015 in comparison to the requirement for existing CHCs of 604 (GOI, 2014-15).

At the first glance, facility survey of public health institutions and DLHS data in Assam for the year 2007 and 2014[30] reveal that there is significant increase in the number of PHCs existing in 2014 at district level compared to those reported existing in 2007. Table 3.20.A depicts the number of PHCs without basic facilities (shortfall of facilities) have gone up such as at least one medial officer (8 to 50)[31], lady medical officer (120 to 260), ANMs (3 to 20), 24 hours delivery services (89 to 204), ambulance facilities (86 to 193) and referral services (23 to 163). The detail status of district wise number of PHCs with maternal care facilities and percentage shortfall of PHCs with maternal care facilities for the year 2007 and 2014 are presented in Table 3.21.A to Table 3.27.A.

Wilcoxon signed-rank test[32] also indicates that there is absolute growth in district wise PHCs (**z** =0.000), however, percentage distribution of PHCs (**z**=0.648) at district level is same

[30] Due to unavailability of data on maternal healthcare facility for various years in Assam, except for the year 2007 and 2014, as such, we have considered only facility health survey of DLHS 2007 and DLHS 2014 for Assam.

[31] The first number refers to total number of PHC's without any medical officer in 2007. The second one refers to the same number in 2014.

[32] A non-parametric test used to assess whether their mean ranks differ when there are two nominal values and one measurement value, for example: in our data, nominal values are 2007 and 2014 and measurement value is maternal care facilities (Mcdonald, 2008).

Wilcoxon sign rank test is a non-parametric test for comparing distribution of two related samples. It is used without assuming normality. The null hypothesis is two distributions are same. For each observation x_i in distribution X_i and x_j in Xj , one computes the absolute difference between each pair

$$|D_{ij}| = |x_i - x_j|$$

Any pair for which the difference is zero is excluded. The differences are then ranked, the smallest $|D_{ij}|$ being ranked 1. In case of ties, the average rank is assigned. Let R_{ij} be the rank of D corresponding to observation pair (i,j). The test statistics is (if there are no ties)

$$W = \sum R_{ij}\,, if\ D_{ij} > 0$$

Under the null, the expected value of D_{ij} is equal to zero.

If there are ties, or if n>50, then the statistic is

$$W' = \frac{\sum R_{ij}}{\sqrt{\sum R_{ij}^2}},$$

Irrespective of the sign of R_{ij}. (Conover,1999, pp 352-53)

between the period of 2007 and 2014 (Table 3.28). This implies growth of PHC's has been even among districts

Table 3.28: Wilcoxon *Signrank Test for Availability of PHCs between the Year 2007 and 2014* (Obs. 23)

Maternal care facilities	Variable description	Significance (z- Value)
No. of PHCs	District wise distribution of PHCs	0.0000
% Distribution of PHCs	Percentage distribution of PHCs	0.6482

Source: Author's estimation

Similarly, Wilcoxon signed-rank test further shows that there is also growth in number of PHCs with no maternal care facilities (such as medial officer, lady medical officer, 24 hours delivery services, ANMs, ambulance facilities and referral services) at z= 0.005, z=0.000, z=003, z=0.000, z=0.000, z=0.000 respectively during 2007 and 2014 (Table 3.29).

Table 3.29: Wilcoxon *Signrank Test for Number of PHC's without Maternal Care Facilities between the Year 2007 and 2014* (Obs. 23)

Maternal care facilities	Variable description	Significance (z- Value)
MO	PHCs with no one Medical Officers	0.0052
LMO	PHCs with no Lady Medical Officers	0.0001
24 hr. DS	PHCs with no 24.hr Delivery Services	0.0031
ANMs	PHCs with no ANMs	0.0006
Amb	PHCs with no Ambulance facility	0.0001
RS	PHCs with no Referral Service	0.0002

Source: Author's estimation

However, Table 3.30 indicates that district wise percentage distribution of PHC's with no maternal care facilities are same except for 24 hours delivery services (z=0.000) and ANMs (z=0.005). In other words, district wise shortage (in terms of percentages) has remained same. However, the shortages in 24 hours delivery and Auxiliary Nurse Midwives (who is the female health outreach worker), have gone up.

Table 3.30: Wilcoxon *Signrank Test for PHC's without Maternal Care Facilities between the Year 2007 and 2014* (Obs. 23) (% distribution)

Maternal care facilities	Variable description	Significance (z- Value)
MO	% of PHCs no Medical Officers	0.5195
LMO	% of PHCs no Lady Medical Officers	0.6925
24 hr. DS	% PHCs no 24.hr Delivery Services	0.0000
ANMs	% of PHCs no ANMs	0.0050
Amb	% of PHCs no Ambulance facility	0.7610
RS	% of PHCs no Referral Service	0.8077

Source: Author's estimation

The result indicate apropos medical institutions (PHCs), concomitant increase in human resources and other maternal care facilities (which have a bearing on maternal mortality) is not observed. This does not augur well for the maternal health scenario of the state.

Most recent data on district level ASHA workers for the year 2015-16 is presented in Table 3.31.A. Further, Table 3.32.A and 3.33.A provides the percentage of mothers who have received financial assistance under JSY for births delivered in a health institution from the recent report of NFHS-IV (2015-16) at state and district level respectively. The state level data shows that in Assam, almost 66 percent of mothers have received JSY financial assistance during their childbirth (vs. at national level 36.4 percent), while at district level, at average 68 percent of mothers have received the same. Accessibility to health institutions is another dimension. District Level Household and Facility Survey III (2007-08) reported that 83.2 percent of villages in Assam have a Sub-Center within 3 km., 68.3 percent of villages have PHCs within 10 km. and 86 percent of villages are serviced by ASHA workers which are in better position as compared to national level, i.e. 71.4 percent, 71.2 percent and 60.1 percent respectively.

3.5.1. Spearman's Correlation Analysis for Maternal care Facilities:

Due to same reasons that has already mentioned in section 3.4.3, Spearman's correlation analysis is undertaken to observe the correlation between MMR and maternal care facilities. Table 3.34 provides the result for Spearman's correlation coefficient.

Table 3.34: ***Results of Spearman's Correlation: Independent Variables with Consideration of MMR*** **(Obs. 23)**

Variables	Rho	Significance (p-value)
Medical officers	-0.1511	0.49
Lady Medical Officers	0.0538	0.80
ANM	-0.0317	0.88
Ambulance	-0.0636	0.77
24hr.DS	-0.0761	0.73
RS	-0.1403	0.52

Source: Author's Estimation

The result indicates that maternal mortality is negatively correlated with availability of PHCs with at least one medical officer, ANMs, ambulance, 24 hr. delivery facilities and referral services.[33] Additionally, MMR is positively correlated with availability of PHCs with at least one lady medical officers. However, none of the relationship is statistically significant.

3.5.2 Cluster Analysis:

As in section 3.4.4., a cluster analysis is taken up for the variables of availability of PHCs with maternal care facilities at district level.[34] A detail of data sources are presented in 3.35 A. Descriptive statistics of all variables are shown in Table 3.36.

Table 3.36: ***Descriptive Statistics of all Variables of Maternal care Facilities*** **(Obs. 23)**

Variable	Mean	Std. Dev.	Min	Max
MMR	223.9603	105.221	86.0.8621	516.631
Medical Officers	14.30435	7.624332	4	37
Lady Medical Officers	5.086957	4.357992	0	17
24 hours Delivery Services	8.086957	3.287899	3	16
ANMs	15.65217	8.637175	4	41
Ambulance	7.608696	3.486847	2	13
Referral Services	9.521739	4.804066	0	19

[33] Our main focus is on maternal care facilities at PHCs because PHCs are considered as the major health care system to provide maternal care for pregnancy and child birth in rural India. PHCs are accessible and affordable at community level. It provides health education, referral services to patients for specialized institutions and logistic support as well (Panchani, 2014)

[34] For example: Medical Officers, Lady Medical Officers, ANM, 24 hours Delivery Facility, Ambulance Facilities and Referral Services at Primary Health Center.

Number of clusters is presented in Table 3.37 which shows that five-group solutions are the most distinct from this hierarchical cluster analysis. The smallest pseudo T-squared value is 17.66 and highest Je (2)/Je (1) is 0.2838.

Table 3.37: ***Number of Clusters Based on Duda/ Hart Stopping-Rule***

Number of Clusters	Duda/ Hart	
	Je(2)/Je(1)	pseudo T-squared
1	0.2910	51.17
2	0.1672	24.90
3	0.2540	41.12
4	0.0000	.
5	**0.2838**	**17.66**
6	0.1386	31.06
7	0.1379	18.75
8	0.1857	17.54
9	0.1503	16.96
10	0.3356	5.94

Out of 23 districts of Assam, five clusters of districts have been formed consisting of nine districts in Cluster 1, seven districts in Cluster 2, one district in Cluster 3 and Cluster 4 and five districts in Cluster 5.[35] The details of clusters with respective mean values of variables that are related to maternal mortality ratio are presented in Table 3.38. A.

[35]Cluster 1 is composed of Bongaigaon, Dhemaji, Dhubri, Goalpara, Lakhimpur, Marigaon, Nagaon, Nalbari, and Tinsukia. Whereas, Cluster 2 consists of Barpeta, Darrang, Hailakandi, Kamrup,Karimganj, Kokrajhar, Sibsagar; Cluster 3 includes Dibrugarh; Cluster 4 is composed of Cachar and Cluster 5 consists of Golaghat, Jorhat, Karbi Anglong, North Cachar Hills and Sonitpur.

Table 3.39: ***Mean Variance of Clustered Districts in Assam (PHCs with Maternal Care Facilities)***

Variables	Cluster 1 (n=9) Mean (SD)	Cluster 2 (n=7) Mean (SD)	Cluster 3 (n=1) Mean (SD)	Cluster 4 (n=1) Mean (SD)	Cluster 5 (n=5) Mean (SD
MO	17.71	21.31	15	14	14.27
	(6.00)	(13.92)	(0)	(0)	(8.2)
LMO	4.72	8.02	9	3	8.17
	(1.80)	(6.88)	(0)	(0)	(6.65)
ANM	18.59	23.53	16	13	20.14
	(7.88)	(15.50)	(0)	(0)	(6.82)
Amb	9.55	7.24	9	11	9.57
	(2.91)	(3.17)	(0)	(0)	(3.47)
24hr.DS	9.47	7.83	9	11	8.84
	(4.09)	(3.26)	(0)	(0)	(2.05)
RS	11.53	8.43	9	14	13.22
	(2.39)	(4.08)	(0)	(0)	(6.75)
MMR	142.24*	210.84	413.31	516.63	304.10
	(29.31)	(18.05)	(0)	(0)	(15.16)

Source: Estimated
Note: One-way ANOVA
***** Significantly different from cluster 1 and cluster 2

The mean variances of five-clustered districts are shown in Table 3.39. Cluster 4 and Cluster 5 districts have comparatively better provisions of PHCs with lady medical officers, ANM, availability of 24 hours delivery services, ambulance facilities and referral services than Cluster 1 districts and Cluster 2 districts. Additionally, the mean value of MMR in Cluster 4 district is 516.63 per 1, 00,000 live births with better availability of PHCs with maternal care facilities compared to other clusters. However, the one-way ANOVA results reveal that variances of any variables of the five clusters are not significant except maternal mortality ratio at $p = 0.000$.

The present cluster analysis also shows a positive relationship between maternal mortality and better availability of PHCs with maternal care facilities, which is similar to the socioeconomic variables as discussed in section 3.4.4.

3.6. Conclusions

This chapter largely focuses on contemporary maternal health scenario of Assam including the trend of maternal deaths and morbidity in order to identify the determining factors for high maternal mortality at macro level. Overall health scenario of Assam shows an adverse health outcome with underutilization and acute shortage of basic infrastructures at health institutions. A district level analysis of maternal mortality ratio demonstrates an upward moving trend during the period of 2011-12 to 2013-14. In addition, hemorrhage and anemia are found major contributing factors to direct and indirect causes of maternal deaths in the state.

In the present study, rank correlation between socioeconomic variables and MMR shows a positive relationship but the result is not statistically significant. Similarly, rank correlation between maternal care facilities and MMR is negatively correlated but insignificant. Second, the complimentary approach of cluster analysis on socioeconomic variables and medical facilities that based on maternal mortality ratio showed that clusters (for socioeconomic variables such as PCI, age of marriage and MMR; maternal care facilities such as MMR) are significantly different from each other. ANOVA result also reflects that concentration of higher maternal mortality ratio is likely to be associated with better socio-economic conditions. Similarly, ANOVA result for maternal care facilities shows that higher MMR is largely associated with availability of better health facilities. Therefore, such results at district level reveal an inverse and challenging to the conventional expectation. There could be three reasons behind it. First, it could be the case that districts with better health care facilities and /or socioeconomic conditions also report higher maternal deaths due to better administration. Second, there could be an endogeneity problem: government is likely to set up more facilities in the districts which have reported higher maternal mortality/ morbidity. Third, it could be the case that districts with better medical facilities attract more critical cases. However, given the paucity of data both in cross section and time series, such hypothesis cannot be tested. At best, such macro data level has to be treated with caution if one has to infer certain policies. Therefore, it is necessary to conduct a more in-depth study in order to examine the determining factors of higher maternal deaths at disaggregated level.

Remaining chapters dealing with disaggregated level data- collected through sampling that attempts to achieve the proposed objective.

Appendix

Tables

Table 3.1.A: ***Selected Socio-economic Maternal Health Indicators: Assam and India***

	India	Assam
Maternal Mortality Ratio (SRS)	167	**300**
Age group of highest maternal deaths (years)NFHS III	20-30	**20-29**
Main cause of maternal death (hemorrhage %)NFHS III	24	**37**
The mean age of marriage (NFHS III)	21	**19**
Total fertility level (NFHS III)	2.4	**2.4**
Use of contraceptive among married women (%) NFHS III	53.0	**54.5**
Home delivery (%) NFHS III	60	**78**
Received postnatal care (%) NFHS III	41.2	**16**
Receiving any Antenatal Care (%) NFHS III	76.4	**70.7**
Prevalence of anemic problem (%) NFHS III	57.9	**70**

Source: NFHS 3; Health & Healthcare of Assam; Central Bureau of Health Intelligence. www.nrhm.nic.in accessed on 6 March 2009; Ministry of Health and Family Welfare; Family welfare Statics of India 2009, SRS 2011-13

Table 3.2.A: ***Trend of Maternal Mortality Ratio in India and Assam from 1997-2013***

Year	India	Assam
1997-98	398	**568**
1999-01	327	**398**
2001-03	301	**490**
2004-06	254	**480**
2007-08	212	**390**
2010-12	178	**328**
2011-13	167	**300**

Source: Registrar General of India, Ministry of Home Affairs (SRS Bulletin)

Table 3.3.A: Administrative Division Wise Maternal Mortality Ratio and Maternal Mortality Rate during 2010-11 & 2012-13

State/ Administrative Divisions	MMR		Maternal Mortality Rate		Life Time Risk (%)	
	2010-11	2012-13	2010-11	2012-13	2010-11	2012-13
Assam	381	301	31	23	1.07	0.79
Hills and Barak Valley Division	342	281	31	24	1.07	0.82
Lower Assam Division	366	254	28	18	0.98	0.64
North Assam Division	367	251	32	20	1.1	0.7
Upper Assam Division	430	404	32	28	1.12	0.98

Source: Assam Annual Health Survey 2010-11 & 2012-13

Table 3.4.A*: Age Specific Death Rate by Sex and Residence 2010*

Age Group	India			Assam		
	Male	Female	Total	Male	Female	Total
10-14	0.9	0.8	0.9	1.2	2	1.6
15-19	1.2	1.4	1.3	1.4	4	2.6
20-24	1.9	1.9	1.9	1.8	3.5	2.7
25-29	2.4	1.9	2.1	4.6	2.1	3.3
30-34	2.7	2	2.4	2.8	2.4	2.6
35-39	4.1	2.3	3.2	3.6	4.4	4
40-44	5	2.8	3.9	6.4	1.6	4.2
45-49	7.3	4.6	6	9.2	9.4	9.3

Source: Sample Registration System 2010

Table 3.5.A: ***Age group wise distribution of deaths (female) by cause of death in India (2001-03)***

Causes of Death	Age Group (% of death)			
	0-4	**15-24**	**34**	**44**
Tuberculosis	0.6	3.2	7.5	13.4
Diarrheal Diseases	15.3	7.2	6.1	5.2
Malaria	3	4.6	4	3.6
Respiratory Infections	23.3	1.3	0.9	1.2
Maternal Conditions	-	12.6	15.4	5.7
Nutritional Deficiencies	3.2	1.5	1.4	1.1
Cardiovascular Diseases	0.4	6.3	9.3	14.3

Source: Census of Death in India, Ministry of Home Affairs, Govt. of India

Table 3.6.A: ***Distribution of Deaths by Major Cause Groups in EAG States & Assam and Other States 2004-06***

Major cause groups	**No of Deaths (%)**	
EAG states & Assam	**Male**	**Female**
Communicable, maternal, prenatal and nutritional conditions	47.3	53.7
Non communicable diseases	37.9	32.9
Injuries	9.5	6.7
Symptoms, signs and ill-defined conditions	5.3	7.2
Other States		
Communicable, maternal, prenatal and nutritional conditions	26.8	30.6
Non communicable diseases	53.8	48.4
Injuries	13.1	9.7
Symptoms, signs and ill-defined conditions	6.3	11.3

Source: Census of death in India 2004-06, Registrar General of India

Table 3.7.A: ***Age Distribution of Maternal and Non Maternal Deaths in India, 2010-12***

Age Groups	Maternal Deaths (%)	Non-Maternal Deaths (%)
15-19	7	12
20-24	39	16
25-29	28	13
30-34	17	12
35-39	7	12
40-44	2	15
45-49	0	19

Source: SRS 2010-12

Table 3.8.A: ***Age specific maternal death of Assam 2010-11***

Age Group	Maternal Death
15-19	28
20-24	112
25-29	117
30-34	81
35-39	50
40-44	24
45-49	11

Source: Assam Annual Health Survey 2010-11

Table 3.9.A: ***Causes of Maternal Deaths (%) from 2001-03 Special Survey of Deaths***

Maternal Causes	India	EAG & Assam	Southern States	Other States
Hemorrhage	38	37	30	40
Sepsis	11	11	17	10
Hypertensive	5	4	13	6
Obstructed Labor	5	5	9	4
Abortion	8	10	4	3
Other Conditions	34	33	26	37

Source: Sample Registration System, Registrar General India

Table 3.10.A: ***District wise receiving any ANC, complication during pregnancy and sought treatment for pregnancy complication in Assam 2007-08***

Districts	Receiving any ANC	Complication during pregnancy	Sought treatment for pregnancy complication
Assam	**74.3**	**60.2**	**45.0**
Tinsukia	72.7	69.5	41.4
Sibasagar	79.3	56.5	55.1
Dibrugarh	85.5	61.6	43.8
Golaghat	72.5	71.5	47.4
Jorhat	88.4	60.5	45.5
Kamrup	90.4	49.9	60.4
Darrang	79.3	64.5	25.7
Barpeta	75.9	53.9	35
Bongaigaon	70.8	43.5	34.6
Dhubri	47.7	56.7	26.9
Goalpara	67.3	61.7	30.9
Nalbari	81.4	38.2	54.5
Kokrajhar	47.8	56.5	41.9
Nagaon	72.6	61.5	34.3
Sonitpur	82.6	46.5	47.8
Marigaon	71.3	59.8	40.9
Lakhimpur	63.5	60.5	41
Dhemaji	65.1	65.4	41.7
N CHills	72.9	65.6	53.5
KarbiAnglong	65.9	34.6	52.4
Karimganj	83.7	83.7	55.5
Hailakandi	89.2	82.9	58.2
Cachar	86.5	81.6	55.2

Source: District Level Household and Facility Survey 2007-2008

Table 3.11.A: ***Districts wise maternal mortality ratio in Assam during 2013-14***

Districts	MMR
Tinsukia	136.66
Sibasagar	192.21
Dibrugarh	413.31
Golaghat	325.31
Jorhat	306.93
Kamrup (R)	357.39
Kamrup (M)	57.77
Darrang	200.50
Barpeta	195.14
Bongaigaon	153.57
Dhubri	166.89
Goalpara	86.86
Nalbari	119.17
Kokrajhar	212.35
Nagaon	171.03
Sonitpur	297.34
Marigaon	123.78
Lakhimpur	115.55
Dhemaji	128.50
N C Hills	335.57
Karbi Anglong	289.66
Karimganj	197.25
Hailakandi	236.69
Cachar	516.63
Baksha	225.93
Chirang	229.15
Udalguri	267.64
Assam	228.03

Sources: estimated by author based on official data from NRHM 2013-14

Table 3.12.A: ***Sources of Data for the Selected Determinants of Maternal Mortality Ratio***

Measures	Variables	Data Sources	Year
Maternal Mortality Ratio	MMR	For estimating district wise MMR, district wise live birth are collected from NRHM, Guwahati, Assam and number of maternal deaths have been collected from maternal death reporting system that available in official website of NRHM Assam.	2013-14
Per capita Income	PCI	Human Development of Report, Assam, 2014	2016
Age of Marriage	AoM	District Level Household Survey Assam (III)	2007-08
Female literacy rate	Flt	Census	2011
Scheduled Tribe	ST	Census	2011
Scheduled Caste	SC	Census	2011

Table 3.16 A: ***Characteristics of Districts and Related Variables of MMR in Assam, Mean Values***

Districts	MMR	PCI	Flt	AoM	SCPOP	STPOP	PCASHA	Cluster
Baksa	225.93	18192	62.63	20.90	7.69	34.84	97.99	2
Barpeta	195.14	21828	59.04	19.80	5.63	1.62	76.59	2
Bongaigaon	153.57	25164	65.18	19.80	11.21	2.55	93.39	1
Cachar	516.63	23052	74.62	21.20	15.25	1.01	90.81	4
Chirang	229.15	21504	57.87	20.50	7.29	37.06	143.52	2
Darrang	200.50	17892	60.40	20.90	4.34	0.91	95.42	2
Dhemaji	128.50	17568	62.13	20.60	6.45	47.45	104.94	1
Dhubri	166.89	16836	54.26	19.10	3.61	0.33	88.24	1
Dibrugarh	413.31	23364	69.52	21.20	4.44	7.76	89.12	3
Goalpara	86.86	22404	64.53	20.20	4.47	22.97	96.21	1
Golaghat	325.31	19788	72.18	21.60	5.84	10.48	93.54	3
Hailakandi	236.70	16632	68.54	19.70	10.72	0.11	102.08	2
Jorhat	306.93	38664	78.22	21.50	8.12	12.82	109.41	3
Kamrup (M)	357.32	63444	85.82	22.80	8.12	5.99	16.83	3
Kamrup (R)	57.77	23316	67.69	23.20	7.11	12.00	108.73	1
Karbi Anglong	289.67	23076	64.62	21.50	4.70	56.34	97.88	3
Karimganj	197.25	19152	73.49	19.60	12.85	0.16	91.97	2
Kokrajhar	212.35	18048	59.54	20.10	3.33	31.41	147.33	2
Lakhimpur	115.56	22248	71.91	21.00	7.85	23.93	99.03	1
Marigaon	123.78	17196	64.99	19.90	12.31	14.29	95.15	1
Nagaon	171.03	25884	69.21	20.40	9.43	4.08	82.66	1
Nalbari	119.17	27516	73.85	22.10	7.80	3.03	96.29	1
NC Hills	335.57	26604	72.15	21.50	2.03	70.92	91.55	3
Sibasagar	192.21	37104	75.69	21.70	3.68	4.26	102.69	2
Sonitpur	297.34	27240	62.55	21.40	5.67	12.07	96.15	3
Tinsukia	136.66	23340	63.54	21.50	2.84	6.18	100.83	1
Udalguri	267.64	20436	59.17	21.10	4.55	32.15	120.36	3

Table 3.18.A: ***Functioning Health Institutions in Assam***

Center	Functioning as on 2005	Functioning as on 2015	Required as on 2015	Shortfall as on 2015
PHC	610	1014	954	0
CHC	100	151	238	87
Sub-Center	5109	4621	5850	1229

Source: Rural Health Statistics 2014-15

Table 3.19.A: ***District Level Availability of Health Center in Assam (as on 2012-13)***

Districts	Number of CHC	Number of PHC	Number of Sub-Center
Tinsukia	9	8	47
Sibasagar	10	14	30
Dibrugarh	10	16	53
Golaghat	6	26	43
Jorhat	9	25	51
Kamrup	24	42	61
Darrang	10	10	20
Barpeta	13	18	39
Bongaigaon	9	32	49
Dhubri	11	15	25
Goalpara	6	24	39
Nalbari	14	14	9
Kokrajhar	4	12	14
Nagaon	19	17	38
Sonitpur	8	17	69
Marigaon	5	19	51
Lakhimpur	7	13	14
Dhemaji	6	13	58
NC Hills	5	4	26
KarbiAnglong	10	13	33
Karimganj	6	6	21
Hailakandi	4	6	8
Cachar	9	15	59

Source: DLHS 2014

Table 3.20.A: ***Availability of maternal care facilities at PHC in Assam between 2007 to 2014***

PHC facilities	No. of PHC 2007	No. of PHC with facilities 07	Shortfall	No. of PHC 2014	No. of PHC with facilities 14	Shortfall
Medical officers	149	141	8	379	329	50
Lady Medical officers	149	29	120	379	119	260
ANM	149	146	3	379	359	20
Ambulance	149	60	89	379	175	204
Delivery services	149	63	86	379	186	193
Referral services	149	124	26	379	216	163

Sources: DLHS 2014 and Facility Survey of Public Health Institutions in Assam 2007

Table 3.21.A: ***District wise Availability of PHCs with Medical Officers in Assam 2007- 2014***

	2007			2014		
Districts	**No. of PHCs**	**PHCs with Medical Officer**	**No. PHCs with No Medical Officer**	**No. of PHCs**	**PHCs with Medical Officer**	**No. PHCs with No Medical Officer**
Tinsukia	4	4	0	8	8	0
Sibasagar	8	8	0	14	14	0
Dibrugarh	6	6	0	16	15	1
Golaghat	5	5	0	26	6	20
Jorhat	7	7	0	25	24	1
Kamrup	14	14	0	42	37	5
Darrang	7	7	0	10	9	1
Barpeta	9	8	1	18	16	2
Bongaigaon	6	6	0	32	26	6
Dhubri	7	7	0	15	13	2
Goalpara	5	5	0	24	22	2
Nalbari	7	7	0	14	13	1
Kokrajhar	4	3	1	12	9	3
Nagaon	11	11	0	17	16	1
Sonitpur	7	7	0	17	16	1
Marigaon	3	3	0	19	19	0
Lakhimpur	6	6	0	13	12	1
Dhemaji	5	3	2	13	12	1
N C Hills	3	2	1	4	4	0
Karbi Anglong	8	6	2	13	13	0
Karimganj	5	4	1	6	5	1
Hailakandi	4	4	0	6	6	0
Cachar	8	8	0	15	14	1

Sources: DLHS 2014 and Facility Survey of Public Health Institutions in Assam 2007.

Table 3.22.A: ***District wise Availability of PHCs with Lady Medical Officers in Assam 2007-2014***

	2007			2014	
Districts	**No. of PHCs**	**PHCs with Lady Medical Officer**	**No. PHCs with No Lady Medical Officer**	**No. of PHCs**	**PHCs with Lady Medical Officer**	**No. PHCs with No Lady Medical Officer**
Tinsukia	4	2	2	8	3	5
Sibasagar	8	2	6	14	11	3
Dibrugarh	6	3	3	16	9	7
Golaghat	5	1	4	26	17	9
Jorhat	7	0	7	25	5	20
Kamrup	14	4	10	42	15	27
Darrang	7	2	5	10	1	9
Barpeta	9	2	7	18	3	15
Bongaigaon	6	1	5	32	6	26
Dhubri	7	0	7	15	2	13
Goalpara	5	0	5	24	4	20
Nalbari	7	1	6	14	3	11
Kokrajhar	4	0	4	12	1	11
Nagaon	11	4	7	17	5	12
Sonitpur	7	1	6	17	5	12
Marigaon	3	1	2	19	7	12
Lakhimpur	6	2	4	13	3	10
Dhemaji	5	2	3	13	7	7
NC Hills	3	1	2	4	4	0
Karbi Anglong	8	0	8	13	2	11
Karimganj	5	0	5	6	1	5
Hailakandi	4	0	4	6	0	6
Cachar	8	0	8	15	3	12

Sources: DLHS 2014 and Facility Survey of Public Health Institutions in Assam 2007

Table 3.23.A: ***District wise Availability of PHCs with ANM in Assam 2007- 2014***

	2007			2014		
Districts	**No. of PHCs**	**PHCs with ANM**	**No. PHCs with No ANM**	**No. of PHCs**	**PHCs with ANM**	**No. PHCs with No ANM**
Tinsukia	4	4	0	8	7	1
Sibasagar	8	8	0	14	14	0
Dibrugarh	6	6	0	16	16	0
Golaghat	5	5	0	26	26	0
Jorhat	7	7	0	25	23	2
Kamrup	14	14	0	42	41	1
Darrang	7	7	0	10	9	2
Barpeta	9	9	0	18	18	0
Bongaigaon	6	6	0	32	31	1
Dhubri	7	7	0	15	13	2
Goalpara	5	5	0	24	22	2
Nalbari	7	7	0	14	12	2
Kokrajhar	4	4	0	12	12	0
Nagaon	11	11	0	17	17	0
Sonitpur	7	7	0	17	17	0
Marigaon	3	3	0	19	18	1
Lakhimpur	6	6	0	13	13	0
Dhemaji	5	5	0	13	11	2
N C Hills	3	3	0	4	4	0
Karbi Anglong	8	7	1	13	12	1
Karimganj	5	5	0	6	6	0
Hailakandi	4	4	0	6	5	2
Cachar	8	8	0	15	13	2

Sources: DLHS 2014 and Facility Survey of Public Health Institutions in Assam 2007

Table 3.24.A: ***District wise Availability of PHCs with Ambulance Facilities in Assam 2007- 2014***

	2007			2014		
Districts	**No. of PHCs**	**PHCs with AmB**	**No. PHCs with No Ambulance**	**No. of PHCs**	**PHCs with AmB**	**No. PHCs with No ambulance**
Tinsukia	4	2	2	8	3	5
Sibasagar	8	2	6	14	8	6
Dibrugarh	6	2	4	16	9	7
Golaghat	5	1	4	26	13	13
Jorhat	7	3	4	25	10	15
Kamrup	14	5	9	42	10	32
Darrang	7	2	5	10	4	6
Barpeta	9	4	5	18	8	10
Bongaigaon	6	2	4	32	12	20
Dhubri	7	1	6	15	10	5
Goalpara	5	2	3	24	13	11
Nalbari	7	2	5	14	7	7
Kokrajhar	4	2	2	12	3	9
Nagaon	11	4	7	17	6	11
Sonitpur	7	3	4	17	9	8
Marigaon	3	3	0	19	10	9
Lakhimpur	6	3	3	13	9	4
Dhemaji	5	3	2	13	8	5
N C Hills	3	2	1	4	2	2
Karbi Anglong	8	2	6	13	5	8
Karimganj	5	2	3	6	2	4
Hailakandi	4	0	4	6	3	3
Cachar	8	7	1	15	11	4

Sources: DLHS 2014 and Facility Survey of Public Health Institutions in Assam 2007

Table 3.25.A: ***District wise Availability of PHCs with Delivery Care in Assam 2007- 2014***

	2007			2014		
Districts	**No. of PHCs**	**PHCs with del**	**No. PHCs with No 24 hr. Delivery Services**	**No. of PHCs**	**PHCs with del**	**No. PHCs with No 24 hr. Delivery Services**
Tinsukia	4	1	3	8	7	1
Sibasagar	8	1	7	14	5	9
Dibrugarh	6	3	3	16	9	7
Golaghat	5	1	4	26	11	15
Jorhat	7	2	5	25	8	17
Kamrup	14	4	10	42	11	31
Darrang	7	3	4	10	5	5
Barpeta	9	3	6	18	9	9
Bongaigaon	6	2	4	32	6	26
Dhubri	7	1	6	15	7	8
Goalpara	5	2	3	24	16	8
Nalbari	7	2	5	14	8	6
Kokrajhar	4	2	2	12	3	9
Nagaon	11	9	2	17	7	10
Sonitpur	7	5	2	17	8	9
Marigaon	3	3	0	19	14	5
Lakhimpur	6	5	1	13	6	7
Dhemaji	5	2	3	13	12	1
N C Hills	3	0	3	4	3	1
Karbi Anglong	8	3	5	13	9	4
Karimganj	5	1	4	6	5	1
Hailakandi	4	1	3	6	6	0
Cachar	8	7	1	15	11	4

Sources: DLHS 2014 and Facility Survey of Public Health Institutions in Assam 2007

Table 3.26.A: ***District wise Availability of PHCs with Referral Services in Assam 2007-2014***

	2007			2014		
Districts	**PHCs**	**PHCs with RS**	**No. PHCs with No Referral Services**	**PHCs**	**PHCs with RS**	**No. PHCs with No Referral Services**
Tinsukia	4	3	1	8	6	2
Sibasagar	8	7	1	14	11	3
Dibrugarh	6	6	1	16	9	7
Golaghat	5	5	0	26	19	7
Jorhat	7	5	0	25	16	9
Kamrup	14	13	2	42	11	31
Darrang	7	6	1	10	6	4
Barpeta	9	7	1	18	10	8
Bongaigaon	6	6	2	32	11	21
Dhubri	7	6	0	15	11	4
Goalpara	5	4	1	24	15	9
Nalbari	7	6	1	14	11	4
Kokrajhar	4	3	1	12	0	12
Nagaon	11	10	1	17	10	7
Sonitpur	7	6	1	17	11	6
Marigaon	3	3	1	19	14	5
Lakhimpur	6	4	0	13	9	4
Dhemaji	5	4	2	13	12	1
NC Hills	3	2	1	4	1	3
Karbi Anglong	8	4	1	13	3	10
Karimganj	5	3	4	6	6	0
Hailakandi	4	3	2	6	3	3
Cachar	8	8	1	15	14	1

Sources: DLHS 2014 and Facility Survey of Public Health Institutions in Assam 2007

Table 3.27.A: ***District wise Percentage Shortfall of Maternal Care Facility during 2007 and 2014 (obs. 23)***

Districts	% PHCs with no MO 07	% PHCs with no of MO 14	% PHCs with no of LMO 07	% PHCs with no LMO 14	% PHCs with no ANM 07	% PHCs with no ANM 14	% PHCs with no Amb 07	% PHCs with no Amb 14	% PHCs with no DS 07	% PHCs with no DS 14	% PHCs with no RS 07	% PHCs with no RS 14
Tinsukia	0	0	1.67	1.90	0	4.76	2.22	2.45	1.16	0.52	3.85	1.24
Sibasagar	0	0	5.00	1.14	0	0	6.67	2.94	10.47	4.66	3.85	1.86
Dibrugarh	0	2	2.50	2.66	0	0	4.44	3.43	8.14	3.63	3.85	4.35
Golaghat	0	40	3.33	3.42	0	0	4.44	6.37	17.44	7.77	0	4.35
Jorhat	0	2	5.83	7.60	0	9.52	4.44	7.35	19.77	8.81	0	5.59
Kamrup	0	10	8.33	10.27	0	4.76	10.00	15.69	36.05	16.06	7.69	19.25
Darrang	0	2	4.17	3.42	0	9.52	5.56	2.94	5.81	2.59	3.85	2.48
Barpeta	12.5	4	5.83	5.70	0	0	5.56	4.90	10.47	4.66	3.85	4.97
Bongaigaon	0	12	4.17	9.89	0	4.76	4.44	9.80	30.23	13.47	7.69	13.04
Dhubri	0	4	5.83	4.94	0	9.52	6.67	2.45	9.30	4.15	0	2.48
Goalpara	0	4	4.17	7.60	0	9.52	3.33	5.39	9.30	4.15	3.85	5.59
Nalbari	0	2	5.00	4.18	0	9.52	5.56	3.43	6.98	3.11	3.85	2.48
Kokrajhar	12.5	6	3.33	4.18	0	0.00	2.22	4.41	10.47	4.66	3.85	7.45
Nagaon	0	2	5.83	4.56	0	0	7.78	5.39	11.63	5.18	3.85	4.35
Sonitpur	0	2	5.00	4.56	0	0	4.44	3.92	10.47	4.66	3.85	3.73
Marigaon	0	0	1.67	4.56	0	4.76	0	4.41	5.81	2.59	3.85	3.11
Lakhimpur	0	2	3.33	3.80	0	0	3.33	1.96	8.14	3.63	0	2.48
Dhemaji	25	2	2.50	2.66	0	9.52	2.22	2.45	1.16	0.52	7.69	0.62
NCHills	12.5	0	1.67	0	0	0	1.11	0.98	1.16	0.52	3.85	1.86
Karbi Anglong	25	0	6.67	4.18	100	4.76	6.67	3.92	4.65	2.07	3.85	6.21
Karimganj	12.5	2	4.17	1.90	0	0	3.33	1.96	1.16	0.52	15.38	0
Hailakandi	0	0	3.33	2.28	0	9.52	4.44	1.47	0	0	7.69	1.86
Cachar	0	2	6.67	4.56	0	9.52	1.11	1.96	4.65	2.07	3.85	0.62

Table 3.31.A: ***ASHA Workers at District Level in Assam 2015-16***

Districts	ASHA Workers
Tinsukia	0.09941
Sibasagar	0.09515
Dibrugarh	0.11429
Golaghat	0.07675
Jorhat	0.09662
Kamrup	0.09668
Darrang	0.10477
Barpeta	0.08414
Bongaigaon	0.10382
Dhubri	0.10068
Goalpara	0.14755
Nalbari	0.0971
Kokrajhar	0.09339
Nagaon	0.10136
Sonitpur	0.09419
Marigaon	0.10451
Lakhimpur	0.11116
Dhemaji	0.10873
DimaHasao	0.08919
KarbiAnglong	0.10048
Karimganj	0.11078
Hailakandi	0.11459
Cachar	0.09654
Chirang	0.09841
Kaprup (M)	0.12565
Baksa	0.14871
Udalguri	0.01683

Source: Author's estimated from NRHM official data

Table 3.32.A: ***Mothers who received financial assistance under Janani Suraksha Yojana (JSY) for births delivered in an institution (%) at District Level in Assam 2015-16***

Districts	JSY beneficiary
Tinsukia	53.8
Sibasagar	69.7
Dibrugarh	63.9
Golaghat	73.1
Jorhat	75
Kamrup	53.9
Darrang	74.3
Barpeta	66.7
Bongaigaon	67.4
Dhubri	48.3
Goalpara	71.4
Nalbari	70.2
Kokrajhar	76.7
Nagaon	62.5
Sonitpur	73.3
Marigaon	80.6
Lakhimpur	78.4
Dhemaji	90.2
DimaHasao	77.6
KarbiAnglong	65.6
Karimganj	75.8
Hailakandi	77
Cachar	49.2
Chirang	68.1
Kaprup (M)	28.4
Baksa	76.8
Udalguri	77.1

Source: NFHS IV

Table 3.33.A: ***Mothers who received financial assistance under Janani Suraksha Yojana (JSY) for births delivered in an institution (%) during*** **2015-16 in Selected Major States of India**

States	% of JSY beneficiary
Andhra Pradesh	17.4
Assam	66.1
Bihar	53.9
Chhattisgarh	66.2
Gujarat	8.9
Haryana	13.5
Karnataka	19.9
Maharashtra	8.7
Madhya Pradesh	61.1
Odisha	72.6
Punjab	19.1
Rajasthan	56.1
Tamil Nadu	29.5
West Bengal	28.7
India	36.4

Source: NFHS IV

Table 3.35.A: ***Sources of Data for Maternal Mortality Ratio and Maternal Healthcare Facility***

Measures	Variables	Data Sources	Year
Maternal Mortality Ratio	MMR	For estimating district wise MMR, district wise live birth are collected from NRHM, Guwahati, Assam and number of maternal deaths have been collected from maternal death reporting system that available in official website of NRHM Assam.	2013-14
Medical Officers	MO	District Level Household Survey Assam (IV) Facility Survey of Public Health Institution of Assam	2014 2007
Lady Medical officers	LMO		
24hr. Delivery Services	24hr.DS		
ANMs	ANM		
Ambulances	Amb		
Referral Services	RS		

Table 3.38.A: ***Characteristics of Districts and Maternal Care Facilities at PHCs related to MMR in Assam, Mean Values***

Districts	MMR	PHCs with Medical officers	PHCs with Lady Medical officers	PHCs with ANM	PHCs with Ambulance	PHCs with Delivery services	PHCs with Referral Services	Cluster
Barpeta	195.136	16	3	18	8	9	10	2
Bongaigaon	153.572	26	6	31	12	6	11	1
Cachar	516.631	14	3	13	11	11	14	4
Darrang	200.496	9	1	9	4	5	6	2
Dhemaji	128.502	12	7	11	8	12	12	1
Dhubri	166.889	13	2	13	10	7	11	1
Dibrugarh	413.31	15	9	16	9	9	9	3
Goalpara	86.8621	22	4	22	13	16	15	1
Golaghat	325.309	6	17	26	13	11	19	5
Hailakandi	236.695	6	0	5	3	6	3	2
Jorhat	306.93	24	5	23	10	8	16	5
Kamrup	230.154	37	15	41	10	11	11	2
Karbi Anglong	289.665	13	2	12	5	9	3	5
Karimganj	197.254	5	1	6	2	5	6	2
Kokrajhar	212.353	9	1	12	3	3	0	2
Lakhimpur	115.555	12	3	13	9	6	9	1
Marigaon	123.782	19	7	18	10	14	14	1
Nagaon	171.029	16	5	17	6	7	10	1
Nalbari	119.173	13	3	12	7	8	11	1
NCHill	335.57	4	4	4	2	3	1	5
Sibasagar	192.212	14	11	14	8	5	11	2
Sonitpur	297.344	16	5	17	9	8	11	5
Tinsukia	136.663	8	3	7	3	7	6	1

Figures

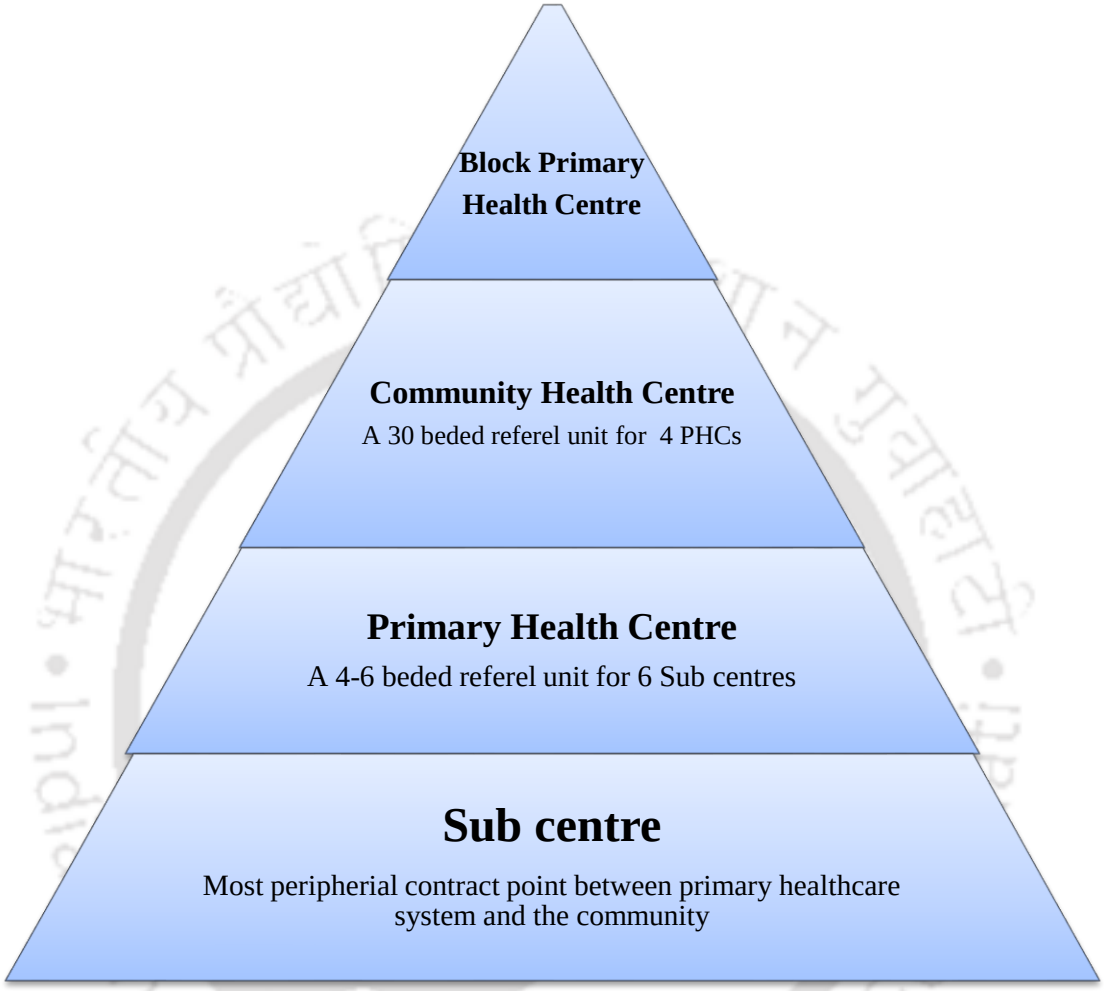


Figure 3.1.A: Hierarchy of health institutions

CHAPTER IV

Field Description and Sample Profile

4.1. Purpose of Field Study

The analysis of contemporary maternal health scenario of Assam in Chapter III is primarily based on aggregate data sourced from various government reports and publications of different years. Trend of maternal mortality and maternal illness reveals that the state has recorded a substantial decline in maternal mortality over the years. However, pregnancy related complications are still a major health problem. District level analysis reveals that concentration of higher maternal mortality ratio is likely to be more in those districts with better socio-economic characteristics and better availability of PHCs with maternal care facilities, which is puzzling and challenges conventional expectation. In our opinion, such results are due to the nature of secondary data. Thus, analysis based on aggregate data may not reveal factors for high maternal deaths in Assam. In order to identify causes behind of adverse maternal outcome, we require more detail study at disaggregated level on women's reproductive health, maternal deaths and socioeconomic background. For that purpose, a field survey has been carried out in selected villages covering those districts of different Administrative Divisions which recorded highest maternal deaths during the year 2013-14.

The field survey collected information on status of maternal health, prenatal experience of women, socio-economic status of pregnant women and her family, awareness about family planning methods, nutritious foods etc. The survey also investigated maternal deaths cases by interviewing members of families who have experienced of maternal deaths.

4.2. Selection of the Area for the Field Study:

The field study has been carried out in eight villages of four districts covering each Administrative Divisions of the state. As the main objective of our study is to look for high incidence of maternal mortality, morbidity and maternal complications, we aim to identify

such cases from which we can get necessary information. Note that, the absolute incidence of maternal death is low itself, so to get data, we chose those areas which has reported high maternal death reporting districts/ BPHC from each Administrative Divisions of Assam.

Multiple stage sampling method is used to identify the villages to carry out the field survey. At first, by using stratified sampling methods,[36] districts under all four Administrative Divisions[37] of Assam are arranged from highest to lowest based on maternal mortality ratio for the period April 2013 and March 2014. The districts with highest maternal mortality ratio reported from each Administrative Divisions are Dibrugarh (413.31), Kamrup (230.15), Sonitpur (297.34) and Cachar (516.63) from Upper Assam Division, Lower Assam Division, North Assam Division and Hills & Barak Valley respectively (Table 4.1).

[36] In stratified sampling method, the entire population is divided into different groups according to some variables that are thought to be related to the variables. Then a sample is taken from every stratum.
[37] For details see Chapter III, p- 4 (footnote 5)

Table 4.1: ***Highest Maternal Mortality Ratio in Administrative Division wise Districts of Assam during 2013-14***

Administrative Divisions	Maternal deaths	Live Births	Maternal Mortality Ratio (per 1 lakh live births)
Upper Assam Division			
Dibrugarh	**98**	**23711**	**413.3103**
Golaghat	50	15370	325.309
Jorhat	52	16942	306.9295
Sibasagar	31	16128	192.2123
Tinsukia	33	24147	136.6629
Lower Assam Division			
Kamrup	**122**	**53008**	**230.1539**
Kokrajhar	35	16482	212.3529
Darrang	38	18953	200.496
Barpeta	69	35360	195.1357
Dhubri	75	44940	166.8892
Bongaigaon	25	16279	153.5721
Nalbari	17	14265	119.1728
Goalpara	20	23025	86.86211
North Assam Division			
Sonitpur	**106**	**35649**	**297.3435**
Nagaon	92	53792	171.0291
Dhemaji	20	15564	128.5017
Marigaon	24	19389	123.7815
Lakhimpur	23	19904	115.5547
Hills and Barak Valley			
Cachar	**203**	**39293**	**516.6315**
North Cachar Hills	14	4172	335.5705
Karbi Anglong	53	18297	289.665
Hailakandi	33	13942	236.6949
Karimganj	52	26362	197.2536

Source: Maternal Deaths and Live births are collected from NRHM, Assam 2013-14 and MMR is estimated by author

From each sample districts, one Block Primary Health Center (BPHC) which reported highest maternal deaths within the sample districts has been selected viz. Barbaruah (86) from Dibrugarh, Chhaygaon (96) from Kamrup, Biswanath Chariali (14) from Sonitpur and Sonai (10) from Cachar. After selecting the Block Primary Health Center, as per reference of BPHC medical officer, purposively two villages from each Block Primary Health Center (total 8 villages) has been identified. These villages are: Janzimukh and Lepetkatta Tea Estate from Barbaruah (Dibrugarh), Muhimari and Patgaon from Chhaygaon (Kamrup), Kadamoni and Sakumato Tea Estate from Biswanath Chariali (Sonitpur) and Motinagar and Silcoorie Tea Estate from Sonai (Cachar). Details are presented in Table 4.2.

Table 4.2: ***Selected Districts and BPHC of four Administrative Divisions of Assam based on Highest Maternal Mortality Ratio Reported in the Period of 2013-14***

Districts (Highest MMR)	Administrative Divisions (AD)	Maternal Mortality Ratio	No of BPHC	Name of BPHC having highest maternal death	Total no of death reported	Villages
Dibrugarh	Upper AD	413.3103	6	Barbaruah	86	Janzimukh,Lepetkatta TE
Kamrup	Lower AD	230.1539	15	Chhaygaon	7	Muhimari, Patgaon
Sonitpur	North AD	297.3435	9	Biswanath Chariali	14	Kadamani, Sakumato TE
Cacher	Hills & Barak Valley	516.6315	9	Sonai	10	Motinagar, Silcoorie TE

Source: estimated MMR; number of BPHC and total no of reported deaths are from NRHM, Assam

Fifteen percent of the total households with reference to availability of sample unit are selected for detail information on maternal experiences of women and maternal deaths through structured questionnaire viz.

a) Currently pregnant women,
b) Mothers who have children aged 0-24 months and
c) Members of families who have experienced of maternal deaths.

Snowball sampling method[38] is applied to identify the sample household in each sample village. This technique identifies respondents through some key-informants in the village and that identified respondent will provide the name of the similar household and so on (ICMR, 2003; Singh, Pandey & Aggarwal, 2007). In this context, BPHC medical officer, Auxiliary Nurse Midwifery (ANMs) and Accredited Social Health Activist (ASHAs) of the respective villages act as key informers to identify the sample household in the selected villages. Further, in our case, sample cases/units are rare as we are focusing on maternal deaths, it is better to concentrate on districts/ villages where maternal deaths are high. Not all household suffer from adverse maternal conditions. Such households/samples provide the necessary counterfactuals. As such, snowball sampling method is the best fit to our sample characteristics.

Accordingly, total 169 households were selected from for the field survey. Household survey was conducted during the period from October 2014 to February 2015 with reference period of 365 days preceding the date of the survey. In addition, a simultaneous survey was also conducted with medical officers and ANMs of the respective villages in four Block Primary Health Center.

4.3. Data Collection:

Data were collected through a door-to-door survey at household level and health institutions. For that purpose, two different structured questionnaires with open and close-ended questions were prepared. The household level questionnaire emphasized on socio-economic indicators of maternal health status of women and in-depth information on maternal death cases. It addressed following key aspects:

(i) General information about the household including family size, age, religion, social class, level of income and occupation, literacy status and educational level, household land ownership, basic amenities at home and consumption expenditure for both food and non-food items;

[38] This is used when the desired sample characteristic is rare (Singh, Pandey, & Aggarwal, 2007).

(ii) Information on currently pregnant women and mother with children aged 0-24 months includes the current age, age at marriage, birth parity and birth spacing, weight of the women, whether or not current pregnancy was wanted by herself, any previous disease or health problems, different symptoms of anemia, perception of pregnancy, complication during and after delivery etc.;

(iii) Information on status of currently pregnant women such as any pregnancy complication, who and when recognized such complications, preference for treatment, check-ups, delivery point and facility to go and person accompanied to health institutions.

(iv) Awareness among pregnant women, husband and other family member about following aspects: antenatal care, where and when to go for antenatal care, ASHA workers, proper diet during pregnancy, supplementary food programmes and distribution of folic and iron tablets through the Anganwadi center, family planning methods and pregnancy terminations, government schemes on maternal health such as *Janani Suraksha Yojana, Janani Sishu Suraksha Karyakram*, *Mamoni Scheme, Ambulance services* etc.

(v) Regarding perspective about health institution: preference for health institutions, doctors, response of doctors, how comfortable to sharing problems with doctors, privacy at health institutions, cleanliness and physical infrastructure of the health institutions etc.

(vi) Regarding delivery related expenditure: health check-ups, drugs and fees, hospital stay cost, cost for normal and C-section delivery, source of maternal health expenditure and

(vii) Reasons for not seeking maternal health services

(viii) History of maternal deaths of women including registration of death, place of death, time, age, pregnancy status, antenatal care, treatment, food habits and daily activity, reasons for deaths as per medical report etc.

Additionally, the questionnaire for health institutions includes: (i) general information on geography of the health institutions such as year of establishment, building type, coverage of village and total population, distance between public health center to sub-center and

community health center to sub-center; (ii) availability of physical facilities namely 24 hour delivery services, provisions of antenatal care and postnatal care, availability of drugs, beds, maternity waiting rooms, labor rooms, C-section, blood storage and other equipment, ambulance services and transport facility, road connectivity, water supply, electricity, telephone facility etc.; (iii) regarding human resources: number of doctors, staff nurse, male and female health assistance, Obstetrician & Gynecology specialist and others; (iv) for monitoring the maternal care activity: number of maternal deaths happened in at institutions, reasons for deaths, referral cases, patients perspective to treatment and family planning methods, about government schemes etc.[39]

4.4. Broad Profile of the Sample Villages:

This section focuses on the brief profile of the sample villages including the location maps of the study areas. Map-4.1 presents the sample districts and spotted the location of study areas in each sample Blocks Primary Health Center.

Based on the availability of sample unit in villages during the field visit, out of 169 sample unit, data were collected 18 from Janzimukh and 17 from Lepetkatta Tea Estate; 30 from Muhimari and 20 from Patgaon, 15 from Kadamoni and 25 from Sakumato Tea Estate; 23 from Motinagar and 21 from Silcoorie Tea Estate (Table 4.3).

[39] All collected data is used both directly and indirectly to analyze various results in our thesis.

Table 4.3: ***Number of Sample Units in Surveyed Block Primary Health Center***

Name of the Villages		Total Units
A. Barbaruah BPHC		
Janzimukh		18
Lepetkatta Tea Estate		17
	Total	**35**
B. Chhaygaon BPHC		
Muhimari		30
Patgaon		20
	Total	**50**
C. Biswanath BPHC		
Kadamoni		15
Sakumato Tea Estate		25
	Total	**40**
D. Sonai BPHC		
Motinagar		23
Silcoorie		21
	Total	**44**
Total (A+B+C+D)		**169**

Source: Field survey 2014-15

4.4.1. Geography and Demography of the Sample Villages:

The following discussion covers geographical location and demography of the surveyed areas under four Block PHCs:

Barbaruah (Dibrugarh): Janzimukh is a Mishing[40] community village under Barbaruah Block Primary Health Center (BPHC), Dibrugarh district located about 40 km. away from the BPHC, in the river embankment of Dihing. According to Census 2011, the village consists of 116 households with total population of 654. Out of 18 interviewed households, majority is from Mishing Community i.e. 83.33 percent and only 16.67 percent households are from Munda community. On the other hand, Lepetkatta Tea Estate located only 5 km.

[40] Mishing/ Mising or Miri is one the tribal groups of Assam.

away from Block Primary Health Center (BPHC), consists of 254 households with total population of 1219 as per Census 2011. Tea Tribe community is dominating segment of population of this studied area.

Chhaygaon (Kamrup): Muhimari inhabited by people who follow Islamic religion and is situated at 31 km. away from the Block Primary Health Center (BPHC) at Chhaygaon, Kamrup. As per 2011 Census, the village consists of 762 households with total population of 4339. Patgoan is a bordering village of Meghalaya, located 12 km. away from Chhaygaon Block Primary Health Center (BPHC), in midst of hills, forest and one small river. The total population of the village is 664 as per 2011 Census considering of Rabha, Boro and Garo communities. Out of total 20 interviewed households, 65 percent belong to Rabha, 20 percent belong to Boro and 15 percent belong to Garo community.

Biswanath Chariali (Sonitpur): Kadamani has located 8 km. away from Biswanath Chariali Block Primary Health Center, consists of 460 households with 2012 total population as per 2011 Census. The population is a combination of different communities such as Assamese speaking Hindu, Bengali speaking Hindu, Tea Tribe community, Nepali and Bihari. Among the interviewed 15 households, 3 households belong to Assamese, 7 households belong to Tea Tribe Community[41], 1 household belong to Nepali, 2 households belong to Bengali and 2 households belong to Bihari. On the other hand, Shakomato Tea Estate located at 5 km away from Biswanath Chariali Block Primary Health Center consists of 334 households with total population of 1660 as per 2011 Census. Tea Tribe Community is the dominating population of the village.

Sonai (Cachar): Silcoorie is the village of Cachar district located at about 15 km. away from Sonai BPHC. Population is 19637 as per 2011 Census. On the other hand, population of Silcoorie Tea Estate is dominated by the Tea Tribe Community. Motinagar, a division of Bhuban Valley Tea Estate is 25 km. away from Sonai BPHC. Population size is 2000, dominated by Tea Tribe Community.

[41] Tea tribe population originally brought from Orissa, Madhya Pradesh, Bihar, Andhra Pradesh and West Bengal into Assam by British colonial planters about 150 years ago for engaging in tea gardens as labourers and subsequently settled in Assam permanently. They are recognized as Other Backward Classes (OBC) by the Government (GOA; Das, 2016).

4.4.2. Socio-Economic Characteristics of the Samples:

In this section, the socio-economic characteristic of the sample respondents is discussed under different heads such as family size, caste and religion, age, education, occupation and land ownership, housing and other amenities etc.

a. Family Size and Structure:

Regarding family size of the sample respondents, recorded data shows that average family size of a household is 4.55 with minimum family size of 2 members and a maximum number of 9 members. Table 4.4 presents that more than 50 percent of households are nuclear, the rest belong to joint family set up.

Table 4.4: ***Distribution of Sample Households According to their Family Structure***

Family type	**No.**	**%**
Nuclear Family	101	59.76
Joint Family	68	40.24
Total	169	100

b. Caste and Religion:

Table 4.5 shows the caste profile of the sample respondents

Table 4.5: ***Distribution of Sample Respondents According to Caste***

Caste	No	%
General	46	27.22
Other Backward Class (OBC)	61	36.09
Scheduled Tribe (ST)	35	20.71
Scheduled Caste (SC)	27	15.98
Total	169	100

In case of religious composition of the sample population, majority is from Hinduism (79.29 percent) and remaining respondents practice Islam (Table 4.6)

Table 4.6: ***Distribution of Sample Respondents According to their Religion***

Religion	No	%
Hinduism	134	79.29
Islam	35	20.71
Total	169	100

c. Age of the Respondents:

The age profile of the sample respondents is presented in Table 4.7. Minimum age of sample respondents is 15 years and maximum age is 39 years, while the mean age is 23 years.

Table 4.7: ***Age Profile of the Respondents***

Age	No.	%
Below 18	28	16.57
19-29	121	71.60
Above 30	20	11.83
Total	169	100

d. Educational Profile:

Table 4.8 presents the educational levels of the respondents. It reveals that illiteracy is higher among the sample respondents and very few have completed at least high school education.

Table 4.8: ***Educational Level of the Sample Respondents***

Educational level	No.	%
Illiterate	88	52.07
Primary (Up to Class 5)	35	20.71
Primary Passed but Below HSLC	30	17.75
HSLC Passed but Below HS	10	5.92
HS Passed but Non Graduate	6	3.55
Graduation	0	0.00
Total	169	100

e. Occupational Profile of the Households:

Distribution of sample respondents as per their occupations is shown in Table 4.9. This table reflects that daily wage labour is the main source of the income of the larger sections of the sample households.

Table 4.9: ***Distribution of Sample Household According to their Occupation***

Occupation	No.	%
Daily worker	128	75.74
Cultivator	10	5.92
Business	23	13.61
Government job	3	1.78
Agricultural Labourer	3	1.78
Farmer	2	1.18
Total	169	100

f. Households Land Holding:

Table 4.10 provides the information on the landholdings of the sample households. It shows an unequal distribution of land.

Table 4.10: ***Distribution of Sample Household According to their Ownership of Land***

Landholding	No.	%
No landholding	86	50.89
above 1 acres	33	19.53
less than 1 acres	50	29.59
Total	169	100

g. Income Profile of the Sample Households:

The income level of the sample households is presented in Table 4.11. The yearly income is calculated from monthly earning of a member in a household from his/her principal occupation[42].

Table shows that the average yearly income of the sample households is Rs. 39615. 38.

[42] In which maximum labour time is spent ((NSSO, 2001)

Table 4.11: ***Distribution of Sample Household According to their Income Level***

Income	No.	%	Average Income
Below Average Income	110	65.09	-
More than Average Income	59	34.91	-
Total	169	100	39615. 38

h. Age at Marriage of the Respondents:

Details of age at marriage of the sample are shown in the Table 4.12. The minimum age at marriage of the sample respondents is found to be 12 years and maximum age is 28 years.

Table 4.12: ***Age at Marriage Profile of the Respondents***

Age at Marriage	No.	%
12 to 14	23	13.61
15-19	96	56.80
20-29	50	29.59
Total	169	100

i. Housing facilities:

Table 4.13 shows housing facilities. Pucca and semi-pucca houses are mostly constructed under the Indira Awaas Yojana (IAY). In case of tea garden labor, quarters provided by the tea garden owner to the permanent workers.

Table 4.13: ***Distribution of Sample Profile According to their Housing Condition***

Housing Condition	No.	%
Kutcha	139	82.25
Pucca	20	11.83
Semi-Pucca	10	5.92
Total	169	100

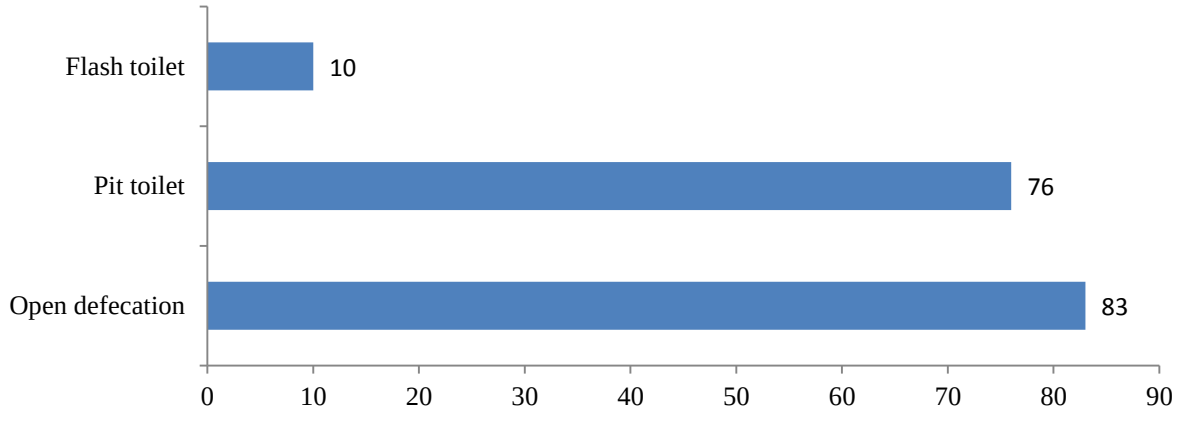
j. Safe Drinking Water and Sanitation Facilities:

The details of availability of safe drinking water and sanitation facilities are shown in the Table 4.14. The table reflects the poor sanitation facilities in the studied areas. Figure 4.j shows that available sanitation facilities at studied areas. However, sanitation facilities at tea garden quarters for permanent workers are underutilized because of their attitudes and beliefs which prevent them from using such toilets (constructed near to their house). Those who have no toilet facilities at homes reported that they do not find it necessary.

Table 4.14: ***Availability of Household Drinking Water Facility***

Drinking Water Facilities	No.	%
Pump tube well	92	54.44
Well	38	22.49
Pipe water	30	17.75
Stream water	9	5.33
Total	169	100

Figure 4.j: Availability of Sanitation Facilities



k. Healthcare Infrastructures at Health Institutions:

Table 4.15 shows the availability of physical facilities and Table 4.16 provides the detail of human resources in sample BPHC's. It is clearly observed that distance between Primary Health Center and Sub Center is barrier to avail emergency treatment as it may take time to

get ambulance facilities from health institution. In addition, BPHCs have no blood storage including limited numbers of ambulance services, beds, maternity wards and labor rooms in all visited health institutions. Absence of Obstetrician & Gynecology specialist is also observed.

Table 4.15: ***Available Physical Facilities at Healthcare Institutions in BPHC Level***

BPHC	Coverage of villages	Distance between PHC & SC	Distance between CHC& SC	Blood Storage	No. of Bed	Maternity ward	Labour room	Ambulance facilities
Chhaygaon	250	30	10	0	30	1	1	3
Biswanath Chariali	234	3	0	0	15	1	1	2
Barbaruah	176	40	30	0	10	1	1	2
Sonai	280	25	0	0	30	1	1	4

Table 4.16: ***Available Human Resources at Healthcare Institutions in BPHC Level***

BPHC	No. of Doctor	No. of Staff Nurse	No. of ANM in SC	Obstetrician &Gynecology specialist
Chhaygaon	5	5	2	0
Biswanath Chariali	4	6	2	0
Barbaruah	4	6	2	0
Sonai	3	7	3	0

4.4.3. Maternal Health Status of the Sample Villages:

I. Profile of Maternal Status:

The detail of the maternal status in the studied villages is shown in Table 4.17.

Table 4.17: ***Maternal Status in the studied villages***

Maternal Status	No	%
Lactating	86	50.89
Pregnant	66	39.05
Maternal death	17	10.06
Total	169	100

II. Status of Pregnancy Outcome:

Table 4.18 provides information on sample pregnancy outcomes. Presence of maternal complication and pregnancy is higher than the occurrence of maternal deaths in each village. In the table, high-risk pregnancy refers pregnancy associated with conditions like preterm labor, preeclampsia, placenta, edema and problems with uterus. Complication during pregnancy includes the problems which occur during pregnancy namely, severe lower abdominal pain, vision problem, severe nausea, swelling of hands and feet etc.

Table 4.18: ***Pregnancy Outcome in Eight Villages of Assam during 2012-13 to 2013-14***

Villages	Maternal deaths	High risk pregnancy	Complicacy in pregnancy	Normal pregnancy	Total pregnancy
Janzimukh	0	0	2	16	18
Lepetkatta TE	3	4	3	7	17
Muhimari	2	4	10	14	30
Patgaon	1	1	2	16	20
Kadamoni	3	0	3	9	15
Shakumato TE	3	10	4	8	25
Silcoorie TE	2	2	1	16	21
Motinagar	3	8	2	10	23
Total	**17**	**29**	**27**	**96**	**169**

III. Use of Contraceptives:

Details regarding usage contraceptives in the studied villages are shown in Table 4.19. The table shows that most commonly used contraception is contraceptive pills.

Table 4.19: ***Use of Contraceptive in Studied Villages***

Use of Contraceptive	No.	%
Contraceptive Pills	15	8.80
Condoms	2	1.18
Copper T	1	0.59
Female Sterilization	2	1.18
Male Sterilization	0	0
None	149	88.17
Total	169	100

Table 4.20 shows the reasons for not using contraceptives. Total sample is 149 couples who do not use any family planning methods.

Table 4.20: ***Reasons For Not Using Contraceptives.***

Reasons for not using contraceptives	No	%
Do not think necessary	44	28.86
Fear to use	25	16.78
Husband's restriction	8	5.37
Want to use later	57	38.26
Due to health problem	4	2.68
Do not Know	11	7.38
Total	149	100

IV. Coverage of Full Antenatal Care:

As per World Health Organization, all pregnant women should have at least four antenatal care (ANC) under the supervision of skilled attendants. Table 4.21 provides the detail information of coverage of antenatal care in the studied villages. However, the analysis of coverage of full ANC in studied villages has included only those women who have completed their three trimesters of their pregnancy till the date of survey and mother with children aged 0-24 months. As such the total sample size is 96 instead of 169.

Table 4.21: ***Coverage of Full Antenatal Care***

No of ANC	No	%
1	2	2.08
2	5	5.21
3	34	35.42
4	55	57.29
Total	96	100

V. Place of Delivery:

Table 4.22 presents the detail information on place of delivery in the studied villages. In this analysis, only those women who have delivered a baby are taken into account. As such, out of 99 delivery cases, 79.80 percent of deliveries have been taken place in health institutions namely, Public Health Center (PHC), Community Health Center (CHC) and Civil hospitals and the rest took place at home.

Table 4.22: ***Place of Delivery***

Delivery Place	**No.**	**%**
Home Delivery	20	20.20
Institutional Delivery	79	79.80
Total	99	100

4.5 Conclusion

The broad profile of the sample respondents presented in this chapter provides the necessary background. The subsequent chapters will places emphasis on examining factors contributing to maternal health within the sample

Map-4.1: Location of Study Areas and Sample Villages

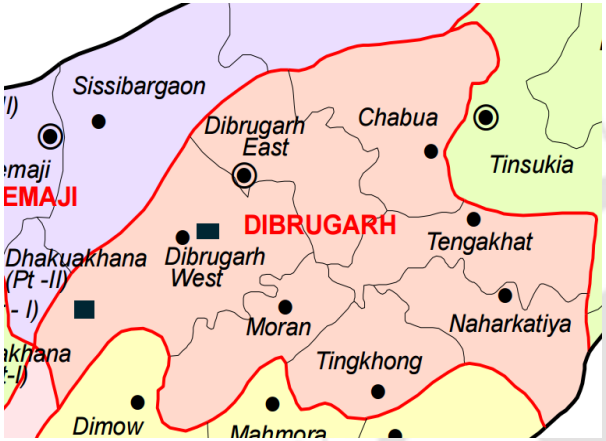


Figure 1: Barbaruah, Dibrugarh

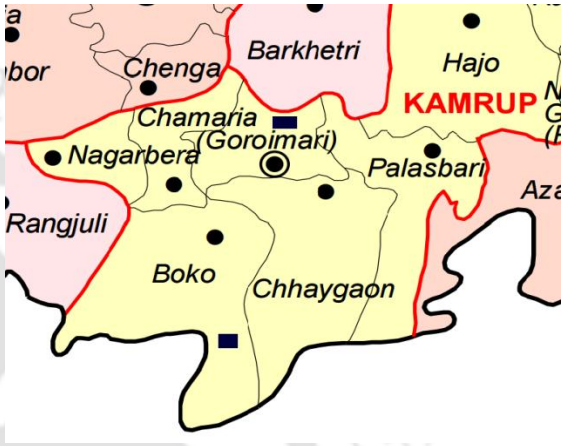


Figure 2: Chhaygaon, Kamrup

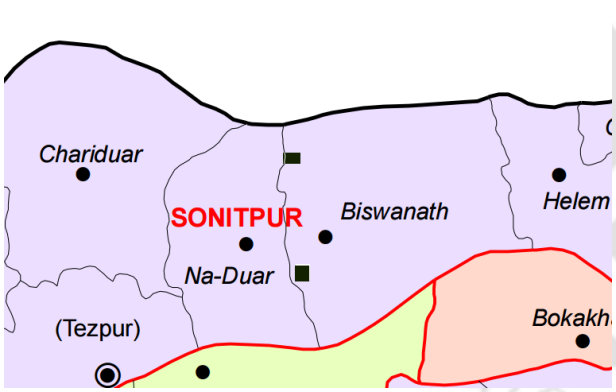


Figure 3: Biswanath Chariali, Sonitpur

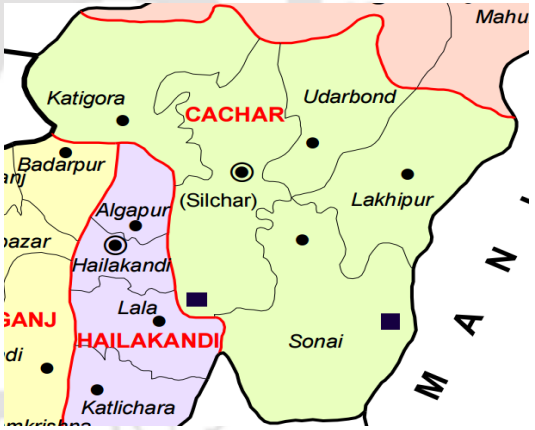


Figure 4: Sonai, Cachar

Note: The study areas are located based on Census Administrative Atlas, 2011. The sample villages are shown by ■

CHAPTER V

Determinants of Maternal Anemia at Disaggregated Level

The profile of samples has been presented in the previous chapter. Observation on maternal health outcome (Section 4.4.3., Chapter IV) revealed that out of 169 interviewed sample units, deaths cases are about 10 percent. On the other hand, about 33 percent have experienced either high-risk pregnancy or complications during pregnancy and around 56.8 percent have normal pregnancy. Thus, apart from maternal death, women also suffered from maternal morbidity.[43] WHO (2015) has pointed out that complications during and post pregnancy are major health problems. It may result in life-threatening obstetric morbidity as well as maternal deaths. About 15 percent of all pregnant women develop complications that require skilled care and may demand major lifesaving interventions (WHO, 2007). Routine care and early detection of danger signs can prevent such events (Campbell & Graham, 2006). Therefore, understanding of poor maternal health outcome will help us focus on context specific lifesaving interventions, in order to ensure universal access to reproductive and maternal health care.

The present chapter is organized into five broad sections. Section 5.1 addresses maternal death profile and tries to identify the association between maternal complications and hemoglobin level. Section 5.2, discusses iron bioavailability and dietary concern. In section 5.3 socio-economic causes of maternal anemia have been identified through regression study and section 5.4 concludes the chapter.

5.1. Profile of Maternal Death Cases:

Table 5.1 A provides a detailed profile of maternal death cases during the one year prior to the survey in studied villages. Analysis of maternal death reveals that out of 17 such cases,

[43] Maternal morbidity: the health problems borne by women during pregnancy and the postpartum period. Firoz et al., (*Bulletin of the World Health Organization* 2013; 91:794-796).

70.59 percent occurred during the postpartum period, 23.53 percent occurred during pregnancy and only 5.88 percent of deaths happened during the period of delivery. It is also observed from the table that anemia, postpartum hemorrhage, pre-eclampsia, respiratory and cardiomyopathy are most common factors.[44] Observation on health status of deceased women shows that the median number of birth order of a woman is 3 (average birth order is 3.82) whereas the highest number is 7 and lowest number is 1. Median age of women at the time of pregnancy-related death is about 28 years (mean age is 29 years) and median weight is about 42 kg. (average weight is 43 kg.);[45] the median hemoglobin level is 8.1 g/dL (mean hemoglobin is 8.37 g/dL). Minimum level of hemoglobin level is 3 g/dL and maximum is 12 g/dL. Maternal history indicates that most of the deceased women experienced maternal complications such as miscarriage (12 percent), anemia (18 percent), stillbirth (12 percent) and hypertension (6 percent). Summary of the table reflects that most of maternal deaths have occurred during postpartum period and around 53 percent of maternal death cases happened due to anemia and related causes.

Apart from death profile, field visits also highlighted other pregnancy outcomes in our sample. Childbirth complications are an outcome of health problem resulted from pregnancy. Any major deviation from normal and healthy labor can be considered as a complication (Laflamme, 2011). In our study, childbirth complications include high-risk pregnancy and complications during pregnancy. The detailed symptoms and difference between high-risk and complicated pregnancy are mentioned in Chapter IV (section 4.4.3. II). Previous studies show that anemia is highly associated with preeclampsia and poor prenatal outcome such as stillbirth, low birth weight, preterm birth etc. (Ali et al., 2011; Laflamme, 2011; Msuya et al., 2011; Tabrizi & Barjasteh, 2015). In our studied villages, out of 169 sample units, 33 percent have faced pregnancy complications where 87 percent of women are anemic. Table 5.2 shows the presence of anemia among women with complications.

[44] Causes of maternal deaths are collected from death register maintained by ANMs of respective villages.
[45] We could not find data on heights as there are not kept in health records, however, weight and age indicates undernourishment.

Table 5.2: Presence of Anemia Among Women with Childbirth Complications (Obs. 56)

	No	%
Anemic	49	87.5
Non-anemic	7	12.5

Source: Field data 2014-15

Viewing this maternal outcome profile, we try to observe the association between two attributes: pregnancy complications and level of hemoglobin concentration (see section 5.1.2, Table 5.5).

The concentration of hemoglobin level during pregnancy is a crucial determinant of maternal outcome (Stephansson et al., 2000; Alizadeh et al., 2014). Lower hemoglobin level is associated with birth complications among women than the non-anemic women. Therefore, the low level of hemoglobin or anemia may increase the risk of postpartum hemorrhage, preeclampsia and preterm birth etc. (Laflamme, 2011; Frass, 2015). Considering the fact, a prior assumption is made in the present study that the lower hemoglobin level leads to more maternal complications. Thus, this study treats lower level of hemoglobin as a proxy of anemia (Gibson, R. S., 2005), next sections will provide a discussion of maternal anemia.

5.1.1. Perspective of Maternal Anemia:

Maternal anemia is a nutritional deficiency disorder that is largely avoidable with proper dietary intake of iron, folic acid during and before pregnancy. Anemia occurs due to lower concentration of red blood cell or hemoglobin level in the peripheral blood to below a certain value (WHO 2011). According to World Health Organization, hemoglobin level below 11 g/dL in pregnant women is defined as anemia and hemoglobin below 7 g/dL is considered as severe anemia (Sharma & Shankar, 2010; Gogoi & Prusty, 2013). Further, classification is shown in Table 5.3.

Table 5.3: ***Hemoglobin Values (g/dL) Defining Anemia Among Women***

	All anemia	Mild anemia	Moderate anemia	Severe anemia
Pregnant women	<11.0	10.0-10.9	7.0-9.9	<7.0
Non-pregnant women (>15 years)	<12.0	10.0-11.9	7.0-9.9	<7.0

Source: WHO. (2001) Iron Deficiency Anemia: Assessment, Prevention, and Control. Geneva, World Health Organization (Adopted from MacDonald et al., 2007)

A review by Sharma and Shankar (2010) showed that anemia contributes significantly to high maternal mortality and serious effects on the foetus during pregnancy. It is argued that maternal anemia is responsible for around 40 percent of maternal deaths in India (Kalaivani, 2009). Studies carried out by MacDonald et al., (2007) and Singh (2012) stressed that iron deficiency is the most common form of anemia due to poor diet, whereas malaria, helminth infections and chronic infections play a major role in development of all anemia cases. An estimate of World Health Organization states that iron deficiency is responsible for 50 percent of all anemia cases (WHO, 2001). Iron nutritional status depends on absorption of iron in the body that is determined by an adequate amount of iron in dietary composition or through the iron supplementation. A balanced diet of heme and non-heme can enhance the iron absorption to maintain hemoglobin level and to reduce the incidence of anemia (DeMaeyer, 1989; Sharma & Shankar, 2010). Indian diets are primarily low in calories and ascorbic acid that causes deficit in bioavailability of dietary iron. This resulted into lower level of hemoglobin which becomes more vulnerable during pregnancy as requirement of iron increases for expanding red cells and development of the foetus and placenta (Hazra and Maitra, 2001; Nair and Iyengar, 2009).

5.1.2. Maternal Anemia in Studied Sample:

Based on the WHO criterion of hemoglobin values, prevalence of anemia among studied sample is presented in Table 5.4.[46] In our sample, more than 90 percent of women are

[46] Data on concentration of hemoglobin level among women are collected from hemoglobin level reported by ANM in health card to each interviewed women during their routine check-ups.

anemic; out of 155 anemic samples, 53 percent are moderately and 19 percent are severally anemic during the reference period of 365 days preceding the date of survey.

Table 5.4: ***Prevalence of Anemia Based on Concentration of Hemoglobin Level among Women of Studied Villages***

Hemoglobin	No.	%
> 12	14	8.28
All anemia	155	91.72
Mild anemia	19	12.26
Moderate anemia	82	52.90
Severe anemia	29	18.17
Total	169	100

Source: field data 2014-15

To observe the association between pregnancy complications and hemoglobin level, contingency table[47] with Chi-Square test is given in Table 5.5.

Table 5.5: ***Concentration of Hemoglobin level with Maternal Complications Among Women in Studied Villages*** **(Obs.=169)**

	No Pregnancy Complications (n=119)	With Pregnancy Complications (n=50)	Chi Square Test
Hb level above 11 g/dL	35 (29%)	4 (8%)	χ^2= 9.0929
Hb level below 11 g/dL	84 (71%)	46 (92%)	p= 0.003

Source: Field data 2014-15

Table 5.5 reflects that concentration of lower hemoglobin level (less than 11 g/dL) is significantly associated with maternal complications (χ^2 = 9.09, p = 0.003).[48]

[47] Contingency tables are used in statistics to summarize the relationship between categorical variables.

[48] Chi Square Test

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Whrer,

i= i[th] position in the table

O= Observed value

E= Expected value

A large χ^2 value indicates that there is an association between the two attributes of the population and a small χ^2 value shows there is difference among different groups.

Therefore, it is noted that pregnancy complication is heavily influenced by the lower level of hemoglobin concentrations. Iron deficiency is the common cause of prevalence of anemia among the population (WHO, 2011).

It is also observed that prevalence of anemia is higher among Tea tribe population as compared to the rest. Table 5.6 shows that prevalence of anemia is significantly high among Tea tribe population (χ^2 = 22.29, p= 0.000). Similarly, caste-wise prevalence of anemia reflects that anemia is highly associated with OBC and Scheduled Caste population (χ^2 = 17.21, p= 0.001). Thus, social deprivations are likely to be associated with iron deprivation.

Table 5.6: ***Prevalence of Anemia based on Population Characteristics and Caste Dummies in Studied Villages*** **(N=169)**

	No. Anemia (Hb>12)	With Anemia (Hb<11)	Chi Square Test
Non-Tea Garden Population	33 (38%)	6 (7%)	χ^2= 22.29
Tea Garden Population	54 (62%)	76 (93%)	p= 0.000
Caste Dummies			
General	14 (30%)	32 (72%)	
OBC	9 (15%)	52 (85%)	χ^2= 17.21
SC	1 (4%)	26 (96%)	p= 0.001
ST	15 (43%)	20 (57%)	

Source: Field data 2014-15

Additionally, Table 5.7 presents the adverse effects of anemia among sample. Distribution of population according to ill health effects of anemia show that more than 50 percent of women suffer from loss of energy, dizziness and headache. Shortness of breath, pale skin and insomnia are reported by 49.70 percent, 44.97 percent and 40.83 percent of women respectively. Rapid heartbeat is reported by only 36 percent of women.

Table 5.7: ***Distribution of Population According to the Ill Effects of Anemia on Health***

Ill Effects of Anemia	No.	%
Loss of energy	89	52.66
Rapid heart beat	61	36.09
Shortness of breath	84	49.70
Dizziness	97	57.40
Pale skin	76	44.97
Insomnia	69	40.83
Headache	98	57.99

Source: Field data 2014-15

Given such background of maternal anemia and its ill effects on health, the following subsection presents a short discussion on dietary-habits and status of iron supplementation.

5.2. Iron Bioavailability and Dietary Concern in the Studied Areas:

Although distribution of iron supplementation is practiced as an alternative to dietary intervention, it may not be too helpful in preventing anemia without an optimum diet maintained by the women of reproductive age group. Galloway and McGuire (1994) found that common reasons for not consumption of iron supplements are non-availability, lack of access, lack of financial support, misunderstood instructions, side effects etc. A study carried out by Mithra et al., (2013) in South India, concluded that compliance of IFA tablets during pregnancy is influenced by age, socioeconomic status, birth order, the cost of IFA tablets and awareness regarding the importance of IFA tablets. Study of Hallberg et al., (1966) and Beard, (2000) commented on severe side effects of oral iron therapy. Patterson et al., (2001) also suggested that dietary treatment for iron deficiency is feasible and results in continuous improvements of iron status in the long term. Such studies suggest that a diet rich in iron appears to be more advantageous over iron supplementations (to counter anemia) as it is cost-effective and shows higher efficacy and benefits in the long-term. Dietary iron absorption depends on bioavailability of iron i.e. amount of heme and non-heme iron in the meal.[49] In

[49] Heme product (animal sources of iron products), non-heme products: plant sources of iron such as grains, cereals, vegetables and nuts) (MacDonald et al., 2007).

most of the developing countries, maternal anemia is due to lack of dietary iron in habitual diets (Thompson, 2013). As per the recommendation of WHO (DeMaeyer, 1989), amount of iron absorption is influenced by the combination of foods taken in a given meal. Due to lack of sufficient food, individuals are at the risk of developing iron deficiency (*ibid*). Hema Priya (2016) and NRHM guideline (2013) also reveals that insufficient iron-rich food and low iron bioavailability are the main causes of developing iron deficiency anemia among women.

5.2.1. Observation from Field:

Discussion with ANM and ASHA workers have further revealed awareness about family planning methods and distribution of free IFA tablets is notwithstanding, improvement of hemoglobin level is not possible, without a proper diet. Observation from field visit shows that, proper diet is not maintained, particularly among the tea labourers. For instance, Table 5.8 provides that the per capita food expenditure on heme food product is high in Muhimari, Patgaon, Janzimukh and Kadamoni as compared to rest of the sample villages.[50]

Table 5.8: ***Village-wise Per Capita Food Expenditure on Heme and Non-Heme Food Product at Monthly Basis during 2014-15***

Villages	Non-Heme product		Heme product		Others	Total food expenditure
	Cereals	Vegetables	Fish	Meat		
Muhimari	273.68	109.14	**52.11**	**36.12**	42.76	513.82
Patgaon	257.45	125.96	**68.09**	**54.79**	50.64	556.91
Janzimukh	238.30	111.70	**49.04**	**50.43**	57.45	506.91
Lepetkatta TE	205.33	117.73	39.60	36.67	61.33	460.67
Kadamoni	221.95	119.88	**65.73**	**59.51**	51.22	518.29
Shakumato TE	290.20	101.67	31.23	25.00	56.67	504.75
Silcoori TE	243.16	130.32	27.89	23.47	56.53	481.37
Motinagar	264.71	116.86	25.88	23.73	55.20	486.37

Source: Survey data 2014-15

[50] The monthly food expenditure of a household is calculated by estimating the rupees spent on food items like heme (meat and fish) and non-heme (cereals- rice, dal, and veg) product and others (oil, salt, and sugar) based on 1 week recall period.

It is clear from the Table 5.8 that in teagarden areas (such as Lepetkatta Tea Estate, Shakumato Tea Estate, Motinagar, Silcoori Tea Estate), the expenditure on heme product is low in their daily diet; typically, their diet is confined to staple foods (cereals) with low iron bioavailability. The population in teagarden areas have less access to diversified diet due to land and geographical bottlenecks. Report of Global Network for the Right to Food and Nutrition 2016, also reveals that given the lack of alternative means of livelihoods, teagarden workers are highly dependent on food rations provided by the Tea Company which are often insufficient, inadequate and of bad quality. The report also says that it is not affordable for the workers with their wage to have adequate amount of food or any additional food to maintain a diversified diet. The daily meal of a worker mostly consists of rice, dal and chapatti and occasionally (on payment day) meat or fish. Evidence from the field survey shows that most of the teagarden workers have no ration card as the causal workers (74.42 percent) are discriminated against in accessing ration card and other facilities like hospitals, housing and other amenities. They solely depend on daily market for their food. On the other hand, people of Janzimukh, Patgaon, Kadamoni, Muhimari have diversified food availability at their own land as they live in a geographically better position along with the available water resources and access to land of their own which help them go for diversified food consumption. Home-grown foods and green leafy vegetables, fish and poultry farms of their own house help to maintain proper food habits.

Additionally, in response to awareness about proper nutritional diet during pregnancy, women from Janzimukh, Patgaon, Muhimari and Kadamoni were quite aware of the nutritional food habits. On the contrary, teagarden workers live in either in quarters provided by management or temporary hut inside teagarden and they do not possess land of their own. They do not have any homegrown food products and have limited access to daily intake of micronutrients either due to their lack of awareness regarding importance of nutritional food habits or lack of financial resources. In case of supplementary nutritional food from Anganwadi center, all respondents from Janzimukh and Patgaon agreed that they accessed rice and peas from Anganwadi center during their pregnancy. However, except in Muhimari (20 percent), more than 50 percent of pregnant women from Kadamoni, Silcoorie TE and Motinagar have received supplementary food during their pregnancy. On the other hand, none have received any such supplementary nutritious food during their pregnancy in

Lepetkatta T E and Shakuamto TE because of irregular distribution of foodstuff to Anganwadi workers to distribute the foods among pregnant women (Table 5.9).

Due to low economic status, women have to work hard for their livelihood with poor dietary diversification. Low dietary intake and consumption of high non-heme product lead to low bioavailability of iron. This results in low hemoglobin level and poor iron status in her body which becomes more vulnerable with high birth order during her childbearing age. In other words, prevalence of nutritional anemia due to low level of hemoglobin is associated with socio-economic factors such as financial and cultural barriers, educational attainment etc. In the next section, we conduct an investigation of several of socio-economic factors that may contribute to maternal anemia.

Table 5.9: ***Percentage of Beneficiary Sample of Supplementary Food***

	No. of Sample	**No. of Beneficiary**	**%**
Muhimari	30	6	20
Patgaon	20	19	95
Janzimukh	18	18	100
Lepetkatta TE	17	0	0
Kadamoni	15	9	60
Shakumato TE	25	0	0
Motinagar	23	15	65
Silcoori TE	21	12	57

Source: Survey data 2014-15

5.3. Socio–Economic Causes of Maternal Anemia in the Studied Areas:

In many cases, anemia during pregnancy is developed due to low socio-economic status, customs and dietary habits. The incidences of anemia among pregnant women vary according to their societal backgrounds, lifestyles and health seeking behaviors across different cultures (Lone, Qureshi, & Emmanuel, 2004). Studies have shown that prevalence of anemia in pregnancy is largely associated with maternal age, level of literacy, socio-economic status and utilization of health care services (Singh et al., 2009; Nwizu et al., 2011; Mahashabde et al., 2014).

Profile of the socio-economic variables that are associated with maternal health status in sample villages is presented in Table 5.10.A. It is observed from the table that selected indicators of maternal health such as age at marriage, literacy, birth order, hemoglobin level and pregnancy complications are comparatively better in villages namely Patgaon, Janzimukh, Kadamoni and Silcoorie. In section 5.1, it is noted that lower cases of maternal death and high-risk pregnancy are reported in these villages. On the other hand, Muhimari, Lepetkatta TE, Shakumato TE and Motinagar are more vulnerable as compared to rest of the studied villages. We hope that our study throws some light on context-specific causes of anemia during pregnancy to prescribe appropriate preventive measures than universal, "one-size-fits-all" type of intervention dietary changes (such as IFA tablets). Based on the previous literature and field observations, following variables are considered in the regression model for examining the maternal anemia at local context.

Literacy **(Lit):** The changes in the rate of female literacy and maternal mortality rate are negatively related (Pillai et al., 2013). Here, literacy is a proxy for educational attainment. Educated women are more likely to have decision making power over proper healthcare before and during their pregnancies (McCarthy & Maine, 1992). They would be more aware about nutritional requirement during pregnancy that helps prevent low birth weight, anemia and hemorrhage (Jain, 2012). The prior assumption is that higher the female literacy, better the concentration of hemoglobin level.

Age of marriage **(AoM):** Age of marriage influences women's health status and adolescent fertility. Girls who marry at an early age are more likely to suffer from anemia due to lack adequate nutrition as they require nutrition over and above the nutritional demand for their adolescent growth. On the other hand, it results in adverse and risky pregnancy, poor knowledge of nutritional diet/ family planning methods, high number of birth order and lack of decision making power for the wellbeing of their families, children and themselves as well. Childbearing with shorter birth spacing makes women more vulnerable to anemia during their childbearing age (Kavitha, 2010). Studies by Biswas and Baruah (2014), Morsy and Alhady (2014) and Singh (2012) have found maternal age is one of the contributing factors to the prevalence of anemia in pregnancy. Hence, the age of marriage is considered as

an explanatory variables assuming higher age of marriage leads to better concentration of hemoglobin level.

Land Ownership **(LO):** Land ownership (a proxy for wealth) is an important factor as an asset for household and index for food availability at household level. Land ownership provides the opportunity for dietary diversifications with food fortification for home consumption and market purpose. A household with land ownership (wealth) can have homegrown food to maintain a proper food habit during pregnancy.

Income **(Y):** Income is current money receipt by the individual from all sources including capital assets, labour, services and property. Income is positively correlated with health outcomes (Case, 2001; Engel et al., 2009). In the context of maternal health, low socioeconomic status of women leads to lower access of nutritional foods during and before her pregnancy which results in lower concentration of iron. The prior assumption is that lower the income level lower the hemoglobin level.

Food expenditure **(FdEx):** The 68th round of the Household Consumer Expenditure Survey conducted by National Sample Survey during 2012 showed that food expenditure accounted for nearly half of the total household expenditure i.e. 52.9 percentage, while medical expenses is only 6.7 percentage. Households which spend more on food may be consuming necessary micronutrients which contribute to better maternal outcome.

Number of birth order **(BO):** The larger number of birth order influences women's reproductive health by increasing the incidence of maternal complication in terms of anemia, edema, preeclampsia and preterm birth. Therefore, the prior assumption in the present study is that higher the birth order, higher the maternal complications.

Use of family planning **(UFP):** Family planning methods helps to maintain birth spacing, reduce the number of abortions and incidence of deaths and disabilities resulted from complications of pregnancy to women. Higher usage of family planning methods lowers the maternal complications.

Based on the argument discussed above, hemoglobin level is considered as a dependent variable for the study and variable such as literacy, income, age of marriage, food expenditure, land ownership, use of family planning and birth order are considered as an independent variable. A summary statistics of all variables are presented in Table 5.11.

Table 5.11 : ***Descriptive Statistics of the Variables Influencing in Concentration of Hemoglobin level***

Variable	Definitions	Mean	Std.Dev.	Min	Max
Lit	Literacy	0.390533	0.48932	0	1
PCI	Per Capita Income	9945.32	6158.334	2000	36250
PCFdEx	Per Capita Food Expenditure	7063.32	2713.541	2790	21060
AoM	Age of Marriage	18	3.278719	12	28
LO	Land Ownership	0.614615	1.091507	0	5.61
UFP	Use of Family Planning	0.118343	0.323974	0	1
BO	Birth Order	0.35503	0.479944	0	1
DTGpop	Dummy Tea-Garden Population	.4852071	.5012664	0	1

5.3.1. Functional Form of the Model:

The functional relationship between the dependent and the independent variables (Model 1) is

$$Hb = f(\text{literacy, age of marriage, land ownership, birth order, use of family planning})$$

We have used *Variance Inflation Factor* (*VIF*) to check the multi-collinearity problem and found no collinearity problem in the present model (Table 5.12.A). Further, the Breusch-Pagan test / Cook-Weisberg test and Cameron & Trivedi's decomposition[51] have been carried out to detect heteroscedasticity in the data set and found no heteroscedasticity problem among the variables (χ^2=7.55, p=0.37). Due to absence of heteroscedasticity problem and continuous nature of dependent variable (concentration of hemoglobin level), OLS regression

[51] It is used to detect general form of heteroscedasticity, error variance are all equal versus the alternative that the error variance are a multiplicative function of one or more variables. A large Chi-Square value indicates that heteroscedasticity is present and small value indicating heteroscedasticity is not a problem (Williams, 2015).

techniques is considered suitable to use in the estimation of the model. Additionally, logarithmic transformations of the dependent variable and the independent variables have been done further to normalize their variation in the model. Robust standard error has been applied to obtain an accurate p-value of the predictor variables. After logarithmic transformations, the model is as follows:

$$\boldsymbol{lnHb_i = \alpha + \beta_0 Lit_i + \beta_1 lnAoM_i + +\beta_2 LO_i + \beta_3 BO_i + \beta_4 UFP_i + \mu_i} \quad \textbf{..... 1}$$

Where,

i= 1, 2,… N; where N is the total observation.

α= Constant

β_i= Vector of Coefficient

lnHb= Natural Log of Hemoglobin Level

Lit= Literacy Level

lnAoM= Natural Log of Age of Marriage

LO=Land Ownership

BO= Birth Order

UFP= Use of Family Planning

μ= Error term

In order to check the robustness of the model, in subsequent models we added control variables such as per capita food expenditure (PCFdEx) in Model 2; per capita income (PCI) in Model 3 and finally we have added Tea Garden dummy (DTGpop) after controlling PCFdEx and PCI, while other things remained constant. Accordingly, the remaining three models are:

$$\boldsymbol{lnHb_i = \alpha + \beta_0 Lit_i + \beta_1 lnAoM_i + \beta_2 LO_i + \beta_3 BO_i + \beta_4 UFP_i + \beta_5 lnPCFdEx_i + \mu_i} \quad \textbf{..... 2}$$

$$\boldsymbol{lnHb_i = \alpha + \beta_0 Lit_i + \beta_1 lnAoM_i + \beta_2 LO_i + \beta_3 BO_i + \beta_4 UFP_i + \beta_5 lnPCFdEx_i + \beta_6 lnPCI_i + \mu_i} \quad \textbf{..... 3}$$

$$lnHb_i = \alpha + \beta_0 Lit_i + \beta_1 lnAoM_i + \beta_2 LO_i + \beta_3 BO_i + \beta_4 UFP_i + \beta_5 lnPCFdEx_i + \beta_6 lnPCI_i + \beta_7 DTGpop_i + \mu_i \quad \text{..... 4}$$

5.3.2. Results:

Table 5.13 provides the robust standard error estimates of the coefficients of the OLS regression model and p-values.

Table 5.13: ***Hemoglobin Level with Associate Variables Based on Primary Data***

Variables	Dependent Variable (Hemoglobin Level)							
	Model 1		**Model 2**		**Model 3**		**Model 4**	
	Coefficient	**t**	**Coefficient**	**t**	**Coefficient**	**t**	**Coefficient**	**t**
Lit	.079886*	1.72	.0808792*	1.75	.0835586*	1.79	.067095	1.46
	(.0463135)		(.0462493)		(.0467139)		(.0458967)	
lnAoM	.1824529	1.46	.1850926	1.49	.1715918	1.36	.1464689	1.17
	(.1246365)		(.1240561)		(.1260556)		(.1246934)	
LO	.059295***	3.24	.0574258***	3.09	.0584949***	3.13	.059959***	3.37
	(.0183202)		(.0185623)		(.0187076)		(.0178045)	
BO	.0109568	0.24	.0126023	0.28	.0114584	0.26	-.0092022	-0.20
	(.044955)		(.0446955)		(.0447645)		(.0468862)	
UFP	-.036568	-0.58	-.0403766	-0.63	-.0455272	-0.71	-.0457748	-0.73
	(.0627803)		(.0637)		(.06391)		(.0628172)	
PCFdEx	-	-	-.0526487	-0.97	-.0821126	-1.28	-.1098439*	-1.66
			(.0540208)		(.0639643)		(.0662663)	
PCI	-	-	-	-	.0333922	0.77	.0558757	1.24
					(.0434481)		(.0451198)	
DTGpop	-	-	-	-	-	-	-.0942548**	-2.01
							(.0468164)	
Constant	1.529965***	4.29	1.986021***	3.22	1.981236***	3.17	2.152596***	3.43
	(.3564481)		(.6174494)		(.6255179)		(.627591)	
R^2		0.09		0.10		0.10		0.12
Prob>F		0.0007		0.0012		0.0026		0.0007
No. of obs.		169		169		169		169
F (5, 163)		4.52	**F (6,162)**	3.87	**F (7,161)**	3.31	**F (8,160)**	3.59
AIC Score		60.410		61.601		63.122		60.749

Note: 1. ***, **, * represent significance at 1%, 5% and 10% level respectively;

2. Figure in parentheses indicates standard errors of the coefficient.

Table 5.13 provides the result of OLS regression models and their associated AIC scores. Model 1 shows concentration of hemoglobin level is positively related with literacy (significance level 10%) and land ownership (a proxy of wealth) (significance level 1 %). The coefficient of literacy shows that compared to respondents with no literacy, the concentration of hemoglobin level is 7% higher among literates. At the same time, compared to households with no land ownership, the concentration of hemoglobin level is 5 % higher among households with land ownership. However, the other predictor variables are found to be insignificant.

The coefficient of land ownership and literacy are positive and statistically significant throughout. Further, after controlling per capita food expenditure and per capita income, Tea Garden dummy is negatively and significantly (at 5 % significance level) associated with concentration of hemoglobin level. It shows that, for interviewees who do not live in tea gardens areas, the level of hemoglobin is 9 percent higher than the respondents who live in tea garden areas. However, the coefficient of food expenditure per capita is negative and statistically significant (albeit at a weaker 10 % significance level).

Table also provides that although Model 1 has the lowest AIC[52] score (60.41) relative to the other, there is substantial evidence in favor of Model 4 (60.74) which is closed to AIC score of Model 1. Moreover, it is also theoretically consistent.

Further, in order to examine the role of literacy and tea garden population on concentration of hemoglobin level, we used Oaxaca-Blinder decomposition method[53] (see Appendix for more detail).

Table 5.14 presents the result of Oaxaca-Blinder decomposition in terms of literacy. However, effects are not significant.

[52] Akaike Information Criterion (AIC) is a criterion to measure the quality of econometric models when different models are estimated with certain set of data (Snipes & Taylor, 2014). Selection of the model is important as some model may not include true variables or some over-fitted model may loss generality. Lower values of AIC correspond with better fit.

[53] The Oaxaca-Blinder decomposition (Oaxaca 1973), explains the gap in the means of an outcome variable between two groups. Blinder Oaxaca decomposition shows that the difference in group specific means can arise from (a) difference in endowment (i.e. there is a difference between groups in terms of explanatory variables), (b) difference in coefficient (that is, the marginal effect of endowments differ from group to group) and (c) an interaction effect which encompasses both a and b (O'Donnell et al., 2008).

Table 5.14: ***Oaxaca decomposition: contribution by endowments, coefficients and interaction in Hemoglobin level with literacy and non-literacy***

Mean prediction for literacy	2.189***
Mean prediction for illiteracy	2.077***
Raw differential (literacy-illiteracy)	-.111
Due to endowments	-.029
Due to coefficient	-.042
Due to interaction	-.040

Source: author estimation
Note: ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively

In Table 5.15, we present group differences in terms of tea garden population. All differences are significant.

Table 5.15: ***Oaxaca decomposition: contribution by endowments, coefficients and interaction in Hemoglobin level with tea garden population and non-tea garden population***

Mean prediction for non-tea garden population	2.204***
Mean prediction for tea garden population	2.033***
Raw differential (tea garden population-non tea garden population)	.170***
Due to endowments	.200***
Due to coefficient	.138***
Due to interaction	-.168***

Source: author estimation
Note: ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively

Thus, Oaxaca-Blinder decomposition on concentration of hemoglobin level helps to understand the difference in haemoglobin level in terms of endowment and coefficient effects. Our results reveal that Oaxaca decomposition in terms of tea garden population is significant.

5.3.3. Discussions:

The finding of the present study provides that literacy is more or less positively associated with hemoglobin level (albeit at weaker level of acceptance). This result echoes that of Bisoi et al., (2011), Alemu & Umeta (2015), Chowdhury et al., (2015), Balasubramanian et al., (2016), Mangla & Singla (2016) and Kumar et al., (2016).

The coefficient of land ownership has a significant impact on level of hemoglobin concentration. This is consistent with study of Haverkate et al., (2014). They have considered land ownership as one of the measures of wealth. They found that higher socioeconomic classes had higher mean of Hb level. Moreover, a household with land of their own has the opportunity to engage in economic activities such as agricultural works, home garden, livestock and poultry farm of their own. An adequate amount of micronutrient food intake is necessary to ensure nutritional adequacy. Even the low-income households with land ownership can be able to maintain their nutritional diet from their homegrown food product. On the other hand, those who have no access to land of their own have to rely on the market for their daily diet. Therefore, land ownership is one of the important factors to a household for self-sustained food product and income as well maintenance of hemoglobin level in the long run.

We also found that tea garden population are more likely to suffer from anemia (this came from both the attribute test as well as regression analysis). This is consistent with Gogoi, (2011), Das et al., (2012) and Sharma et al., (2012)[54]

In sum, our result shows that landownership and living in non-tea garden habitat are important for better haemoglobin prospects. Given our previous discussion, these results imply dietary inclusion of iron is to be more important than distribution of IFA tablets. People who have their own land or live in areas where bioavailability of heme products (fish, meat) are high enough due to immediate geography, will fare better in terms of maternal health. As a policy prescription, one has to rethink the idea of distribution of IFA tablets: probably direct distribution of heme products in a form which is acceptable to the population will matter. Protection of wages of tea garden labourers and enactment of better working conditions will also increase their economic position (so that dependence on cereal based food goes down). This can also be thought of as a policy.

[54] Prevalence of anemia, particularly in tea garden areas of Assam have been broadly discussed in chapter II section 2.2.2 b.

5.4. Conclusions:

In this chapter, determinants of adverse maternal outcome and maternal deaths have been discussed in the context of our sample. More than 90 percent women are anemic and burgeoned with maternal complications. The study also revealed that Tea garden population, OBC and SC population are significantly associated with prevalence of anemia.

Further, to analyze the factors of lower concentration of hemoglobin level (i.e. a proxy of maternal anemia) monthly food expenditure per capita on heme and non-heme product is included. It is clear from the field observations that an inadequate dietary iron intake and lack of micronutrient rich food product has an adverse impact on the development of anemia during pregnancy at Tea Garden areas compared to the rest of the studied areas. In addition, impact of socio-economic variables on hemoglobin concentration has been examined. The result shows that literacy, land ownership and tea garden habitats are important determinants of hemoglobin level. However, evidence in favor of literacy rate (in terms of level of significance) is a bit weak.

Micronutrient food-based approach can be taken as preventive strategies of nutritional deficiency and malnutrition. It promotes the availability and accessibility of iron-rich foods which contain heme iron and non-heme food products that are good source of vitamin A, C as well as folic acid. Promoting home gardens, small scale animal husbandry to maintain regional and local variation of diet, ensuring seasonal availability in the iron containing foods are vital to enhance the bioavailability (Biswas and Baruah, 2014). Nair and Iyengar (2009) have pointed out that food fortification and food supplementation are important components of food-based approach to improve micronutrient. However, households with limited access to land, can go for small home gardening which requires minimal space, fast-growing (example includes pumpkin, cucumber and small animal husbandry) for home consumption (Ruel and Carol, 2000; Hillenbrand and Waid, 2010; Waid, 2011). However, there have to be cooperative efforts of Government and non-governmental organizations to support and promote such food-based intervention along with iron supplementation programmes in order to increase the efficacy to develop iron status among pregnant women. It is therefore, observed that there exists an acute requirement to include local context for prevention of anemia, rather than universal, “one-size-fits-all” type intervention to all anemia cases. It is

also well known that maternal anemia is largely preventable with timely interventions (Kotecha, 2011; Viveki, 2012; Osungbade & Oladunjoye, 2012).

It can be argued that anemia and other factors are not problems per se, but their persistence is. Given the availability of a health system, such persistence can only be explained if the patients do not engage with the system, or even if they do so, interactions are likely to be intermittent and inadequate. In the next chapter, such behavior is examined in depth.

Appendix

Table 5.1.A: ***Profile of Maternal Death Cases at Studied Villages***

Cases	Age	Education Level	Weight	Birth Parity	Hb Level	Maternal History	When did Death Occur	Causes of Deaths
Case 1 (Muhimari)	19	9	41	1	9.3	0	Postpartum	Anemia and Severe Weakness
Case 2 (Muhimari)	35	3	40	4	11.4	High BP	Postpartum	Pre-Eclampsia
Case 3 (Patgaon)	35	0	40	7	6.1	0	Postpartum	Anemia
Case 4 (Lepetkatta TE)	35	0	48	5	8.1	0	Postpartum	Anemia and Weakness
Case 5 (Lepetkatta TE)	38	0	40	7	7	Nerve Problem	Postpartum	Anemia
Case 6 (Lepetkatta TE)	25	0	47	2	8.6	0	Postpartum	Pre-Eclampsia and Anemia
Case 7 (Kadamoni)	26	0	48	2	11.4	Still birth	Postpartum	Postpartum Alcoholism
Case 8 (Kadamoni)	26	0	49	5	8.2	Miscarriage	Postpartum	Postpartum Hemorrhage
Case 9 (Kadamoni)	28	0	45	3	12	Miscarriage	During Pregnancy	Miscarriage and Sever Abdominal Pain
Case 10 (Sakumato TE)	24	0	37	4	8	Anemic	During Delivery	Hemorrhage
Case 11 (Sakumato TE)	25	0	39	1	9.2	0	During Pregnancy	Severe anemia
Case 12 (Sakumato TE)	23	0	42	3	7	Anemic	During Pregnancy	Severe anemia
Case 13 (Motinagar)	39	0	49	6	3	Still birth	Postpartum	Anemia and Pre-Eclampsia
Case 14 (Motinagar)	32	0	36	3	8	Anemic	Postpartum	Edema
Case 15 (Motinagar)	33	0	48	6	10	0	During Pregnancy	Antepartum Hemorrhage
Case 16 (Silcoorie TE)	25	4	44	3	7	0	Postpartum	Respiratory problem
Case 17 (Silcoorie TE)	28	5	41	3	8	0	Postpartum	Cardiomyopathy

Source: Field data 2014-15

Table 5.10.A: ***Some Selected Indicators of Maternal Health Status of Women***

Background Characteristic	Muhimari	Patgoan	Janzimukh	Lepetkatta TE	Kadamoni	Shakumato TE	Silcoorie TE	Motinagar
Average Household Income	46733.33	30000.00	43235.29	45941.18	45333.33	34200.00	47045.45	35913.04
Age at Marriage								
> 15	33.33	0.00	0.00	35.29	6.67	8.00	4.76	21.74
15-20	60.00	85.00	55.55	58.82	46.67	80.00	76.19	56.52
20>	6.67	15.00	44.44	5.88	46.67	12.00	19.04	21.74
Literacy								
Illiterate	30.00	30.00	55.55	82.35	46.67	80.00	14.29	69.57
Literate	60.00	45.00	33.33	11.76	33.33	20.00	76.19	17.39
Only sign	10.00	25.00	16.66	5.88	20.00	0.00	9.52	13.04
Birth Order								
1	30.00	75.00	27.77	23.52	40.00	47.83	4.76	52.17
2 to 3	56.67	20.00	61.11	52.94	46.67	32.00	43.48	30.43
4 to 5	13.33	0.00	11.11	17.64	13.33	24.00	8.69	8.69
6 to 7	0.00	5.00	0.00	5.88	0.00	0.00	0.00	8.69
Hemoglobin Level								
<7	26.67	15.00	0.00	17.64	0.00	40.00	0.00	21.74
7 to 9	26.67	35.00	11.11	76.47	20.00	48.00	57.14	65.21
10 to 12	46.67	85.00	88.89	5.88	80.00	12.00	42.86	13.04
Pregnancy Complicacy								
With complicacy	53.33	25.00	11.11	58.82	33.33	64.00	23.80	47.83
No complicacy	46.67	75.00	88.89	41.17	66.67	36.00	76.19	52.17

Source: Field data 2014-15

Table 5.12.A: ***VIF for Socioeconomic Variables***

Variable	VIF	1/VIF
Literacy	1.1	0.909428
Birth Order	1.09	0.913329
Land Ownership	1.06	0.941429
Age of Marriage	1.06	0.942864
Use of Family Planning	1.01	0.985666
Mean VIF	1.07	

Oaxaca-Blinder Decomposition:

The outcome variable is level of hemoglobin. Therefore the gap between mean outcomes, Y^a and Y^b (here, a and b are two groups) is equal to

$$
\begin{aligned}
& Y^a - Y^b \\
&= \beta^a X^a - \beta^b X^b \\
&= \beta^b X^a - \beta^b X^b + \beta^a X^b - \beta^b X^b + (\beta^b X^b - \beta^b X^a - \beta^a X^b + \beta^b X^b) \\
&= \beta^b (X^a - X^b) + X^b (\beta^a - \beta^b) + (X^a - X^b)(\beta^a - \beta^b) \\
&= \beta^b \Delta X + X^b \Delta \beta + \Delta X \Delta \beta \\
&= E + C + CE
\end{aligned}
$$

The gap between a and b on outcome variable is due to (a) a gap in endowments (that is, due to differing distribution of Xs) (E) or (b) a gap in coefficients (β) or (c) a gap arising from interaction of endowment and coefficients (CE) (Saikia, Moradhvaj, & Bora, 2016). In the above equation, X^a and X^b are the vectors of explanatory variables (age of marriage, birth order, use of family planning methods, per capita income, per capita food expenditure, landownership) evaluated at the means for literate/illiterate groups as well as and tea garden/non-tea garden population respectively.

CHAPTER VI

Barriers to Maternal Health Seeking Behavior

In the present chapter, the factors of maternal health seeking behavior are examined. As discussed in chapter V, maternal complication is one of the serious concerns in the field of maternal health study. It is noted that although 33 percent of women in our sample have faced complications during pregnancy, 70 percent of them are not willing to seek care from formal healthcare facilities. In such cases, study of maternal health seeking behavior (hereafter MHSB) helps identify the difficulties faced by women in decisions to seek care from health institutions regarding their reproductive health in terms of financial, cultural, social and structural constraints. Women may need additional support from family and society regarding childcare, household duties, or long travel to health institutions. Women's perspectives for such conditions are crucial for understanding the response behavior. Decision to seek health care and choices made during pregnancy and childbirth influence the utilization of health care facilities. Further, such study also acts as a pathway to identify reasons that have been already discussed in "Three Delay Model" in chapter 2. Given this, such a study enables us to understand the factors affecting decision making mechanisms within the households as well as importance of multiple stakeholders (Government, policymakers and donors) of the society.

The rest of the chapter is organized under six sections. Section 6.1 deals with conceptual framework of MHSB. Section 6.2 addresses present status of MHSB of the sample. Section 6.3 describes methodology of the study. Section 6.4 deals with the result of our regression model. Section 6.5 discusses significant determinants of health seeking behavior. Section 6.6 provides a summary and conclusion.

6.1. Conceptual Framework of MHSB:

The term "health-seeking behavior", a part of the broader concept of health behavior, is an important tool for understanding the complex behavior of population in engagement with the health system. "Health-seeking behavior" can be defined as any activity undertaken by individuals who perceive that they have a health problem for the purpose

of finding an appropriate remedy (Ward, Mertens, & Thomas, 1997). Health behavior of an individual is mostly influenced by health beliefs, traditional and religious healthcare practices, lifestyle and his/her standard of living in a society (Sutton, 2004). Health Belief Model (HBM) developed by Hochbaum, Rosenstock and Kegels during 1950s has been the most commonly used conceptual framework in health behavior research (Glanz & Bishop, 2010; Abraham & Sheeran, 2015; Jones et al., 2015). According to this model, health behavior is determined by perception towards diseases and their behaviors in response to reduce the burden of diseases (Hochbaum, 1958 as cited in Champion & Skinner, 2008). Such personal perception is influenced by four core elements- perceived seriousness, perceived susceptibility, perceived benefits and perceived barriers. The first two elements are related to individual's belief about seriousness of diseases and the latter elements consist of beliefs regarding benefits of new behavior and individuals own evaluation of adopting a new behavior which enables perceived barriers to change. In addition, individual behavior is also influenced by cues to action and self-efficacy. Cues to actions are various events, people and things such as media reports and campaigns, awareness programms and reminder from health warning lables on a product etc. that promote change in behavior, whereas, self-efficacy is the individual's beliefs in the capacity of performing a new behavior to overcome the barriers. These elements are the key factors to influence the perceptions and hence actions and health behavior (MacKian, 2003; Champion & Skinner, 2008; Hayden, 2014).

Suchman (1965) described five stages of an individual's decision-making in relation to involve different types of decisions and actions concerning medical care. These five stages include symptom experience, decision to seek professional care, contacting a doctor, being a patient and the recovery stage, which represents the sequence of illness behavior from recognizing symptoms to care is sought. A similar approach of decision to seek care was developed by Chrisman (1977) where health seeking behavior refers to the steps taken by an individual who perceives a need for help as a remedial action to rectify ill health. The argument is that recognition of symptoms of illness is not the necessary condition for the health seeking actions as these actions are largely influenced by pre-existing beliefs, treatment choice, and social networks.

Therefore, assessing health seeking behavior must include a broader cultural context where the effects of social interaction and social norms are more essential component than the knowledge and attitude of the pregnant woman herself (Ewbank, 1994). Thus, to

seek medical help for maternal illness depends upon factors of community level rather than individual and household factors because individuals are clustered within families and families within communities (Babalola & Fatusi, 2009). For women's access to healthcare services regarding their reproductive and sexual health, is often limited despite the availability of these services (Chamberlain et al., 2007). This happens due to the structural conditions (social status, education, caste and class, health institutions) under which they live; they cannot imagine seeking healthcare or will to utilize these services *(ibid).* Further, provision of healthcare services for women does not translate into usage despite the advances in medical knowledge. The health attainment will come up with behavioral change. This change is the result of collective efforts which include individuals, organizations and communities (Currie & Wiesenberg, 2010). Although the combination of beliefs leads to change in behavior also depends on numbers of situational factors. Three major factors influence the decision making of women for utilization of available health care resources namely at first she must decide that she has health problem. Secondly, she feels that she can seek health care and finally she decides to seek care. All these steps are contributed in delaying the seeking care and barriers to utilization of maternity care (*ibid*).

There are two major approaches towards the use of health services and factors that influence people's behavior in relation to their health- "end point" (utilization of formal system or *health care seeking behavior*) and the "process" (illness response or *health seeking behavior*) (Mackian, Bedri, & Hermione, 2004). The first approach, utilization of health system focuses on only the end point utilization of healthcare system. Studies (Tripping and Segall, 1995; MacKian, 2003; Mackian, Bedri, & Hermione, 2004) have identified several factors such as geography, economic, cultural and organizational which influence the decision to engage with healthcare system. A key point that emerges is the following: only providing education and knowledge about illness perception at individual level are not sufficient to change the attitude towards seeking medical care or to remove barrier to access health services. Health promoting programme should also include community level intervention (maternal education and awarness) to induce changes ine human behavior (MacKian, 2003). The second approach focuses on individual health seeking behavior in terms of social environment. MacPhill and Campbell (2001) have argued that knowledge about illness is not sufficient to make decision for seeking healthcare, as individial's particular behavior is influenced by immediate practical

environment. To understand the behavior around health seeking decision, Lash (2000) emphasized the 'reflexive communities' which reflect the particlular behavior of an individual regarding decisions and actions in relation to their health is largely based on social, practical and immediate environmant rather individual's own knowledge and information. Further, the idea of social capital helps in understanding the health seeking behavior as it provides a means of shifting focus from individuals to social groups. Social capital is defined as social resources and norms, networks or processes and conditions within society that allow for development of human and material capital (MacKian, 2003; Mackian, Bedri, & Hermione, 2004). For better understanding of human health seeking behavior, we need to address the issues of social capital and reflexive communities because individual actions are more likely to be guided by their wider structures around them.

It is clear from the above discussion that health seeking behavior is crucial to understanding an individual engagement with and utilization of health care system given socio-cultural, demographic and environmental background. Existing literature have identified several factors influencing MHSB. For instance, Fenta (2005) assessed the factors influencing the utilization of such services in Ethiopia during 2004. The study found that maternal age, educational level, partner's attitudes including lack of awarness about danger signs during pregnancy are the major contributors to non-use of maternal care services. Osubor et al., (2006) showed that, in Nigeria, agents are more likely to prefer Traditional Birth Attendants (TBAs) due to greater accessibility, lower cost and more convenience. Further, local beliefs, perceptions, and knowledge of community members about maternal health problems also played an important role in MHSB. Koenig et al., (2007) have examined MHSB in Bangladesh and identified main factors are to be medical cost and socio-economic disparities. Jayaraman et al., (2008) in the context of Rwanda, have found that regular visits to antenatal care and wealth strongly influences choice of delivery in a health facility. Moreover, female headed households and women with higher-order birth are less likely to access health care facilities. Supply side factors like availability and quality care, cost of seeking care also play an important role. A related study by Tasnim et al., (2009) in Bangladesh found that high cost, non-availability of drugs and beds, ignorance about complications, cultural norms, and attitudes of health providers are major reasons for not availing health care services. According to Chomat et al., (2014) for the indigenous mothers living in Quetzaltenango, Guatemala, poor

utilization of maternal care services are caused by socioeconomic disparities, ethnic and linguistic differences, personal experience with health institutions and health providers, influence of husband and other family members. Benova et al., (2014) have shown that for women living in rural Egypt showed economic and socio-cultural factors are positively associated with MHSB.

A limited number of similar studies are available for India. Navaneetham and Dharmalingam (2002) carried out their studies in Southern India (states of Andhra Pradesh, Kerala, Karnataka and Tamil Nadu). They showed that differences in utilization pattern of maternal care arises due to variations in the implementation of maternal health care program and differences in availability and accessibility of the maternal services between the states as well. Agarwal et al., (2007) have examined the utilization pattern of maternal care in an urban slum in Delhi. Their results reflect that awareness and knowledge about maternity care and accessibility of modern maternity facilities have significant influence on health seeking behavior. Similarly, Mahapatro (2013) found that, in Odisha, transportations and financial constraints, community perceptions and attitudes towards maternity care, influence of elderly person and other family members are the major barriers and determinants of MHSB. Bhattacherjee et al., (2013) found that in tea gardens of Darjeeling district of West Bengal, ignorance and distacne to health care institutions are main reasons for non-utlization of health care services. Srivastava et al., (2014) showed that in Rohilkhand Region of Uttar Pradesh that mother's education and husband's occupation are the strong predictors of utilization of maternal health care services. Likewise, Tiwari et al., (2014) showed accessibility and availability of maternal care services increased the utilization of healthcare facilities in Madhya Pradesh.

A few studies regarding utilization of reproductive healthcare are available in the context of Assam. For instance, a case study carried out by Khound (2016) in Jorhat district of Assam found that socio-economic barriers (such as: lack of awareness, financial constraint, do not think it necessary) are the major factors for lower utilization of these services. Mazumder's study (2016) revealed that among the Karbis[55] of Guwahati city, mothers' education is positively related to awareness of antenatal care and place of delivery.

[55] One of the main tribes of Assam. Karbi's are mainly found in North Cachar Hills, Kamrup, Nagaon and Sonitpur districts of Assam.

Available literature provides an insight about the various explanatory variables for assessing the low utilization of maternal healthcare services. No such comprehansive study was done in Assam. The following sections will discuss the MHSB among the population of studied areas and detail study of factors affecting in shaping health seeking behavior at disaggregated level.

The study of health seeking behavior enables to identify the reasons for use and non-use of available health care services and perceptions of population towards healthcare system of a particular social setting (Kroeger, 1983).

6.2. Health Seeking Behavior in Sample:

On the backdrop of conceptual framework, the present study focuses on health seeking behavior rather health care seeking behavior as observed within the sample. As provided in chapter IV (Table 4.4.3.II), out of 169 interviewed eligible women, only 56.80 percent of women had normal pregnancy; 10.06 percent reported cases of maternal deaths and 17.16 percent were involved in high risk pregnancy. On the other hand, 15.98 percent have complications in their pregnancy. However, despite such poor maternal health outcome, the coverage of full antenatal care is less than 60 percent (Chapter IV, section 4.4.3, Table IV) and facility-based delivery is only around 80 percent (Chapter IV, section 4.4.3, Table V) during the survey period. Around 88 percent of women did not use modern methods of family planning (Chapter IV, section 4.4.3, Table III). Interviews with pregnant women and health providers highlighted that although the pregnant women are familiar with use of available facilities at village level sub-centers. Howerver, they ignored the referral advice provided by ANM's to seek medical help from nearby health institutions with better facilities. Regarding reasons for such behavior, a number of factors are reported which are further categorised as geographical, organizational, cultural and socio-economic factors. Such categorization is based on MacKin, Bedri and Hemione (2004), with some modifications. Details are provided in Table 6.1.

Table 6.1: ***A Framework for MHSB***

Category	Determinants	Measures	Variables
Geographical	Distance and physical access	Far from home	FH
		Bad roads	BR
Organizational	Quality care	Doctors not responsive	DnR
		Non Availability of ambulance	NAmb
		Non Availability of Female health provide	NFhP
Cultural	Knowledge and perceptions	Husband restriction	HR
		Hesitation	Hesi
		Ignorance	Ign
Socio-economic	Social structure and economic cost	Cost of drugs	CoD
		Cost of Transportation	CoT
		Long queue	LQ
		Non availability of person at home	NPaH
		Heavy workload	HW
		Income level	Y
		Age at Marriage	AoM
		Land Ownership	LO
		Literacy	Lit

The descriptive statistics of the selected explanatory variables are presented in Table 6.2

Table 6.2: ***Descriptive Statistics of the Variables Influencing MHSB***

Measures	Variables	Mean	Std. Dev	Min	Max
Not Seeking Care	NSC	0.64497	0.479944	0	1
Far From Home	F H	0.029586	0.169945	0	1
Bad Roads	B R	0.005917	0.076923	0	1
Doctors not Responsive	DnR	0.011834	0.108461	0	1
Non Availability of Ambulance	NAmb	0.029586	0.169945	0	1
Non Availability of Female Health Provides	NFhP	0.153846	0.361873	0	1
Husband Restriction	H R	0.029586	0.169945	0	1
Hesitations	Hesi	0.053254	0.225208	0	1
Ignorance	Ign	0.035503	0.185597	0	1
Cost of Drugs	CoD	0.118343	0.323974	0	1
Cost of Transportations	CoT	0.189349	0.39295	0	1
Long Queue	L Q	0.266272	0.443322	0	1
Non Availability of Person at Home	NPaH	0.142012	0.3501	0	1
Heavy Workload	HW	0.047337	0.21299	0	1
Literacy	Lit	0.390533	0.48932	0	1
Land Ownership	LO	0.614615	1.091507	0	5.61
Income Level	Y	39615.38	19011.9	10000	145000
Age of Marriage	AoM	18	3.278719	12	28

6.3. Methodology:

6.3.1. Rationale for Model Selection: Bayesian Analysis

To understand health seeking behavior among the population of the studied villages, a logisitic regression is used. Formally, a logistic model measures the relationship between a categorical dependent variable and one or more indepencent variables by estimating the probabilities by using the logistic function. It is used to predict the odds of in favor of an outcome based on the values of the indedent variables.

We run a logistic model where “not seeking care” is coded as 1 and “seeking care” is coded as zero. In the right-hand side of equation (1), the parameters of GEO, ORG, CUL and SOCECO are coded as 1 for “if cause problem in accessing health facilities” and zero otherwise. For example: if bad road is coded as 1, this means that due to bad roads they face problem in accessing the health facilities. However, the parameters of land ownership, income level and age at marriage have continuous values (descriptive table available in Table 6.2). The functional form of the specified model for the estimation of MHSB can be specified in the following manner:

The response variable p_i, where p_i is the probability to Not Health Seeking Behavior and defined by

$$p_i = \left(\frac{exp(\lambda_i)}{1 + exp(\lambda_i)} \right)$$

Where,

λ_i denotes logit model and takes the form:

$$Logit(NSC_i) = \alpha + \boldsymbol{\beta_1}(\mathrm{GEO}_i) + \boldsymbol{\beta_2}(\mathrm{ORG_i}) + \boldsymbol{\beta_3}(\mathrm{CUL_i}) + \boldsymbol{\beta_4}(\mathrm{SOCECO_i}) + \mu_i \quad \ldots (1)$$

In the left-hand side of the equation, NSC_i where i denote the total number of sample interviewed women included in the study. In right hand side of equation (1), β= Vector of coefficients; α = Constant; GEO_i= Geographical Factors; ORG_i= Organizational Factors; CUL_i= Cultural Factors; $SOCECO_i$= Socio-economic Factors; μ_i = error term.

However, in the present analysis, given the data set, it has been observed that use of logistic regression model leads to a complete separation problem or perfect prediction failure, i.e. the outcome variables separate a predictor variable or a combination of predictor variables completely and in such case maximum likelihood estimates do not exist[56] (Hosmer & Lemeshow, 2000; Allison, 2003; Heinze & Schemper, 2002; Zorn, 2005; Abrahantes & Aerts, 2012). Hence, as an alternative, we undertake Bayesian approach to logistic regression model (Allison, 2003; Abrahantes & Aerts, 2012; Gelman et al., 2014; Rainey, 2014). Recently, Bayesian framework has become the preferred method and more balanced perspective to health care research and biostatistics. Such popularity is due to its algorithmic simplicity, generality, multi-comparisons including the posterior distribution of Bayesian model is the combination of prior information with evidence from observation. It also can make a direct probability statement about the parameters (Spiegelhalter, Myles, Jones, & Abrams, 2000; Spiegelhalter, 2004; Goubar, et al., 2008). Details of Bayesian approach is discussed the following sections.

[56] See Appendix 6A : Traditional logit model

6.3.2. Conceptual Framework of Bayesian Approach:

Bayesian analysis is the statistical methodology which forms the posterior distribution by combining prior knowledge of the model parameters and evidence from the observed data sample. It consists of three major elements: first it includes a prior distribution. This is the key component in a Bayesian model incorporating prior information (before observing the data) about model parameters i.e. prior reflects the background knowledge of the parameters of the model before observing the current data. There are two types of priors- informative and noninformative. Informative priors provide definite information about the variables; on the other hand, the noninformative prior assigns equal probabilities to all values of the parameters (Glickman & Van Dyk, 2007). The second element is a likelihood function, which includes information about model parameters based on the observed data, and finally, the posterior inference that results from updating the prior knowledge about model parameters with evidence from the observed data. According to Bayes' theorem prior knowledge is updated by the current data and that results updated knowledge in the form of posterior distribution (Gelman et. al, 2014). The general form of Bayesian inference is as follows:

$$\pi(\theta/y) = \frac{\pi(y/\theta)\,\pi(\theta)}{\pi(\mathrm{y})} = \frac{\pi(\mathrm{y}/\theta)\,\pi(\theta)}{\int \pi(y/\theta)\,\pi(\theta)\,d\theta} \qquad 1$$

Where, θ denotes the (vector of) parameters of interest and y the observed data, the left hand side $\pi\ (\theta/y)$ is the posterior distribution of the parameters given data, which is obtained from right-hand side $\pi\ (y/\theta)$ i.e. the likelihood function and π (θ) which is the prior distribution of θ that express our beliefs about the parameters and π (y) is the marginal likelihood and plays the role of the normalizing constant of the density of the posterior distribution.[57]

[57] For example, let y| θ follow a Normal distribution with mean μ and variance σ^2, where σ is known. One proposes a prior distribution of θ. For example, a common assumption is θ follows normal distribution with mean β and variance ρ^2. Then it can be shown that the posterior distribution of θ is

$$\pi(\theta|\mathrm{y}) \sim \mathrm{N}\left(\frac{\rho^2}{\left(\sigma^2/\mathrm{N}\right)+\rho^2}\bar{\mathrm{y}} + \frac{\sigma^2/\mathrm{N}}{\left(\sigma^2/\mathrm{N}\right)+\rho^2}\beta, \frac{\left(\sigma^2/\mathrm{N}\right)\rho^2}{\left(\sigma^2/\mathrm{N}\right)+\rho^2} \right)$$

From here, one can calculate the expected value of θ and compute a confidence interval etc.

In general, there are two issues here: how to propose the prior distributions and how to find the posterior distribution. We have proposed priors are-all the parameters that are captured under four categories of determinants of health seeking behavior viz. geographical, organizational, cultural and socio-economic factors (see Table 6.1). It is noted that priors can be determined from the past information for which, in our present analysis selected parameters for priors are chosen based on the prior information from the findings of the previous literature.

The model employs the Markov Chain Monte Carlo (MCMC) algorithm to construct Markov chain that has the desired distribution as its equilibrium distribution. A Markov chain is able to improve its approximation to the true distribution at each step in the simulation. It is very difficult to work on posterior densities and summarize inference from the complex model of Bayesian framework; however, in this regard MCMC helps to generate samples from an arbitrary posterior density. MCMC is a general computing technique that can be used to generate fair samples from a probability in high dimensional distribution, using random numbers drawn from uniform probability in certain range (UCLAStatistics, 2013). This was first introduced by Nicholas Metropolis et al., (1953) and later it was generalized in the field of statistical problem by Hastings (1970) and this algorithm is referred as Metropolis-Hastings Markov Chain Monte Carlo algorithm (Brooks, 1998). Further, MCMC is also considered as an easy to implement and time efficient (Myunga, Karabatsosb, & Iverson, 2005). Additionally, the simulation algorithm is easily extensible to those models which have a large number of parameters or high complexity, although it often causes problem in practice (Jones & Huddleston, 2010).

Bayesian models measure the 95 percent Highest Probability Density (HPD) region for each parameter. There are two types of credible intervals often used in practice: equal-tailed credible intervals and highest posterior density credible intervals. Credible interval is an interval from the domain of the marginal posterior distribution of that parameter. For example a 95% credible interval for a scalar parameter is an interval in which the parameter belongs to with the probability of 95%. Equal trialed credible intervals refer to a credible interval in such a way that both tails of the marginal posterior distribution have the same probability. However, a highest posterior density credible interval has the shortest width among all other credible intervals. The 95 percent HPD region is the Bayesian “confidence interval” that evaluates whether the parameter is significant or not.

If the 95 percent HPD region for each parameter does not include 0, this means parameter has significant effect for the model (STATAmanual).

Further, there is difference in hypothesis testing procedures between frequentist and Bayesian analysis. In frequentist hypothesis testing, is often considered a point hypothesis such as H_0: $\theta = \theta_0$ versus H_a: $\theta \neq \theta_0$. A decision procedure is devised by which, on the basis of a set of collected data, the null hypothesis will either be rejected in favor of H_a, or accepted. Bayesian hypothesis testing does not really need a distinction between the null and alternative hypotheses, in the sense that they are defined in a frequentist statistic. There is no need to "protect" the null hypothesis. The answer in the Bayesian context is a probability statement about θ that is free of any deterministic presumptions. So, the conclusion of Bayesian hypothesis testing is not an acceptance or rejection of the null hypothesis per se, but an explicit probability statement about the tested hypothesis (*ibid*).

The following section provides description of the key component of Bayesian approach such as likelihood function and the prior distribution for the present model.

6.3.3. Description of Likelihood and Priors:

The present model consists of prior distribution of relevant parameters such as factors of geographical, organizational, cultural including socio-economic (details has been shown in Table 1, section 6.2.), each parameters representing a binary choice probabilities of seeking care whereas parameters of geographical, organizational, cultural and a part of socio-economic are considered as binary numbers and some socio-economic variables assign with continuous values (examples: income, age, land ownership). Data are collected from 169 respondents from the sample villages. These likelihood and prior distributions are associated with individual's social and immediate environment influencing decision making process in the engagement of an individual with the health system. Posterior inference of the model describes the impact of relevant parameters on shaping MHSB of the studied areas. The details of Bayesian binary logistic model and computational methods are described in the following sections.

6.3.4. Bayesian Binary Logistic Model

The posterior density distribution for binary logistic regression is presented in this section. Bayes' theorem show how the probability of an event is affected by the new information, given new information is true. Suppose that there is a sequence of events β and A. The rule of conditional probability i.e. as per Bayes theorem,

$$P(\beta|A) = [P(A|\beta).P(\beta)]/P(A) \quad (2)$$

The left-hand side of the equation is the conditional probability of event β given event A. The right-hand side of the equation is the probability of event A given event β divided by the event A.

We replace A with y, which is observed data and dependent upon other observed variables as follows:

$$(y|\boldsymbol{Z}) = \boldsymbol{Z}\beta + \varepsilon \quad (3)$$

Where y is m×1 vector of observations and y=0 or 1. For the right-handed side of the equation, **Z** is a m× k matrix of fixed elements, β is a k×1 vector of coefficients, and ε is a m×1 vector of random disturbances. The dichotomous response 0 and 1 can be transformed to the probability of P (y = 1) and P (y = 0) and the coefficient β represents the change of the probability when fixed elements change. When error terms have logistic distributions,

$$P\ (y = 1|\boldsymbol{Z}) = 1/[1 + \exp(\boldsymbol{Z}\beta)] \quad (4)$$

Equation (4) represents the observed data and the coefficients to be estimated. The goal of the logistic regression is to estimate unknown parameters β. In such case, maximum likelihood estimation can be used to obtain the set of parameters for which the probability of the observed data is greatest. The likelihood function is

$$l(\beta, \sigma|\boldsymbol{Z}, \boldsymbol{y}) = \prod_{i=1}^{n}[P_i]^{yi}[1 - P_i]^{1-y_i} \quad (5)$$

With observed data **[Z, y]**, the likelihood function can be maximized relative to the unknown parameter vector β and σ. In Bayesian approach, the current knowledge regarding the unknown parameter can be updated if the prior information is known. We can estimate the posterior distribution as follows.

$$p(\sigma|\boldsymbol{Z},\boldsymbol{y}) = [l(\beta,\sigma|\boldsymbol{Z},\boldsymbol{y}).p(\beta)]/p(y) \quad (6)$$

Since the p(y) is a constant relative to β, the posterior distribution is proportional to the product of the likelihood function and the prior distribution. Therefore, equation (6) can be rewritten as

$$p(\sigma|\boldsymbol{Z},\boldsymbol{y}) \propto p(\beta).l(\beta,\sigma|\boldsymbol{Z},\boldsymbol{y}) \quad (7)$$

Considering the normal distribution, equation (7), the likelihood function can be written as follows

$$l(\beta,\sigma|\boldsymbol{Z},\boldsymbol{y}) = (2\pi\sigma^2)^{-n/2}\, exp[(-1/2\sigma^2)(y-\boldsymbol{Z}\beta)'(y-\boldsymbol{Z}\beta)]$$

$$= (2\pi\sigma^2)^{-n/2}\, exp[(-1/2\sigma^2)\sum(y_i - z_i\ \beta_i)^2]$$

$$\propto (\sigma)^{-n}\, exp[(-1/2\sigma^2)\sum(y_i - z_i\ \beta_i)^2] \quad (8)$$

It is assumed that p (β) follows the normal distribution, p (β) ~N (μ,σ^2) and it is independent and identically distributed. In this case, a posterior distribution with uninformative priors is as follows

$$p(\beta|\boldsymbol{Z},\boldsymbol{y}) \propto (\sigma^2)^{-n-2} exp[\left(-\tfrac{1}{2\sigma^2}\right)\sum(y_i - z_i\ \beta_i)^2] \quad (9)$$

Equation (9) incorporates the prior information p (β), and likelihood function.

Bayesian approach tries to provide the posterior probability which is conditional on the observed data. The inference of β can be drawn by using M-H Markov Chain Monte Carlo algorithm and the credible interval.

6.3.5. Computational Methods:

The estimation has been carried out by using standard tools of Markov Chain Monte Carlo (MCMC) simulation. For the sampling process in the MCMC method, burn-in of 5,000 iterations with MCMC sample size of 12,000 and finally total 17,000 MCMC iterations were selected for the posterior inference which is an accurate and efficient with higher Effective Sample Size (ESS) of all the parameters. Use of MCMC method produces some level of autocorrelation. Thus, to evaluate of statistical efficiency of such methods, ESS is calculated which is the number of effectively independent samples from

the total number of posterior samples (Calderhead, 2014; BEAST websitehttp://beast.bio.ed.ac.uk/Increasing_ESSs). Low ESS relative to MCMC sample suggests the convergence problems. In this analysis, due to having low ESS, two parameters namely income level and age at marriage have been excluded from the study. Details of the effective sample size table are shown in Table 6.3.A. Chi-squared test is carried out to determine if there are non-random associations between two categorical variables. Results from Chi-squared test are presented in Appendix (Table 6.4.A to Table 6.6.A). Result shows that test is found to be significant for the variable of cost of transportation with non-availability of ambulance (p=0.000) and far from home (p=0.020). Similarly, husband restriction is significantly associated with female health provider (p=0.00) and doctors not responsiveness (p=0.01). We dropped parameter of cost of transportation and husband restriction from this model.[58] The acceptance rate of the *Metropolis–Hastings algorithm* of the preferred model is 43 percent out of 12,000 MCMC sample size where average efficiency is 16 percent. This framework is also used the 95 percent Highest Probability Density (HPD) region for each parameter in the model.

Further, another important component of Bayesian inference is that compare two models, say M_1 and M_2, which provides support for a model over another based on the Bayes factor, computed by calculating the posterior odds ratio. The Bayes factor of two models is the ratio of their marginal likelihoods which is calculated by using the same dataset that provides relative probabilities of how well each model fits the data compared with the base model. The present analysis compares three models with three different prior distributions to find the one that best fits the data. In the first model (base model), we have considered normal prior with a fixed variance. Secondly, we compute the second model with uninformative prior and informative prior. For former one, we have used uniformative priors. To construct informative priors, we uses the information obtained for $N \sim (\mu, \sigma)$ from the former to replace the uninformative distributions $N \sim (0, 1)$.

6.4. Results for Health Seeking Behavior:

Table 6.7 provides the posterior probability distribution. The result shows that parameters of geographical determinants like far from home (distance) and bad roads (road

[58] See Table 6.4 A to Table 6.6 A in Appendix for detail explanation of variable selection based on chi-squared test.

conditions); unresponsive doctors (organizational factor) and cost of drugs, land ownership and literacy (socio-economic determinants) have no significant effects on predicting the health seeking behavior as the Highest Posterior Density (HPD) at 95 percent credible interval for these variables include 0 (the details of HPD is mentioned in the section 6.3.2.). On the other hand, out of four categories of determinants, the HPD intervals of the factors of cultural determinants; parameters of organizational category such as non-availability of female health providers, non-availability of ambulance and variables of socio-economic determinants like long queue, non-availability of person at home and heavy workloads do not include 0, therefore they represent significant barriers to MHSB in the surveyed villages at Highest Posterior Density (HPD) of 95 percent credible interval for all parameters.

Table 6.7 : ***Posterior Distribution for Binary Logistic Regression Model in Response to Health Seeking Behavior in Surveyed Villages, (Not Seeking care=1 , Seeking care=0) (Base model)***

Categories	Measures	Posterior Means	Std. Dev.	MCSE	HPD (95% Cred. Interval)	
Geographical	FH	1.3669	2.6288	0.0550	-3.6042	6.7765
	BR	0.1478	3.0012	0.0580	-5.6033	6.1708
Organizational	DnR	1.7078	2.5192	0.0532	-3.1876	6.5308
	NAmb	**3.6275**	**1.9804**	**0.0396**	**0.0696**	**7.8555**
	NFhP	**4.9924**	**1.8831**	**0.0460**	**1.3603**	**8.6802**
Cultural	**Hesi**	**5.4343**	**1.6388**	**0.0355**	**2.3477**	**8.7011**
	Ign	**5.4940**	**1.6705**	**0.0388**	**2.4380**	**8.8330**
Socio economic	CoD	2.3415	2.1767	0.0502	-1.5621	6.8692
	LQ	**6.4431**	**1.5276**	**0.0361**	**3.5282**	**9.3770**
	NPaH	**6.4397**	**1.4361**	**0.0310**	**3.9396**	**9.3660**
	HW	**5.5274**	**1.6628**	**0.0361**	**2.5754**	**8.9613**
	LO	-0.0406	0.3289	0.0092	-0.7052	0.5973
	Lit	-0.2451	0.8000	0.0250	-1.7957	1.3505

Source: Authors' estimation based on field data (2014-15)

Note: The dependent variable is women choice between not seeking care and seeking care. Not seeking care is coded as 1, 0 otherwise. "C.I." means credible interval. Statistically significant factors have been highlighted.

Table 6.8 presents the results from the second model using the uninformative priors, and Table 6.9 presents results with informative priors. The HPD level of the both models show that the effects of organizational parameters such as non-availability of female health providers; cultural determinants like hesitation and ignorance; and socio-economic

determinants like long queue, non-availability of person at home and heavy workloads remain significant in these models. However, road conditions (geographical factor) in model of uninformative priors and non-availability of ambulance facilities (organizational factors) is found significant in model of informative priors. The difference in results in Table 6.8 and 6.9 indicates that the prior information regarding the mean and standard deviation of the parameter has an impact on the estimates.

Table 6.8 : ***Posterior Distribution for Binary Logistic Regression Model with Uninformative Priors in Response to Health Seeking Behavior in Surveyed Villages (Not Seeking care=1 , Seeking care=0)***

Categories	Measures	Posterior Means	Std. Dev.	MCSE	HPD (95% Cred. Interval)	
Geographical	FH	-3.7332	2.0780	0.0557	-7.9115	0.2081
	BR	**-7.3065**	**2.3921**	**0.0588**	**-11.884**	**-2.4692**
Organizational	DnR	-3.0179	2.0642	0.0661	-7.0649	0.9737
	NAmb	0.1420	1.6080	0.0384	-2.8481	3.4049
	NFhP	**5.7070**	**1.7233**	**0.0597**	**2.3030**	**8.9809**
Cultural	**Hesi**	**2.9595**	**1.1580**	**0.0264**	**0.7871**	**5.2609**
	Ign	**2.9975**	**1.1156**	**0.0240**	**0.8452**	**5.2511**
Socio economic	CoD	0.1339	1.4360	0.0406	-2.4977	3.0767
	LQ	**4.9284**	**1.1346**	**0.0316**	**2.9163**	**7.2242**
	NPaH	**4.2514**	**0.9917**	**0.0218**	**2.5328**	**6.3405**
	HW	**2.9993**	**1.1190**	**0.0245**	**0.8938**	**5.2740**
	LO	-0.0611	0.2624	0.0074	-1.5906	0.4498
	Lit	-0.4774	0.5857	0.0176	-1.5906	0.6883

Source: Authors' estimation based on field data (2014-15)

Table 6.9 : ***Posterior Distribution for Binary Logistic Regression Model with Informative Priors in Response to Health Seeking Behavior in Surveyed Villages (Not Seeking care=1 , Seeking care=0)***

Categories	Measures	Posterior Means	Std. Dev.	MCSE	HPD (95% Cred. Interval)	
Geographical	FH	2.0207	2.6670	0.0542	-2.7768	7.6567
	BR	0.0427	3.0411	0.0576	-6.2047	5.6659
Organizational	DnR	2.2889	2.5527	0.0551	-2.6026	7.2464
	NAmb	**4.1578**	**2.1078**	**0.0437**	**0.1621**	**8.2352**
	NFhP	**5.2331**	**1.9747**	**0.0441**	**1.4814**	**9.0044**
Cultural	**Hesi**	**5.8137**	**1.7912**	**0.0392**	**2.5277**	**9.2797**
	Ign	**5.7952**	**1.6480**	**0.0345**	**2.9550**	**9.3029**
Socio economic	CoD	2.8301	2.3509	0.0515	-1.5932	7.3670
	LQ	**6.7153**	**1.5714**	**0.0352**	**3.8688**	**9.8631**
	NPaH	**6.7932**	**1.5370**	**0.0356**	**4.1089**	**9.9374**
	HW	**5.7867**	**1.6602**	**0.0357**	**2.9572**	**9.1364**
	LO	-0.1884	0.8004	0.0246	-1.7764	1.3588
	Lit	-0.1884	0.8004	0.0246	-1.7764	1.3588

Source: Authors' estimation based on field data (2014-15)

Computation of Bayes factor indicates that the uninformative prior model performs worse than other two models. The value log (BF) 4.98 provides a strong evidence in favor of the informative priors model. Thus, the informative priors model (Table 6.9) is the best fit among the three (Table 6.10).

Table 6.10: Bayes Factor of the Considered Models

	DIC	log(ML)	log(BF)
Uninformative Priors	68.21162	-133.273	-99.5461
Informative Priors	27.92656	-28.743	4.984218
Base Model	31.36061	-33.7272	.

Note: Marginal likelihood (ML) is computed using Laplace-Metropolis approximation

.

The model with informative prior thus demonstrates that non-availability of female health provider and ambulance facilities increase the probability of not seeking care for maternal health. Similarly, this probability tends to increase if hesitation and ignorance tend to increase. Additionally, long queue, non-availability of person at home and heavy workload are significant barriers to MHSB.

6.5. Discussion:

The result of posterior probabilities indicate that out of four broad categories of determining factors of MHSB, the parameters of geographical determinant (distance and road conditions) have no significant effects on shaping MHSB among studied population. A study in Guatemala done by Gleia et al., (2003) to examine the factors associated with use of biomedical care during pregnancy found that availability and accessibility of biomedical facilities have modest effects as women's decision to seek care is more likely to associate with quality of care. Chomat et al., (2014) also investigated factors affecting utilization of maternal health services in Guatemala. The result showed that accessibility of services may not necessarily translate into increased utilization of services if these facilities are lacking of medicines and other equipment, staffed with minimally trained personnel, personal experience with health providers etc. We find that geographical factors indicating accessibility of health facilities such as distance from home (distance) and road conditions are statistically insignificant. The other predictors appear to be more important in causing barriers of MHSB.

In the context of organizational determinants, non-availability of female health providers and non-availability of ambulance services have significant effects on discouraging people to seek maternal healthcare from the health system. Non-availability of female health providers discourage patients from going to health facilities for better treatment (such as: specialist doctors, gynecologist) other than the Sub-Center where the local ASHA workers or ANMs are available. It may be the case that respondents are not comfortable to share their reproductive problem with male doctors. The observation is consistent with Schepper et al., (2005). His literature survey also identified that given the lack of female health providers, female patients may be embarrassed undergo physical examination during pregnancy with male physician. Singh et al., (2012) have also identified non-availability of female health professionals at CHCs/BHCs as a factor behind inaccessible of health services. Similarly, studies on health seeking behaviors during pregnancy in Pakistan by Qureshi et al., (2016) and Anwar et al., (2012) have found lack of female health provider is one major barrier. Another important finding of our study is that non-availability of ambulance at the time of emergency is a critical factor. The respondents argued that they do not have financial resources to afford a vehicle in a short notice. Further, other than the delivery of a baby, ambulance services are not free for the patients. Frequently they use bicycle, but it is not convenient during

last trimester or with newborn. Though the respondents have the willingness to go for health check-ups during pregnancy and post delivery period, but, the financial constraints are the main barriers. This result of our study is also found to be consistent with findings from the other studies. Ruth et al., (2016) studied in Ethiopia to understand the social context of maternal health related behaviors. They found that increase in ambulance facilities tends to increase the rate of skilled birth attendance. A study in a rural community of Africa (Munguambe et al., 2016) found that limited access to transport facilities and lack of ambulance services make more complex in decision making process to seek health care at the health facility.

The parameters of cultural determinants, namely hesitation and ignorance have a strong influence on MHSB. Such factors have a large impact on shaping wider health seeking behavior (Navaneetham & Dharmalingam, 2002; Babalola & Fatusi, 2009). Ignorance and hesitations for maternal healthcare during pregnancy are common factors that develop due to cultural practice and beliefs (Fenta, 2005; Ramarajan, 2011; Bhattacherjee, Datta, Saha, & Chakraborty, 2013). Due to hesitations (such as- fear of doctors, communicating with doctors, unfamiliar hospital environment and surroundings) the patients prefer to go for traditional healers or local health facilities instead. Despite being diagnosed with anemia and related symptoms, they ignore all these illnesses (for example: edema, pale skin, dizziness and hypertension etc.) as these are not considered as serious health problems. They believe these are the common experience of a pregnant woman. Our study complements such observations.

Other factors such as long queue, non-availability of person at home and heavy workloads are found to be significant barriers. About 26 percent of respondents want to avoid standing in a long queue for the regular check-up at health institutions. The foregone opportunity cost, either in terms of heavy household duties (such as working in paddy fields, cooking, housekeeping, childcare, elder care etc. which nobody can share) or loss of daily wages from their workplace outside the home is a major deterrent. Such heavy household responsibilities prevent women from visiting health institutions for regular check-up. Most of the time, they continue their work until their time of labour and resume work shortly after their delivery. Pregnant women do not want to stay longer in health institutions after her delivery (required for minimum time frame is 48 hours after delivery), because of non-availability of attendants in the hospitals, cost of lodging and food of attendants and non-availability of person at home for looking after their family.

Patients often do not find any person to accompany them to the hospitals at the time of emergency or for a regular check-up in the last month of their pregnancy: husbands are not available at home during day time and neighbours are busy with their daily household activities. These results of the present study are consistent with observation from studies in other contexts. Yiran et al., (2015) examined the challenges that the migrant women encounter in the process of seeking maternal health care in Ghana. They found that long queue and waiting times at health facilities are one of the factors that affecting accessibility to maternal health care services. Simkhada (2010) in the context of Nepal, pointed out that women have to work hard even during their pregnancy which does not allow them to attend antenatal care services from health institutions. Studies in Ethiopia, India, Nigeria, Zimbabwe, and Vietnam revealed the lack of antenatal care is one of the risk factors for maternal mortality in these countries (Marilyn,1996; Bloom, Theo, & Wypij, 1999). Absence of persons at home to take care of pregnant women during the period of pregnancy is another significant barrier.

6.6. Conclusion:

This chapter discusses the factors influencing health seeking behavior among sample population. The result shows that the health seeking behavior of an individual is influenced by organizational factors such as non-availability of female health providers and ambulances, cultural factors viz. ignorance, hesitations and socioeconomic factors such as long queue, non-availability of persons at home, heavy workloads.

Sometimes distinction between the various factors are blurred, or point to some other problems. Long queue, for example, can be result of inadequate provision of medical facility compared to number of patients. Non availability of female health providers could be a problem with organization as well as a cultural factor. Cultural factors point to a social setting where the “value” of women is less as a person due to (already entrenched) patriarchal biases. Such patriarchal biases work through heavy workload which nobody is willing to share because the workload is a woman’s job and duty at the same time.

From the discussion, it is clear that health promotion action needs to expand the focus beyond individual behavior to the people’s social interactions and immediate environments. Considering the availabilitiy, accessibility and affordability of health

services, local and context-specific needs to be taken care of. In addition to encourage utilzation, ensuring availability of physical infrastructure and female health providers, community level awareness and maternal education are needed. This will help the population to upgrade their knowledge and perception towards women reproductive health issues. Along with that, frequent visit of ASHA workers during last trimester of pregnancy is important, so that women can get assistantance at the time of emergency. This will reduce the problem of non-availability of the person at home.

Appendix

Table 6.3.A: ***Effective Sample Sizes of all Variables***

	ESS	Corr.time	Efficiency
Seeking care			
Far from home	2113.61	5.68	0.1761
Bad roads	2709.58	4.43	0.2258
Doctors not responsive	1941.9	6.18	0.1618
Non-Availability of ambulance	2158.74	5.56	0.1799
Non-Availability of female health provider	1357.69	8.84	0.1131
Husband restriction	2125.13	5.65	0.1771
Hesitation	1587.17	7.56	0.1323
Ignorance	1973.57	6.08	0.1645
Cost of drugs	1896.86	6.33	0.1581
Cost of transportation	1511.27	7.94	0.1259
Long queue	1123.91	10.68	0.0937
Non availability of person at home	1873.47	6.41	0.1561
Heavy workload	1729.66	6.94	0.1441
Land ownership	1313.51	9.14	0.1095
Literacy	787.4	15.24	0.0656

Note: **ESS** = effective sample size i.e. the number of effectively independent samples from the total number of posterior samples collected that the Markov chain is equivalent to.

Corr. time: Correlation times i.e. an estimated lag after which autocorrelation in an MCMC sample is small.

Efficiency: the lower the correlation times are and the higher the efficiencies are the better.

Chi-Squared Test for Variable Selection:

Given the variables, we would like to remove variables which are significantly associated with the others. We propose that perception about roads, perceptions about distance, non-availability of ambulance and cost of transportation are likely to be related with each other. To see the association between categorical variables, we propose a chi square test, the results of which are given below (Table 6.4.A)

Table 6.4 A: Chi-Squared (p-Value) for Selected Variables

	FH	BR	NAmb	CoT
Far from home (FH)	0	0.86	0.69	0.02
Bad roads (BR)	0.86	0	0.86	0.63
Non-availability of ambulance (NAmb)	0.69	0.86	0	0.27
Cost of transportation (CoT)	0.02	0.63	0.00	0

Since cost of transportation is significantly associated with far from home (distance perception) and non-availability of ambulance facilities, we can drop cost of transportation.

In a similar fashion, perceptions about organization such as non-availability of female health provider, unresponsive doctors are likely to be associated with each other. At the same time, such organizational shortfalls may spill over cultural factors like husband restriction, hesitation, and ignorance about health facilities. The results are reported in Table 6.5. A:

Table 6.5 A: Chi-Squared (p-Value) for Selected Variables

	DnR	NAFhP	HR	Hesi	Ign
Doctors not responsive (DnR)	0	0.80	0.01	0.74	0.79
Non-availability Female health provider (NAFhP)	0.80	0	0.00	0.19	0.93
Husband restriction (HR)	0.01	0.00	0	0.59	0.66
Hesitation (Hesi)	0.74	0.19	0.59	0	0.55
Ignorance (Ign)	0.79	0.93	0.66	0.55	0

Result indicates that husband restriction is significantly associated with non-availability of female health providers and unresponsive doctors. We drop husband restriction from the model.

Similarly, non-availability of person at home, long queue and heavy workload are likely to be related. So, we run chi square test with these variables (Table 6.6.A). Result shows that none of the variables are significantly associated. We keep all these three variables in our model.

Table 6.6 A: Chi-Squared (p-Value) for Selected Variables

	LQ	**NAPaH**	**HW**
Long queue (LQ)	0	0.23	0.92
Non-availability of person at home (NAPaH)	0.23	0	0.24
Heavy workload (HW)	0.92	0.24	0

Traditional Logit model:

note: farfromhome != 0 predicts success perfectly

farfromhome dropped and 5 obs not used

note: badroads != 0 predicts success perfectly

badroads dropped and 1 obs not used

note: doctorsnotresponsive != 0 predicts success perfectly

doctorsnotresponsive dropped and 2 obs not used

note: availabilityofambulance != 0 predicts success perfectly

availabilityofambulance dropped and 5 obs not used

note: femalehealthprovider != 0 predicts success perfectly

femalehealthprovider dropped and 19 obs not used

note: hesitation != 0 predicts success perfectly

hesitation dropped and 9 obs not used

note: ignorance != 0 predicts success perfectly

ignorance dropped and 5 obs not used

note: costofdrugs != 0 predicts success perfectly

costofdrugs dropped and 18 obs not used

note: longqueue != 0 predicts success perfectly

longqueue dropped and 13 obs not used

note: nonavailabilityofpersonathome != 0 predicts success perfectly

nonavailabilityofpersonathome dropped and 19 obs not used

note: heavyworkload != 0 predicts success perfectly

heavyworkload dropped and 6 obs not used

Table 6.11 A: Logit regression for not seeking care with associate variables

Variables	Not Seeking care	
	Odd ratio (Std. err.)	z
Far from home	1 (Omitted)	
Bad roads	1 (Omitted)	
Doctors not responsive	1 (Omitted)	
Ambulance facilities	1 (Omitted)	
Female health provider	1 (Omitted)	
Husband restriction	1 (Omitted)	
Hesitation	1 (Omitted)	
Ignorance	1 (Omitted)	
Cost of drugs	1 (Omitted)	
Cost of transportation	1 (Omitted)	
Long Queue	1 (Omitted)	
NA person at home	1 (Omitted)	
Heavy household work	1 (Omitted)	
Literacy	1.54 (1.381)	0.49
Landownership	1.23 (.3281)	0.80
No of observation	67	

CHAPTER VII

Summary of Findings, Conclusions and Policy Suggestions

The present chapter provides a conclusion to the discussions, debates and analysis of maternal health and maternal mortality in Assam. Mothers' health during pregnancy and post-partum is associated with well-being of her infant. Hence, identifying and treating health problems during pregnancy reduce future burdens on public health. Study of maternal health also indicates the sectors where scarce public money should be spent to improve health outcome. Given such a significance of maternal health, the analysis of this thesis reflects a broad view of contemporary maternal health scenario of Assam. Maternal mortality is a key indicator for assessing social status of women, socio-economic development and degree of access to healthcare services. One of the Sustainable Development Goals (SDG) 2015, targets to reduce maternal deaths to less than 70 per 1, 00,000 live births by 2030.

As per Sample Registration System (SRS) 2013, Assam exhibits highest MMR in India (300 versus 167 per 1, 00,000 live births at national level). Although this rate has dropped significantly from 598 during 1997-98, the persistence remains a concern. Government of Assam and India have taken initiatives to reduce the number of maternal deaths by emphasizing on antenatal and postnatal care to pregnant women under the supervision of trained medical staff and nurses in health institutions. Utilization of these maternal health care services depends highly on socio-economic interactions and immediate social environment than the decision of a pregnant woman herself. Mere provision of health care facilities does not translate into utilization of these services. Keeping this background in mind, the broad objective of the thesis is to analyze such persistence of high maternal mortality rate at district level in Assam.

In order to achieve this objective, the study makes an attempt to investigate the maternal mortality at a disaggregated level. First, we investigate to what extent, factors that have been identified by theoretical literature fits the data from districts in Assam. Next, we move to disaggregated level through sampling. The same question is re-iterated in terms

of maternal anemia, which proxies for maternal health. Third, we examine the factors that shape maternal health seeking behavior.

In sum, the present thesis attempts to answer questions such as-

- Why the study of maternal health is significant to public health system (particularly in Assam)?
- What are the context-specific factors responsible for maternal deaths at community level?
- What are the linkages between maternal complications, health seeking behavior and improvement of maternal health outcome?

In order to answer these questions, it is important to have current knowledge on maternal health scenario in Assam. Initial chapters are devoted to the present situation of maternal health care and the analysis of factors determining poor maternal health care. The following section includes summary of the findings of the study.

7.1. Summary of the Findings:

Literature review presented in Chapter 2. It attempts to identify the factors influencing of maternal mortality. Identification of key factors is a prelude to pursue strategies to improve maternal health. One group of studies have advocated the supply side policies- access to Emergency Obstetric Care (EmOC) at health intuitions including the trained midwives and availability of drugs are major interventions in reduction of maternal mortality. Another set of literature has focused on the demand side of the health care services in terms of utilization of health institutions. Both the demand and supply-side factors are important to improve the maternal health outcome. The chapter provides a theoretical insight to identify context-specific factors of maternal health. Assam automatically becomes a choice of research because of the persistence of high maternal death coupled with existence of limited (in number as well as in scope) studies. We propose to fill the gap in this research. .

Chapter 3 discusses maternal health scenario in Assam. The data here is taken from Government reports and publications. Hemorrhage is found to be prominent among the direct medical causes of maternal deaths while anemia is a major contributor to indirect

causes of deaths. Given limited number of data points, rank correlation was computed to examine the relationship between MMR and socioeconomic variables and maternal care facilities. To supplement results derived from the rank correlation, we group the districts according to MMR and other explanatory variables. Then, using ANOVA, we try to see if there are any significant differences among the clusters. The preliminary result is puzzling in the sense that maternal mortality rate is higher in districts with better socioeconomic conditions and better availability of maternity care. Such puzzling results have also surfaced elsewhere under different context (Alauddin, 1986; Srinivasan, 2016). The basic message is, macro (district level) data is probably a bad choice for analyzing maternal mortality. One needs to look for data generated at a more disaggregated level.

In chapter 4, the details of field selections, data collection and the broad profile of sample villages are described. The survey was carried out in eight villages of four districts of Assam that were identified by multi-stage sampling. By using stratified sampling methods, all districts under four Administrative Divisions of Assam were arranged from highest to lowest based on maternal mortality ratio (MMR) for the period of April 2013 and March 2014. This helped us identify four districts with highest MMR- Kamrup, Dibrugarh, Sonitpur and Cacher. From each district, we selected which Block Primary Health Centers (BPHC) has reported the highest maternal death. Finally, as per reference with the Medical Officer (MO) from selected BPHC, two villages from each BPHC (total 8 villages) were selected purposively for carrying out the survey. Employing snowball sample techniques we interviewed the following from each sample village

- Currently pregnant women
- Mothers who have children aged 0-24 months
- Members of families who have experienced of maternal deaths.

We interviewed 169 subjects. The survey period was from September 2014 to February 2015 with the reference period of 365 days preceding the date of the survey.

Immediate determinants of maternal death cases and maternal health outcomes are analyzed in chapter 5. It is observed that maternal anemia is highly prevalent and so are maternal complications (including maternal death). A chi-squared test was performed to test for degree of association between maternal complications and anemia, and the

association turned out to be significant. In what follows, we have used the level of hemoglobin as a proxy for maternal health. The concentration of hemoglobin level is an important indicator of iron status, i.e. anemia or iron deficiency during pregnancy is leading cause of maternal mortality. We also investigate bioavailability of iron and its impact on lower concentration of hemoglobin level. Higher fraction of non-heme products in daily diet lowers the absorption of iron, resulting poor iron status in red blood cell and that leads to lower hemoglobin level. Next, an OLS robust standard error model has been used to examine the socioeconomic determinants of hemoglobin level. The result revealed socio-economic factors affecting the lower level of hemoglobin is significantly associated with literacy, land ownership and tea garden habitats. However, evidence in favor of literacy rate (in terms of level of significance) is a bit weak.

Chapter 6 deals with the reproductive health seeking behavior of the sample. As observed from chapter 5, majority of women in studied areas are suffering from maternal complications due to anemia and related health conditions. Ceteris paribus, these conditions are easily prevented with regular and simple check-ups. Therefore, this chapter investigates the factors affecting maternal health seeking behavior. It is found that there is very low utilization of maternal care services among women in the studied villages. Broad reviews on maternal health seeking behavior and important barriers identified by previous literature are presented in this chapter. To deduce relevant barriers in our sample, we undertake an analysis based on Bayesian logistic regression. The most important findings are that non-availability of ambulance and female health providers; ignorance and hesitation; long queue at facilities, non-availability of persons at home and heavy workload are main barriers of maternal health seeking behavior.

7.2. Conclusions and Contributions:

The main thrust of the thesis is to investigate the determinants of high maternal mortality in Assam at disaggregated level. To facilitate this objective, the thesis proceeds with answering three important questions: analysis of maternal mortality at district level based on secondary data. Second, what are socioeconomic determinants of maternal complications at micro level? Third, what are the factors conditioning demand for reproductive health care at micro level?

The district level analysis outlined in chapter 3 tried to achieve the first objective i.e. through analyzing the macro data. The discussion of this chapter reveals that maternal mortality is higher in better off districts in terms of socioeconomic conditions and maternal care facilities, which is puzzling and challenges the conventional inverse relationship. Chapter 5 has dealt with maternal deaths at disaggregated level. We found that maternal anemia, the main cause of maternal deaths and maternal illness, results from socioeconomic factors as well as the low iron bioavailability in dietary intake. Existing literature on Assam did not have anything similar.

Further, chapter 6 has engaged with the third objective i.e. the demand for maternal health care in order to identify the barriers to maternal health seeking. The findings showed that major barriers can be captured under broad categories of organizational, cultural and socioeconomic factors. We believe that such a comprehensive study was not done previously for Assam.

Given this, we can venture the hypothesis that objective of the thesis has been successfully addressed.

7.3. Policy Implications:

Based on those results, one of the major implications of our thesis is that health policymakers should consider context specific factors for adverse maternal outcome. This will help in taking an effective preventive measure and a better target for improvement of hemoglobin level among the pregnant women at disaggregated level rather than universal, "one-size-fits-all" type intervention, for example, distribution of iron tablets. The study also points out that low iron bioavailability and imbalanced diet in daily intake has influential impact on iron status of women particularly during pregnancy and postpartum period. Food-based approach could be considered as one of the effective interventions for multi-nutritional benefits through cooperative efforts from both Government and non-government organizations. Encouraging the households for home gardening, animal husbandry may result in long-term improvement of iron status and lead to better health outcome.

The second implication of the study is that individual's health seeking behavior is influenced by an immediate practical environment. The mere provision of health care

facilities does not translate into practice, as the health attainment requires behavioral change of population. The present study shows that along with organizational determinants, cultural and socio-economic factors are the strong predictors of seeking medical help during pregnancy. Therefore, the heath promotion needs to include individual behavior, social interactions and immediate environments to encourage health seeking behavior of the population. Based on the present result, to encourage people to seek medical help, ensuring availability of physical infrastructure and female health providers, spreading community level awareness and maternal education are needed.

Another indirect implication of this study is that it provides an application of the framework of three delays. We show that two main delays are there: such as delay in decision to seek care and delay in receiving adequate health care in the studied areas. Delay in decision to seek care is largely due to lack of awareness and ignorance (most of the time) about the dangerous signs of anemia and related symptoms during pregnancy. Delay in receiving adequate health care is the result of lack of ambulance facilities and female health providers. Such evidence underlines the policymakers' reasons for delay in seeking care and where public money should be spent to improve maternal health outcome.

Finally, the implication of the study in improving maternal outcome is based on preventive measures for maternal anemia. The preventive measures can be understood on context-specific factors, community level awareness and maternal education, frequent visits of health personnel to pregnant women of the respective villages. This study adds new results in existing literature of determinants factors of maternal mortality. In this regard, land ownership and living in non-tea garden habitat are important for reducing the incidence of maternal anemia at disaggregated level.

7.4. Future Scope of the Research:

Given the time constraint, our sample constituted only eight villages from four districts. One can make the study more comprehensive by increasing the sample size, in terms of time frame, villages and districts, i.e. a panel over time. The current study has used structured questionnaire to carry out the household level door-to-door survey. Adding to

that, focus group discussion will give more opportunity to interrogate with stakeholders of the society.

Based on the findings of this study, further research can examine the efficiency of investment in the maternal health sector to address these identified factors at disaggregated level. Further, discussions of this study can be utilized in study of nutritional status and its impact on women during pregnancy and after childbirths. Additionally, model-based result of the present analysis provides suggestion to future studies to include more explanatory variables of maternal health for higher level of generalization.

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