Internship Training
At
Piramal Swasthya Management and Research Institute (Patna, Bihar)



(16 March – 16 June 2026)

A Report

By

Ayush Vardhan
On
Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar.

Under guidance of
Dr. Anandhi Ramachandran

PGDM (Hospital and Health Management)
2024-2026



International Institute of Health Management Research

Internship Training
At
Piramal Swasthya Management and Research Institute (Patna, Bihar)

(16 March – 16 June 2026)

A Report

By

Ayush Vardhan
On
Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar.

Under guidance of
Dr. Anandhi Ramachandran

PGDM (Hospital and Health Management)
2024-2026

International Institute of Health Management Research

(Completion of Internship Training from Piramal Swasthya)

The certificate is awarded to

Name: Ayush Vardhan

In recognition of having successfully completed
his/her Dissertation in the department of

RMLE

and has successfully completed her Project on Title of:
Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar.

Date: 16th March – 16th June 2026.

Organization: Piramal Swasthya Management and Research Institute

He/She comes across as a committed, sincere & diligent
person who has a strong drive & zeal for learning

We wish him/her all the best for future endeavors

Organization Supervisor
Head

Head-HR/Department

Piramal Swasthya Management and Research Institute
Head Office: 3rd Floor, No. 6-3-1112, Oyster Complex,
Greenlands Road, Somajiguda, Begumpet, Hyderabad – 500 016
piramalswasthya.org

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Ayush Vardhan student of PGDM (Hospital & Health Management) from International Institute of Health Management Research, New Delhi has undergone internship training at Piramal Swasthya Patna, Bihar from 16th March to 16th June 2026. The Candidate has successfully carried out the project designated to him during internship training and his/her approach to the study has been sincere, scientific and analytical.

The Internship is in fulfillment of the course requirements. I wish him all success in all his/her future endeavors.

Dr. Punit Yadav
Academic and Student Affairs
IIHMR, New Delhi

Dr. Anandhi Ramachandran
Mentor
IIHMR, New Delhi

Certificate of Approval

The following dissertation titled **"Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar."** at **"Piramal Swasthya Patna, Bihar"** is hereby approved as a certified study in management carried out and presented in a manner satisfactorily to warrant its acceptance as a prerequisite for the award of **PGDM (Hospital & Health Management)** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

Dissertation Examination Committee for evaluation of dissertation.

Name	**Signature**
Ekta Saroha	
Dr. Mukesh Ravi Raushan.	

Certificate from Dissertation Advisory Committee

This is to certify that **Mr. Ayush Vardhan,** a graduate student of the **PGDM (Hospital & Health Management)** has worked under our guidance and supervision. He is submitting this dissertation titled **"Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar."** at **"Piramal Swasthya Patna, Bihar"** in partial fulfillment of the requirements for the award of the **PGDM (Hospital & Health Management).**

This dissertation has the requisite standard and to the best of our knowledge no part of it has been reproduced from any other dissertation, monograph, report or book.

Dr. Anandhi Ramachandran
Professor
IIHMR, Delhi

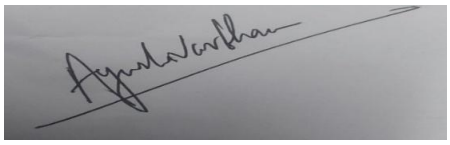
Dr. Tanmay Mahapatra
Director, Data and Learning,
Piramal Swasthya

INTERNATIONAL INSTITUTE OF HEALTH MANAGEMENT RESEARCH, NEW DELHI

CERTIFICATE BY STUDENT

This is to certify that the dissertation titled **Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar** and submitted by **Ayush Vardhan** Enrollment No. **PG/24/020** under the supervision of **Dr. Anandhi Ramachandran** for award of PGDM (Hospital & Health Management) of the Institute carried out during the period from 16th March 2026 to 16th June 2026 embodies my original work and has not formed the basis for the award of any degree, diploma associate ship, fellowship, titles in this or any other Institute or other similar institution of higher learning.

Signature:



FEEDBACK FORM

(Mentor: IIHMR)

Name of the Student: Ayush Vardhan

Name of the Organization in Which Dissertation Has Been Completed: Piramal Swasthya Management and Research Institute, Patna, Bihar.

Area of Dissertation: Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar.

Attendance: Complete (100%)

Objectives Met: Yes, Report & ppt made & submitted

Deliverables: Report
presentation

Strengths: Proactive in starting new activities & learning new concepts

Suggestions for Improvement: Should avoid procrastination

Suggestions for Institute (Course Curriculum, Industry Interaction, Placement, Alumni):

—

Date: 14 June 2026
Place: Patna Bihar

Signature of the Officer-in-Charge (Internship)

FEEDBACK FORM

(Organization Mentor)

Name of the Student: Ayush Vardhan

Name of the Organisation in Which Dissertation Has Been Completed: Piramal Swasthya Management and Research Institute, Patna, Bihar.

Area of Dissertation: Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar.

Attendance: Perfect adherence to internship norms.

Objectives Met:

- Applied public health research and data analysis skills in real-world projects.
- Conducted data quality assurance through MWRA backchecks.
- Developed reports, presentations, and literature reviews.
- Strengthened understanding of RMNCAH and adolescent health programs.

Deliverables:

- MWRA backcheck reports and data quality summaries.
- MAI district-wise and consolidated analysis reports.
- Adolescent health descriptive analysis and PPT.
- Literature review reports and case study documentation.
- Dissertation research outputs and presentations.
- Data support for Bihar story ppt.

Strengths:

- Strong analytical and reporting skills.
- Attention to data quality and accuracy.
- Effective documentation and presentation preparation.
- Quick learner and adaptable team member.

Suggestions for Improvement:

- More exposure to field implementation activities.
- Increased involvement in advanced statistical analysis.
- Greater participation in stakeholder review meetings.

Suggestions for Institute (Course Curriculum, Industry Interaction, Placement, Alumni):

- Provide more live projects and field-based learning opportunities.

Date: 14 June 2026
Place: Patna Bihar



Signature of the Officer-in-Charge (Internship)

INTERNATIONAL INSTITUTE OF HEALTH
MANAGEMENT RESEARCH (IIHMR)
Plot No. 3, Sector 18A, Phase- II, Dwarka, New Delhi- 110075
Ph. +91-11-30418900, www.iihmrdelhi.edu.in

CERTIFICATE ON PLAGIARISM CHECK

Name of Student (in block letter)	**Dr./Mr./Ms.: Ayush Vardhan**		
Enrollment/Roll No.	PG/24/020	**Batch Year**	2024-26
Course Specialization (Choose one)	Hospital Management	Health Management	Healthcare IT
Name of Guide/Supervisor	Dr / Prof.: **Dr. Anandhi Ramachandran**		
Title of the Dissertation/Summer Assignment	**Distribution and Determinants of Antenatal Care and Birth Preparedness among Pregnant Women in Rural Bihar.**		
Plagiarism detect software used	**"TURNITIN"**		
Similar contents acceptable (%)	Up to **15** Percent as per policy		
Total words and % of similar contents Identified	17776 Words and **12%.**		
Date of validation (DD/MM/YYYY)	06/05/2026		

Guide/Supervisor
Name: **Dr. Anandhi Ramachandran**
Signature:

Student
Name: **Ayush Vardhan**
Signature:

Report checked by

Institute Librarian
Affairs)

Signature:
Date:
Library Seal

Dean (Academics and Student

Signature:
Date:
(Seal)

A.2) Organization Profile:

Piramal Foundation creates creative answers to problems that stand in the way of India's economic potential being fully realized. India has started the process of guaranteeing universal health coverage, and Piramal Swasthya is helping with that by using its experience and knowledge of creating ground-breaking solutions that have a big impact. The goal of Piramal Swasthya is to close the gaps in public healthcare by supporting and enhancing the Government of India's plan to achieve universal health coverage. One of the biggest non-profits in India's primary public healthcare sector, Piramal Swasthya focuses on non-communicable diseases, maternal health, and child and adolescent health.

Piramal Swasthya (a subsidiary of Piramal Foundation) is among the largest not-for-profit primary public healthcare organisations in India. With more than ten years of expertise, Piramal Swasthya has managed several healthcare innovations at scale that are meeting the primary healthcare requirements of most India's underprivileged and Marginalised communities. Through 35 creative public healthcare delivery schemes, Piramal Swasthya operates in 21 Indian states and has provided services to over 112 million beneficiaries to date. Over 2500 workers, including more than 250 physicians, are employed by Piramal Swasthya and collaborate with Seva Bhav.

The Group's key values-Knowledge, Action, Care, and Impact-direct the organization as it fulfills its social obligations.

Acknowledgements

I am deeply grateful for the invaluable learning and career development opportunity I received during my internship training with the **Piramal Swasthya Foundation in Bihar**. Being part of this initiative was a truly enriching experience, and I consider myself fortunate to have engaged with such dedicated professionals and experts who supported me throughout this journey.

I would like to extend my heartfelt thanks to **Dr. Tanmay Mahapatra** (Director, Data and Learning, Piramal Swasthya Management and Research Institute), for their consistent guidance, encouragement, and valuable insights. Their mentorship played a vital role in the successful completion of my project, and I am sincerely appreciative of their contributions.

I am also thankful to **Dr. Shuchi Sree Akhouri** for his supervision and to **Mr. N.S. Reddy**, **Mr. Saurabh Kumar** and **Mr. Ashish Kashyap** for their assistance, collaboration, and support in providing the data and direction necessary for this study.

A special note of gratitude to my mentor, **Dr. Anandhi Ramachandran** (Assistant Professor, IIHMR Delhi), whose continuous support was instrumental in shaping both the academic and field components of my work. I also wish to thank **Dr. Sutapa Bandyopadhyay Neogi** (Director, IIHMR Delhi) and **Dr. Punit Yadav** (Associate Dean, Academics and Student Affairs, IIHMR Delhi) for their encouragement and valuable feedback.

This internship has been a significant milestone in my professional development. I am committed to applying the knowledge and skills I have gained and will continue striving for excellence in my future endeavors. I look forward to future opportunities to collaborate with many of you again.

Ayush Vardhan

Contents

Chapter 1: Introduction 1
Background 1
1.1 Problem Statement 3
Study Objectives 4
Rationale: 4
CHAPTER 2: Literature review 5
Overview 5
2.1 Global Burden of Maternal Mortality and the role of Antenatal care 5
2.2. Utilization of antenatal care services, prevalence and patterns: 6
2.2.1 Global and Regional Estimates 6
2.2.2 South Asian Context 7
2.3 Birth Preparedness and Complication Readiness: Conceptual Framework and Measurement 10
2.3.1 Conceptual Framework 10
2.3.2 Global prevalence of preparation for and responding to birth complications 11
2.3.3 Birth Preparedness and Complication Readiness in South Asia 12
2.3.4 Determinants of Birth Preparedness and Complication Readiness 12
2.4 Linkages between ante natal care and birth preparedness. 14
2.5 Contextual Factors Influencing Maternal Healthcare Utilization 15
2.5.1 Rural-Urban Differences 15
2.5.2 Socioeconomic Determinants 15
2.5.3 Health System Factors 16
2.6 Outcomes Associated with Antenatal Care and Birth Preparedness 17
2.7 Gaps in Literature and Rationale for the Present Study 19
2.8 Summary 20
Chapter 3: Methodology 21
3.1 Study Objectives 21
3.1.1 Specific Objectives 21
3.2 Study Design 22
3.3 Study Area 22
3.4 Study Population 23
3.5 Sampling Design 23
3.6 Sample Size and Analytical Sample 23
3.7 Literature Search Strategy 24
3.7.1 Population"[Mesh]) AND ("India"[Mesh] OR Bihar)) 24
3.8 Data Collection Platform 24

3.9 Data Management and Cleaning 24
3.10 Study Variables 25
3.10.1 Dependent Variables 25
3.10.2 Independent Variables 25
3.11 Statistical Analysis 25
3.12 Ethical Considerations 26
Chapter 4 26
4.1 Results overview 26
4.2 Socio-demographic and Obstetric Characteristics of the Study Population 26
4.2.1 Antenatal Care Indicators 27
4.2.2 Frontline Health Worker Counselling 27
4.2.3 Birth Preparedness Practices 28
4.3 Bivariate Analysis 29
4.3.1 Bivariate Analysis: Determinants of Receiving ≥4 ANC Visits 29
4.3.2 Bivariate Analysis: Determinants of Adequate Birth Preparedness 32
4.4 Multivariable Logistic Regression Analysis 34
4.4.1 Determinants of Receiving ≥4 ANC Visits 34
4.4.2 Determinants of Adequate Birth Preparedness 36
4.5 Summary of Chapter Findings 37
CHAPTER 5: DISCUSSION 38
5.1 Overview of the Study Findings 38
5.2 Antenatal Care Utilization and Its Determinants 38
5.3 Birth Preparedness and Complication Readiness and Its Determinants 39
5.4 Association Between Antenatal Care Utilization and Birth Preparedness 40
5.5 Programmatic and Policy Implications 41
5.6 Strengths and Limitations 42
CHAPTER 6: Conclusion and Recommendations 42
6.1 Conclusion 42
6.2 Recommendations 43
6.2.1 Policy Level 43
6.2.2 Health System Level 43
6.2.3 Community Level 44
6.2.4 Programmatic Level 44
6.2.5 Future Research 44
Supplementary 45
Appendix ..... **Error! Bookmark not defined.**
A.1 Evidence Table 45

A.2 Indicator Matix 45
A.3 SAS code 45
Bibliography 46

List of Figures

Figure No.	Title	Page No.
Figure 3.1	Map of the Study Area Showing Administrative Divisions of Bihar	22

List of Tables

Table No.	Title	Page No.
Table 4.1	Distribution of Socio-demographic, Obstetric and Health System Characteristics of Respondents and Crude Prevalence of 4+ ANC Visits and Adequate BPCR	27
Table 4.2	Association Between Socio-demographic Factors and 4+ ANC Visits	29
Table 4.3	Association Between Socio-demographic Factors and Adequate BPCR	32
Table 4.4	Association Between Obstetric and Health System Factors and 4+ ANC Visits	30
Table 4.5	Association Between Obstetric and Health System Factors and Adequate BPCR	33
Table 4.6	Multivariable Logistic Regression Analysis of Determinants of 4+ ANC Visits	34
Table 4.7	Multivariable Logistic Regression Analysis of Determinants of Adequate BPCR	36
Table 4.8	Association Between Antenatal Care Utilization and Birth Preparedness and Complication Readiness	37

List of Symbols and Abbreviations

Abbreviation/Symbol	Full Form
ANC	Antenatal Care
BPCR	Birth Preparedness and Complication Readiness
ASHA	Accredited Social Health Activist
CHW	Community Health Worker
DHS	Demographic and Health Survey
EAG	Empowered Action Group
GOI	Government of India
JSY	Janani Suraksha Yojana
JSSK	Janani Shishu Suraksha Karyakram
PMSMA	Pradhan Mantri Surakshit Matritva Abhiyan
NFHS	National Family Health Survey
WHO	World Health Organization
LMIC	Low- and Middle-Income Country
PSU	Primary Sampling Unit
SSU	Secondary Sampling Unit
RMLE	Research Methods and Learning Experience
SAS	Statistical Analysis System
MNCH	Maternal, Newborn and Child Health
CI	Confidence Interval
LCI	Lower Confidence Interval
UCI	Upper Confidence Interval
OR	Odds Ratio
COR	Crude Odds Ratio

AOR	**Adjusted Odds Ratio**
RR	**Relative Risk**
SD	**Standard Deviation**
IFA	**Iron and Folic Acid**
TT	**Tetanus Toxoid**
PHC	**Primary Health Centre**
SC	**Sub-Centre**
OBC	**Other Backward Classes**
SC/ST	**Scheduled Castes/Scheduled Tribes**
N	**Total Sample Size**
n	**Frequency/Number of Respondents**
%	**Percentage**
χ^2	**Chi-square Statistic**
p	**Probability Value (p-value)**
≥	**Greater than or Equal to**
≤	**Less than or Equal to**
95% CI	**95 Percent Confidence Interval**

Chapter 1: Introduction

Background

Maternal health remains a major public health priority worldwide and serves as an important indicator of the effectiveness of healthcare systems and overall socioeconomic development. Despite significant reductions in maternal mortality over the last two decades, preventable maternal and neonatal deaths continue to occur disproportionately in low- and middle-income countries (LMICs). These disparities are largely attributed to inequitable access to healthcare services, socioeconomic inequalities, and weaknesses in health systems. Although widespread global measures have led to significant instances of maternal mortality reduction in the last 20 years, avoidable maternal and newborn deaths still occur at a disproportionately high ratio in the low- and middle-income countries (LMICs), indicating a systemic inequality in access to quality healthcare, socioeconomic inequalities, and structural inefficiencies in the health systems (1-5). The use of antenatal care (ANC), birth preparedness and complication readiness (BPCR) is also one of the most efficient strategies to combat such problems because both techniques consider the preventative and the emergency aspects of maternal healthcare.

It is generally accepted that antenatal care is one of the most important platforms of maternal healthcare provision of detecting and managing pregnancy-related complications, nutritional supplementation, immunization and health education. The recommendation by the World Health Organization is a minimum of eight ANC contacts that require making sure that the pregnancy process is a positive experience and that the health outcomes are better. Nevertheless, as has been observable globally, the usage and quality of ANC services continue to be insufficient especially in rural and underserved regions in LMICs (2, 3, 6). Research based on Demographic and Health Survey (DHS) statistics and national surveys indicate that a low percentage of women have adequate ANC, and large proportions of women have significant disparities in socioeconomic, demographic, and geographic groups (1-5).

The ANC utilization determinants are multifactorial and function at personal, family, and community level. The association with ANC uptake has always been reported to be significant with maternal age, educational attainment, parity, marital status, and employment (2, 7-10). Mother education is one of the strongest determinants that can increase the knowledge and autonomy among women and their capacity in negotiating healthcare systems (4, 5, 7). Housing wealth also determines the ability to pay healthcare

services and other related expenses that include transport and medicines (2, 10). The other dimension that is critical is geographic location in that rural women have significantly reduced access to quality ANC than urban women due to the lack of proper infrastructure, transport, and lack of qualified health services (1, 8, 9). In addition to accessibility, the quality of ANC services should also be addressed; in numerous LMICs, the lack of access to ANC services is accompanied by their severe insufficiency associated with blood pressure checks, laboratory testing, and counseling and discourages the use and trust that women have in health systems (6, 11).

Birth preparedness and complication readiness is an active process that is used to outline plans of giving birth and preparing in case of obstetric crises to the pregnant women and the family. The key BPCR components are finding a qualified birth attendant, the birth facility, the delivery transport, the saving of finances required in the delivery process, and the signs of danger during pregnancy and birth. BPCR is especially critical in rural and resource-limited environments, in which the delay in seeking, reaching, and receiving care is one of the important factors in maternal mortality. BPCR practices have not been optimized in most settings even though their significance is acknowledged. The community and facility-based studies that are held in Ethiopia, Uganda and Ghana, Thailand and Somaliland are in constant agreement that among pregnant women the level of birth preparedness, the absence of awareness on danger signs and the lack of emergency arrangements, frequently occurs (12-17). According to the systematic reviews and meta-analyses, maternal education, danger sign awareness, parity, residential location, and ANC usage are important determinants of BPCR practices (18-22). The ability and desire of women to participate in birth preparedness is further determined by sociocultural influences through the restraining gender roles, family decision-making processes, and community ideas (23).The connection between the application of ANC and BPCR is quite well-developed in the literature. ANC contacts are one of the vital possibilities' healthcare providers should have to help women be aware of danger signs, birth planning, and preparedness to an emergency. Those women that initiate ANC early and continue high attendance are always more prone to engage in sufficient BPCR (20, 24, 25). The evidence that counseling and health education provided as part of the ANC services is a key contributor to enhancement of the preparedness to birth behaviours cannot be ignored, which in turn supports the idea that enhancing the quality and coverage of ANC services by making them crucial not just in preventing cases, but also in facilitating the development of emergency preparedness (11, 26). Maternal health is an area where national focus has been long-standing and such flagship programmes as the

Janani Suraksha Yojana (JSY), Janani Shishu Suraksha Karyakram (JSSK) and Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) have been established with the aim of increasing access to institutional delivery and antenatal care. Although over the years, ANC coverage on these programs has increased, per the National Family Health Survey (NFHS) results, the number of women receiving full and quality adjusted ANC is low with significant differences in states and sub-population groups (27, 28). The determinants of ANC use that were found to be important in the Indian population comprise maternal education, household wealth, caste, parity and media exposure, and disadvantaged populations such as women of lower caste and rural population are always less likely to receive recommended care (7, 28).

Bihar, which is one of the Empowered Action Group (EAG) states gives an especially alarming picture. Although ANC uptake has been progressively improving as recorded during the rounds of NFHS, the level of coverage and quality care in Bihar is still one of the lowest in the nation (29). An ANC quality-adjusted coverage survey of Bihar at the population level revealed that the largest share of ANC visits was below the standards of recommendations, and the essential gaps in service delivery factors such as blood pressure measurement, urine screening, and counseling were present (30). Such shortcomings are made worse by inadequate healthcare facilities, lack of qualified providers and strong socioeconomic limitations that define a large part of rural Bihar. Research conducted in similar contexts in rural India has created awareness on family support, distance to health facilities, media exposure, and unplanned pregnancies as being crucial risks to ANC uptake (8, 9, 31). Equally, the level of birth preparedness in rural Indian states like West Bengal, Karnataka and Uttar Pradesh is low with limited number of women having knowledge of danger signs, not having transport or emergency funds, and having no expectations that may occur in obstetrics (27, 32-34).

1.1 Problem Statement

Although several maternal health programmes have been implemented in India, substantial disparities continue to exist in the utilization of antenatal care services and birth preparedness practices, particularly in rural areas. Bihar continues to report lower maternal health indicators compared to many other Indian states. Inadequate antenatal care utilization and poor birth preparedness may increase the risk of maternal and neonatal complications. However, limited evidence is available regarding the determinants of antenatal care utilization and birth preparedness among pregnant women in rural Bihar.

Understanding these factors is essential for designing targeted interventions aimed at improving maternal health outcomes.

Study Objectives

General Objective

To examine the distribution and determinants of antenatal care utilization and birth preparedness among pregnant women in rural Bihar.

Specific Objectives

1. To examine socio-demographic factors associated with antenatal care utilization and birth preparedness.
2. To determine the association between antenatal care and birth preparedness practices.

Rationale:

In rural Bihar, there are still geographical, socio-economic and health system disadvantages preventing equitable access to maternal health services. The differences in education, family resources, parity and contact of the women with frontline health workers can have an impact on whether the women will get adequate antenatal care and take the necessary steps towards birth preparedness. The mechanisms of these factors in rural Bihar setting are important during the discovery of groups in the population that may need more programmatic focus. Available evidence in Bihar has mostly been on the coverage of antenatal care or directly on various selected maternal health indicators. There is limited population-based analysis conducted to evaluate the level of birth preparedness especially when considering the use of antenatal care. As birth preparedness practices are usually encouraged throughout the antenatal contacts, the study of these two elements together could reveal the information concerning the continuum of the maternal health service use in rural areas.

The overall assessment based on the community and rural based data in Bihar would provide an opportunity to explain the difference in the antennal care usage and birth preparedness level in different social-demographic groups. Thus, the proposed research will evaluate the percentage of antenatal coverage and birth preparedness, as well as the factors related to these variables in rural Bihar among women. The results are likely to lead to context-specific evidence to promote the interpretation of the service utilization tendencies and define the spheres in which the maternal health programmes in Bihar could use some reinforcement

CHAPTER 2: Literature review

Overview

Maternal and newborn health is currently and continually one of the greatest priorities globally and is especially high in low- and middle-income countries (LMICs) where the prevalence of preventable maternal morbidity and mortality continues to rise. A few interventions were highlighted as the most important ones needed to reduce this burden, most notably, antenatal care (ANC) use, birth preparedness and complication readiness were accorded wide attention in the public health literature.

This chapter draws on studies across a wide range of geographical and socioeconomic settings, with an onus on the Indian subcontinent, Sub-Saharan Africa and South Asia, to review and understand the evidence base around these three interconnected domains. The World Health Organization (WHO) recommends at least eight contacts of antenatal care, each of which includes a package of clinical examinations, health education and preventive interventions. Even in the light of this advice, quality ANC care is not widely available, especially in remote areas and among disadvantaged groups. At the same time, birth preparedness and complication readiness (BPCR) has become a key strategy of safe motherhood (SM) programming, targeting those who are pregnant, their families and communities, to prepare for safe childbirth and to identify warning signs. In this chapter, the evidence examined covers the factors affecting utilization of ANC and BPCR practices, the outcomes of ANC and BPCR experiences, and relationships between utilization of ANC and implementation of BPCR practices. A diversity of study designs was investigated in community-based cross-sectional studies, facility-based surveys, systematic reviews and meta-analyses of such studies, and intervention studies. The review is structured thematically, to give a coherent understanding of the evidence landscape and highlight gaps identified by the present study.

2.1 Global Burden of Maternal Mortality and the role of Antenatal care

Maternal mortality is still a very serious health concern worldwide: most of these deaths take place in South Asia and Sub-Saharan Africa. Most maternal deaths, due to haemorrhage, sepsis, eclampsia, obstructed labour and unsafe abortion, are preventable with prompt and effective maternal health services. Antenatal care is a pivotal moment to help contribute to the continuum of maternal care provision, helping to detect and prevent complications, advising women on warning signs and supporting referrals. There are

well-documented relationships between utilization of the ANC services and maternal and neonatal health outcomes in literature. The effectiveness of ANC provision has been consistently shown to be associated with delivery with a skilled birth attendant, utilization of postnatal care services and positive birth outcomes for women with adequate ANC coverage. In Ethiopia, Mohammed et al. (11) showed that ANC quality, as a predictor of SCBs, was directly linked to the use of SCBs through a longitudinal panel survey. This identification highlights not only the need for ANC services to be delivered in sufficient numbers, but of good quality. Although ANCs are believed to provide a clear benefit, low levels of coverage are being seen in many high burden places. The coverage of quality adjusted antenatal care is another large programmatic gap, as reported by Mohammed et al. (25) at the population level in Bihar, India. The study found that there are disparities in terms of the number of attendances to ANC, and in terms of source of care, even if women do attend ANC, the quality and quantity of the information they receive or self-provided is often inadequate. This is an ambitious double task of coverage and quality and requires a thorough assessment of factors influencing the utilization of ANC and of factors influencing the quality of ANC services.

2.2. Utilization of antenatal care services, prevalence and patterns:

2.2.1 Global and Regional Estimates

There is considerable variation at the global level in terms of coverage of ANC. There exist significant variations across and within countries in terms of ANC coverage. Although high income countries have reached a level of nearly universalization regarding the frequency of ANC visits, LMICs still experience poor ANC uptake and quality. In Sub-Saharan Africa, Bain et al. (4) implemented a cross-sectional analysis of national level data from a range of countries from the DHS to identify prevalence and determinants of maternal healthcare utilization through the eyes of young women, highlighting the contextually variable nature of maternal services utilization, and noting low reported levels of utilization for young women in rural areas and among adolescent women. Their multi-country analysis revealed the overlapping vulnerable population characteristics that influence ANC coverage among women in various countries. In Ethiopia, Abebe & Debelew (5) evaluated the utilization of maternal health care services among pregnant women living in Kersa district of Jimma zone and revealed that awareness creation and communication of ANC services were high, but the utilization of ANC services are low,

especially four or above services visits.

In a systematic review and meta-analysis, Demissie et al.(6) found that the burden of poor-quality antenatal care is high in Sub-Saharan Africa, with a considerable variability in the quality of the service provided across wealth quintiles, education and place of residence. Tibenderana et al. (7) in Tanzania studied the receiving of ANC components to women of reproductive age and determined that although many women started attending ANC during pregnancy, few women were receiving all the maternal ANC components. The lack of congruence with ANC attendance and receipt of quality components is a common theme in literature and suggests the importance of measuring the quality of ANC along with coverage indicators.

2.2.2 South Asian Context

ANC utilization in South Asia, especially in India and Bangladesh is important because it is an area that bears an unfair burden of the global maternal mortality burden, and therefore, is the focus of much research attention. Kumar et al.(2) used the NFHS-4 data to explore the utilization, equity and determinants of F/Ac (Full Antenatal Care). Their study showed that although there had been an improvement in overall ANC coverage over this period, there were disparities in this coverage, with women from ST groups (ST scheduled caste and ST scheduled tribes), those with less schooling, and the rural women being the worst served regarding full ANC coverage. This has been confirmed by the study conducted by Girotra et al. (3) who analysed the data from the NFHS-5 (2019-21) which showed that despite improvements, the coverage and quality of ANC remained a concern, especially in poor states. **The state of Bihar, India has been a hotspot in the maternal health arena because of the poor performance in maternal health outcomes on average.** Dehury & Samal (26) made a comparative study of the NFHS-3 and NFHS-4 state fact sheets and highlighted the bad performance of the maternal health situation in Bihar in comparison to the national average and similar states like MP. According to their analysis, three main factors explain Bihar's high ratio of maternal deaths, low institutional attendance at delivery, low attendance at skilled birth managers and low antenatal care attendance, all present in the state. Studies have examined quality adjusted ANC coverage at the population level in recent years. More recently Dandona et al.(25) estimated the rate of quality adjusted ANC coverage on a population-level in Bihar, and they determined that the coverage of QA-ACN was significantly lower than the crude estimates suggest, meaning that many women attending the first ANC visit do not receive the full package of recommended ANC interventions. Singh et al. (8)

conducted a cross-sectional study in rural women in Uttar Pradesh to examine the influencing factors for utilization of maternal health services but found that it depended on a combination of both individual, household, and community influences.

There were a few significant positive determinants that were found to be associated with significant factors of ANC utilization, these are identified as Women's education, Husbands education, Household wealth and Exposure to mass media whereas distance to health facilities and Absence of transportation were identified as major barriers. A similar study was carried out by Rustagi et al. (9) to compare ANC utilization between urban and rural areas of Delhi and the results was consistent with the present study as ANC services were far higher in the urban areas in general but there was significant variation among different urban groups; with women living in slums facing ANC utilization challenges similar to rural women. But in slum context Sharma et al. (30) were able to document those factors of life that have significant influence on maternal healthcare service utilization in a western industrialized city of India. In Bangladesh, Sakib et al.(1) explored sociodemographic and socioeconomic drivers of the utilization of any ANC visit based on BDHS 2017-18.

As expected, and consistent with the region's general literature, they found that maternal education scores, wealth quintile, and place of delivery were important in the likelihood of ANC usage. They also observed that inequalities in accessing ANC were also evident among women as, for instance, women from the lower wealth quintile were significantly less likely to make the recommended number of ANCs and those residing in rural areas were less likely than their urban counterparts. Utilization of ANC Services of various determinants will be covered here. This literature has been extensively explored, and a common theme has emerged of a set of basic factors that are central to both individual, household, and community-level which can impact the access to and utilization of ANC services. Andersen's three-part conceptual model of health services utilization, a predisposing, enabling, and need based model which has been widely used as theory to conceptualize these factors. In a cross-sectional study by Habeeb et al. (10) on determinants of ANC utilization among Saudi women, the enabling factors (insurance status, household income and health facilities' proximity) emerged as the most significant determinants of ANC use in this setting.

The general pattern of the enabling factors having a critical role has been mirrored in a range of geographic settings, with specific enabling factors varying from setting to setting. These Manulata & Swain (28) factors, maternal age, decision making autonomy, parity and education level, have been consistently identified in the literature as factors at

the individual level. Women's utilization of ANC tends to be lower for younger women, especially adolescents, and high parity women may think that subsequent pregnancies don't need ANC. Education works in many ways, such as increased health literacy, increasing autonomy in decision making and adapting to the health systems. In the rural context of Odisha, India, Manulata & Swain (28) reported the significant association among utilization of antenatal health care services, body mass index, socioeconomic status, education of woman and obstetric history with formats that educated women were significantly more likely to enter into antenatal care services in the first trimester and to attend the recommended number of visits. Other factors at the household level such as wealth and husband education and support also have an important effect on utilization of ANC. Whilst men's health-seeking is often dependent on motivation, women's is significantly shaped by their husband or mothers-in-law and social factors within the household should be considered when implementing interventions. Geographic access to healthcare facilities as well as the presence of female healthcare providers and norms of community around healthcare-seeking are also critical at the community-level. Nath Jha et al. (31) measured the adequacy of ANC utilization by conducting a study in West Bengal, India, to explore its relationships, and found that spatial accessibility to health care services and the presence of antenatal workers in the community to provide support were among the most influential determinants of adequate ANC receipt. Antenatal Care Services: Quality of care delivered to mothers before giving birth. Recent years have seen a shift in awareness of quality as a unique aspect of ANC coverage, in addition to the fact that it is separate from and a factor connected with coverage. The WHO ANC model lists a variety of clinical examinations, laboratory tests, preventive activities (including iron-folic acid supplement, tetanus toxoid immunization or vaccine) and health education elements that should be offered at each ANC visit. Any studies that evaluate quality of access and do not just count the number of women who attend ANC, but discover what they get when they go, always show that women receive less than the full value of ANC. In a systematic review and meta-analysis, Demissie et al. (6) included studies on the quality of ANC which concluded that poor quality ANC is associated with not measuring blood pressure, not screening for any other infection, and not providing counseling on danger signs and preparedness of birth. These deficiencies are especially acute in remote and rural health facilities with inadequate provider training and supplies or supervision. This was consistent with the findings of Tibenderana et al. (7)) which revealed that preventive interventions and health education were poorly provided for women even though they had good attendance to ANC in Tanzania.

Analyzing the utilization and determinants of adequate quality ANC in India, Girotra et al. (3) reported that exposure to all the recommended components of ANC are early initiation, the recommended number of ANC visits, iron-folic acid supplementation, tetanus toxoid immunization, blood pressure, abdominal examination, blood and urine testing, and birth preparedness counselling which was experienced by a minority of women. The states with poorest quality adjusted ANC coverage were mainly from the central and eastern region like Bihar and Uttar Pradesh. This was corroborated by Dandona et al. (25) in the analysis for Bihar, where they observed that quality adjusted ANC coverage was significantly lower than crude coverage, and providers other than sub-centers or primary health centers did have better quality, as noted by the private providers and public hospitals.

2.3 Birth Preparedness and Complication Readiness: Conceptual Framework and Measurement

2.3.1 Conceptual Framework

Birth preparedness and complication readiness (BPCR) is an initiative recommended by three internationally developing health organizations that promotes early preparation of pregnant women, family members and communities in anticipation of normal delivery, and in preparation for emergency responses. The JHPIEGO Maternal and Neonatal Health Program implemented a BPCR programme that is widely adopted and includes selecting a skilled birth attendant; selecting a health facility for childbirth; saving money for childbirth and emergencies; arranging transport to a health facility; identifying a blood donor, making arrangements for newborn care, and awareness for danger signs during pregnancy, delivery and the postpartum period. The explanations behind BPCR interventions are rooted in the three delays model, which suggests that most maternal deaths are due to delays in: (1) recognizing need for care and deciding to seek it; (2) reaching the appropriate care facility; and (3) receiving appropriate care at that facility. The focus of the BPCR interventions is the elimination of the first and second delay, meaning that women and families have access to providers and facilities before the emergency, and they have prepared their logistics, including transport and financing, for childcare in the event of an emergency. BPCR has not been uniformly tested or applied in different studies, making for some difficulty in comparing them. Most studies measure BPCR components as a composite and women's status is considered “good” if they meet a predetermined number of the components. There are not definitive studies that would conclude with a universally accepted level for the number of components - some use three

or more components, others four or more, and cross study comparisons are difficult. Saaka & Alhassan (14) found that adopting uniform approaches to measurement could be crucial for meaningful comparisons of the prevalence of BPCR across settings in Ghana.

2.3.2 Global prevalence of preparation for and responding to birth complications

There is a wide variability in BPCR practice among studies and contexts, depending on the methods used to score for scoring BPCR, different sociodemographic contexts, and different maternal health programs. The prevalence in Sub-Saharan Africa and South Asia, where BPCR has been most widely studied, vary considerably, from less than 30% to more than 70%. In Ethiopia, where BPCR has been extensively studied, a few systematic reviews and meta-analyses aggregating available evidence have been carried out. In a systematic review and meta-analysis of BPCR determinants in Africa, Alamrew, Sisay, et al. (21) reported that BPCR was moderately practiced the continent over, with significant heterogeneity across country, study setting, and measurement method. In another meta-analysis on BPCR practice among Ethiopian women, the findings were found to be similarly variable, with women living in rural areas and women with lower attainment levels having lower levels of BPCR practice throughout. Adu-Gyamfi et al.) (17) in West Africa performed a facility-based cross-sectional study that revealed that although many pregnant women had heard of various components of BPCR, only a relatively small proportion had undertaken multiple components as suggested by their awareness of BPCR. This knowledge–practice gap is regularly pointed to in BPCR literature. In this regard, Saaka & Alhassan (14) found that practice of BPCR was distributed with high variations below optimal levels with emphasis on financial preparation being the most poorly completed component in Kassena-Nankana district, specifically in Ghana. The study by Ahmed et al.(16) was a community-based cross sectional study among recently delivered women in Somaliland, in Hargeisa and reported that though majority of women were aware of at least some BPCR components, full preparation such as having a complex birth attendant, arranging transport, and saving money was not common. Analogous findings were observed in Uganda, where Opus et al. (18) identified determinants of Achieving Birth Preparedness and Complications Readiness among mothers attending ANC at Katakwi General Hospital are ANC Utilization, understanding of danger signs and household decision making authority.

2.3.3 Birth Preparedness and Complication Readiness in South Asia

However, there is comparatively less literature on BPCR prevalence in India as compared to Sub-Saharan Africa with studies now emerging and increasingly providing evidence on both prevalence and determinants. Pandey et al. (29) evaluated the situation around preparedness for childbirth and SCAR for recently delivered mothers and women who were pregnant in rural Varanasi, noting that the preparedness level was not ideal and had potential to be improved, especially in financial preparedness and agreed blood donor. The study highlighted the need to provide targeted counseling during the ANC visit for enhancing BPCR practice. (27) carried out a study on BPCR among women who are availed antenatal services from the Antenatal Clinic in the area of Hooghly district in West Bengal, they have found that higher education, better household income, higher number of ANC care and bringing awareness regarding danger signs to the antenatal clinic by health worker have significantly associated with better BPCR practice. These findings are within the range of similar values found in the general literature and highlight the need to consider ANC as an avenue for the provision of BPCR counseling and education. In Meghalaya, with unique sociodemographic traits, level of BPCR was recorded to be present in pregnant women and was found to be generally higher than other studies conducted in India which may be attributed to the "matrilineal" social structure and comparatively higher women autonomy in the region. This is an important discovery as a reminder of the cultural and social contexts that influence BPCR behaviors. A similar conclusion was drawn for those who were beneficiaries of the rural primary health center in Dakshina Kannada district of Karnataka with regards to BPCR being linked to educational attainment and utilization of ANC services by women beneficiaries, as stated by Akshaya & Shivalli (34). However, the potential of structured community-based programmes to enhance BPCR practice, even in low-resource rural community settings, was highlighted in Odisha through a study by Swain et al. (23) that assessed the effectiveness of an interventional study focused on the promotion of BPCR through a continuous training programme in the community.

2.3.4 Determinants of Birth Preparedness and Complication Readiness

Much work has been done on the issue of BPCR determinants, and there are systematic trends of findings in different environments. When a child's predictors of BPCR are examined at the individual level, maternal education is one of the most consistent predictors. Compared with no-educated women, women with secondary or higher education are much more likely to have adequate BPCR practice, possibly because of their greater health literacy, autonomy in making decisions and understanding of the

importance of being prepared for delivery and possible complications. After controlling the variety of individual variables included in the model, Demsash et al.(19) performed a multilevel analysis of birth preparedness and pregnancy complication readiness in Ethiopia and identified community-level variables, such as the presence of community health workers (CHWs) and availability of health facilities, to be independently associated with BPCR practice above and beyond the individual-level predictors. This discovery reinforces the need to consider multilevel determinants in the development of BPCR interventions. Utilization of antenatal care services is one of the most continuously reported factors associated with practice of BPCR in different settings. However, women who are attending more ANC visits, and those with higher level of quality ANC care, are much more likely to demonstrate adequate BPCR. In pregnant women, ANC visits were predictive of birth preparedness, and there was a dose response association between each ANC visit and likelihood of preparedness where increased ANC visits predicted increased likelihood of birth preparedness (actual birth preparedness) according to Atta R (12). The result underscores the potential for improving the quality of ANC to yield benefits for the downstream practice of BPCR and the importance of ANC as a platform for BPCR counselling and education. Firstly, the knowledge of obstetric danger signs is an important intermediate outcome on the pathway from the use of ANC to practice of BPCR. Women who receive no counsel regarding danger signals during ANC will be less likely to know their next steps during an emergency and to have prepared prior to the emergency. In their study in the Yirgalem general hospital, southern Ethiopia, Mesele & Anmut (33) revealed that counseling on danger signals during ANC was one of the strongest predictors of good BPCR practice; this highlights the significance of counseling people around danger sign during ANC. Another factor is to do with household decision making power, especially in a patriarchal society where women might not have the freedom to choose how to seek care for health, how to spend money, and how to arrange transportation. Based on the findings of Segni Mulugeta Tafasa et al. (35) a cross-sectional study was conducted in Chelia District, Central Ethiopia, women who were engaged in the decision making process showed a significant latitude of adequate practice of BPCR, thus there is a need to tackle gender dynamics in BPCR programming. Depending on the context, multiparity has been reported to be correlated with increased or decreased BPCR practice. Likely in some environments there may be a higher number of multiparous women who know more about danger signs and have more experience with the health system, thereby resulting in higher BPCR. In other contexts, multiparous women might feel content about preparing, thinking that this process will be the same as

in past deliveries. In Oromia, Ethiopia, perceptions of the pregnant women and health care providers regarding BPCR were also different and varied between primiparous and multiparous women, depending on the BPCR component Tejineh & Lumadi (13).

2.4 Linkages between ante natal care and birth preparedness.

Utilization of the ANC and BPCR practice is among the most consistently reported linkages in maternal health literature. Being a structured platform for health education, counselling and interpersonal communication between healthcare providers and pregnant women; ANCTC is indeed a crucial tool in the campaign to foster BPCR. The number, content and quality of ANC contacts are all associated with the level of BPCR information that is given to pregnant women and absorbed into their behaviors. To build a clear causal pathway from ANC quality to preparedness to skilled delivery care, Mohammed et al. (11) tested a longitudinal panel survey in Ethiopia where the route from ANC quality to birth preparedness was a well-established intermediate step found to have a direct effect on skilled delivery attendance. This finding has implications to apply to program design and indicates a potential "ripple effect" throughout the continuum of maternal care. These results were echoed in the study by Atta R (12) on linkage between ANC visits and BP which found that women who had four or more ANC visits were significantly more likely to have identified a skilled birth attendant, saved money for delivery and emergencies as well as arranged for transport to a health facility. All these BPCR components are very important in creating ways to access care should a complication arise and the linkage between these components and ANC use reflects the programmatic significance of improving ANC utilization and quality. In eastern Ethiopia, Ali et al. (20) analyzed the full continuum of care for maternal health and reported that having adequate BPCR was significantly associated with having completed the full continuum of care, while using ANC early and completing their expected ANC visits were significantly associated with the use of skilled delivery and postnatal care. The two results confirm an understanding of ANC as a point of socio-structural entry into the larger health care continuum than an isolated event. The two studies conducted in Thailand Kiataphiwasu & Kaewkiattikun (15) indicated that compared to pregnant women who attended ANC in a tertiary hospital, the majority of those pregnant women in the study had fairly high BPCR and (15) showed that BPCR counseling was not universally implemented, even within the higher resource setting. Some of the factors that were positively associated with high BPCR included being multiparas and having a history of obstetric complications, which indicating the

significant contribution of previous experiences in the motivation of preparedness behavior in this context.

2.5 Contextual Factors Influencing Maternal Healthcare Utilization

2.5.1 Rural-Urban Differences

There has been a consistent documentation of differences between rural and urban utilization of ANC and practice of BPCR in many maternal health literatures. There are so many overlapping factors which restrict rural women from using healthcare such as more distance to health facilities, fragile transportation system, lesser education, household poor economic status, lesser reach to mass media, and less exposure to health communication. These barriers magnify each other and bring very harsh disparities on maternal health services utilization by rural women. Rustagi et al. (9) reported high disparity in the use of ANCs between rural and urban women in Delhi, and women living in slums received ANC services that was substantially less than for those who did not live in slums within the urban population. This research was extended by Sharma et al.(30) to the urban slums of an industrialized city (west India) and the results indicated that socioeconomic constraints to maternal healthcare service utilization were similar in slum and rural communities. The findings indicate that place of residence is not a strong enough predictor of access and that intra-urban disparities should be measured as well as rural-urban disparities. Compared to the rest of the country, the rural-urban gap is very large in the state of the present study, Bihar. Dandona et al.(25) reported that by quality adjusted ANC coverage, there was a major difference between coverage in the rural versus the urban setting of the State, with increased differences when accounting for the source of ANC-or public versus private-and the types of ANC received. Similarly, Dehury & Samal (26) reported that, Bihar's maternal health indicators were found to be low when compared with the other similar states of country and rural areas of the state showed poor performance regarding its maternal health indicators, especially with regard to antenatal care coverage and skilled birth attendance.

2.5.2 Socioeconomic Determinants

Overall, there are significant differences in the utilization of ANC and BPCR practice according to socioeconomic status based on wealth quintiles, educational level and occupation in all study settings. Indeed, richer, more educated women are consistently more likely to attend ANC, and to have completed the ANC visits, accessed high quality of ANC and exhibited adequate BPCR practice. These links are operational in various ways: by being able to pay for services, to access and process health information and to

have increased autonomy in health care decision making. In their study using NFHS-4 data, Kumar et al.(2) have identified wealth quintile to be the strongest predictor of full ANC utilization in India, women in the highest wealth quintile being three to four times more likely to receive full ANC as compared to women in the lowest quintile. The same conclusion was reached by Bain et al. (4), who also reported a health care utilization gap for young women, between lower- and higher-income groups, across Sub-Saharan Africa, and specifically that in nations where public care is less developed, and out-of-pocket payments constitute a larger cost barrier, poverty is associated with less utilization of ANC. Education, as a direct aid of the health-seeking behavior, has been a special case because of its close association with occurrence of maternal health services, which at the same time work as a proxy of socioeconomic status. Women with education have higher health literacy, greater capacity to identify signs of danger, more ability to communicate effectively with a healthcare provider and greater ability to exercise autonomy in health care decisions. Also, despite controlling for other socioeconomic factors, education was among the most important factors influencing ANC utilization in Bangladesh Sakib et al. (1), implying that the impact of education is independent of being a proxy for wealth.

2.5.3 Health System Factors

The availability, accessibility, and quality of health system services are major considerations that influence women's access to ANC and quality of provider TA services. ANC utilization and quality are affected by a range of factors including health facility density, health provider availability, essential medicines provision and equipment, and provider-client interactions. Challenges in the health system in many LMICs such as staff shortages, stock out of essential supplies, poor infrastructure, and lack of supervision of peripheral facilities are factors that reduce the quality of ANC. Girotra et al. (3) observed a significant difference between the source of ANC (public and private) with the quality of care received (on some indicators) and worries about equity of access due to higher costs to the out of pocket, given the quality of the care provided in private facilities. With relevance to health system strengthening, Dandona et al. (25) found that source of ANC was a key near-universal determinant of quality adjusted coverage, which held true across the entire Bihar state. In India, Accredited Social Health Activists (ASHAs) and health extension workers in Ethiopia are potential agents between the household and health facility that could help increase the utilization of ANC services and uptake of BPCR. These frontline workers help the clients to get in touch with facility-based care, to participate in early initiation of ANC and counsel them about client care.

Empowering CHWs to influence maternal health seeking behaviors, Singh et al.(8) observed in UP that the Active ASHAs had positive effects on utilization of ANC services and institutional delivery among their households.

2.6 Outcomes Associated with Antenatal Care and Birth Preparedness

Finally, the rationale for investing in the quality of ANC services and the implementation of BCPRs is based on their proven effect on maternal and neonatal health outcomes. Significant body of literature is available that provides empirical support to the association between the use of adequate ANC services and increased availability of skilled birth attendance, institutional delivery, utilization of postnatal care services, and decreased maternal and neonatal mortality and morbidity rates. Showing that in Ethiopia, quality ANC contributes to maternal mortality reduction, Mohammed et al. (11) presented evidence that it improves the likelihood that women will be attended by a skilled birth attendant, a strong proximate determinant of reducing maternal mortality. Their study looked at women across the ANC spectrum and followed these women through to skilled attendance at birth and showed a clear cause-and-effect relationship between the quality of ANC received and skilled birth attendance and that better quality of ANC services could be a means of reducing maternal mortality. Ali et al.(20) analyzed the entire range of maternal health services in the east of Ethiopia and revealed that women who attended several ANC visits attended postnatal care and were more likely to give birth with a skilled attendant if they were able to make appropriate BPCR. This continuum of care from preconception to the postpartum period offers an important framework within which to appreciate the relationship of ANC to BPCR in relation to a full system of maternal health care. This intervention-level evidence from (23) in rural Odisha, India found that community-based interventions promoting BPCR knowledge and practice led to overall BPCR benefits, including increased levels of institutional delivery and decreased adverse birth outcomes. Evidence of the effects of BPCR interventions is mixed, but observational evidence consistently bolsters the link between BPCR practices and improved maternal births and outcomes, despite the limitations of the evidence base. Adequate care for the ANC by the postnatal women of Odisha has been observed to generate positive health perceptions of the pregnant women, such as increased institutional deliveries and reduced adverse pregnancy outcomes in the study conducted by Manulata & Swain (28). These findings further emphasize the critical importance of promoting the utilization of ANC services, which has not only maternal health implications but also impacts the health of

the newborns too. Over the past ten years, the proportion of children born with a promontory plan has stayed around 30%. The percentage of children born with a birth plan has remained approximately 30% over the last decade. The use of ANC and implementation of BPCR has been a subject of numerous intervention trials that have included health system strengthening, community mobilization, and individual counseling strategies. Although the evidence base around specific interventions continues to build, there are several modalities of interventions known to have positive potential to enhance maternal uptake of health care services. Some studies indicate that intervention in communities, such as baby health visits, women's groups, community mobilization, and home visits by CHWs has been effective in increasing ANC attendance and BPCR practice in a variety of settings. In remote areas of Odisha, (23) showed that continuous training by the community resulted in significant improvement in intermediate outcome (knowledge and practice) as well as outcome (birth outcomes). The mobilization of communities seems to work in Sub-Saharan countries, but it is important to be cautious with the generalization of the specific models across contexts. Supplements to demand-side interventions include health system interventions to improve the quality of ANC services, such as training of providers, improving supervision, strengthening of supply chains, and improving health facility infrastructure. In the analysis, Girotra et al. (3) observed that strengthening the quality of ANC services would need to make such services available through supply-side reinforcement (increasing the ability of service providers to deliver quality services) and through demand-side reinforcement (women recognizing their rights and entitlements to quality services and then ensuring that these are delivered). The inclusion of BPCR counselling into the routine ANC service is a highly cost-effective strategy recommended by WHO and international health bodies; it is a low-resource strategy that is highly effective in both terms of cost per reach and effectiveness. Results across all settings evidence that women who receive systematic counselling by ANC providers from all the BPCR components show significantly more practices in BPCR, while the others do not. Women who receive systematic counselling by ANC providers for all the BPCR components showed significantly higher practices in BPCR, compared to other women who did not receive systematic counselling. The receipt of BPCR related counseling at ANC was one of the strongest predictors of adequate birth preparedness that was also confirmed by Atta R (12) which indicates the potential of this integrated approach. Increasing attention has been paid to male partner engagement in ANC/BPCR to enhance maternal healthcare utilization and preparedness. Managing male partner involvement in BPCR education and planning will have the potential to address

the household level barriers to care in many settings due to the key role husbands play in women's health care decision making. (13) emphasized that efforts to sensitize the pregnant women and their family members to BPCR education were important but highlighted that positive actions taken by male partners played a pivotal role in women's ability to act upon their knowledge of BPCR.

2.7 Gaps in Literature and Rationale for the Present Study

Although the amount of literature focusing on ANC utilization and BPCR practice are significant and, on the increase, there are some important gaps that the current study aims to fill. At the national and regional level, there is substantial evidence on trends and determinants of ANC use and BPCR in India; however, there is a scarcity of evidence specific to Bihar, one of the lowest performing States for maternal health on the national level. Previous studies by Dandona et al. (25) and have revealed the state of maternal health in Bihar, however there is little available detail on the quality of the ANC service and the practice of BPCR at the community level in the state. Second, most studies conducted in India have focused on measuring ANC utilization, and BPCR practice as separate indicators, without considering how ANC quality affects the levels of BPCR practice. For designing integrated interventions to achieve what they call the quality of ANC and an improvement in BPCR practice, knowledge of these pathways is important. The present study is a contribution to this gap as it looks at the utilization of ANC services as well as the practice of BPCR and considers the relationship between the two. Third, though the evidence base for BPCR in India is expanding, it is predominantly from the states of southern and eastern India, and from the minimal evidence in the Hindi heartland states of Bihar and Uttar Pradesh in which maternal health outcomes are lowest and thus the need for evidence-based programming is greatest. The studies conducted by Pandey et al.(29) in Varanasi and Shree et al. (27) in West Bengal are key contributions and more work is required at community level in Bihar throughout the state to guide program planning at the state level. Fourth, the systematic reviews by Alamrew, Ayele, et al. (22) have integrated evidence on the determinant of BPCs throughout Africa and Ethiopia but there is no systematic review with similar focus on the South Asia context and even more distinctively on India. The primary data of this study can contribute to synthesizing the South Asian literature in future. Further, there is limited evidence addressing the interactions among individual-level determinants and community-level determinants of the ANC and BPCR outcomes. Last, evidence in Indian context is limited around the moderation effect of community-level factors (like availability of health facilities,

community level education, and community density of CHWs) on the association between individual-level determinants and ANC and BPCR outcomes. The multilevel analytical approach used by Demsash et al. (19) in the Ethiopian context and adopted in this study for identifying points for intervention in the community level in Bihar, shows potential.

2.8 Summary

In this chapter, an extensive corpus of literature has been examined to characterize the utilization of antenatal care, birth preparedness, complication readiness, and to assess the level of these practices throughout the world in general, and in South Asia in particular. The evidence closely reflects an overall level of relatively low and variable ANC utilization in low and middle income countries and a significant variation across countries in the levels of and gaps in utilization of the health facility and in the quality of services available at the ANC. Household decision makers, geographic access to health facilities, education, and socioeconomic status are some of the most model-consistent factors affecting the use of ANC services across settings. Birth preparedness and complication readiness practices are also poor in many settings, especially for lower education attainment, lower household wealth, and lower ANC utilization. It is evident from the literature that ANC is a key platform of counselling and education for BPCR, whereby good quality and frequent ANC reception are significantly associated with good practice in BPCR. ANC quality, in turn, is associated with BPCR practice, which translates to implications for skilled birth attendance and other maternal health outcomes along the continuum of care. From the maternal health indicators in the context of India, Bihar derives its importance as having abysmal maternal health scenario in combination with huge lag between the utilization of ANC visits and the practice of BPCR. National-level data from NFHS are useful for understanding but community-level data combining the quality of ANC services and the practice of BPCR in the Bihar context are crucial for program planning at the state-level and designing interventions. The present study aims to add to this evidence base in Bihar by presenting detailed community level data on ANC utilization and determinants of BPCR utilization with implications for the design of targeted interventions to improve maternal health in Bihar which is known to have a high disease burden. The evidence presented in this chapter reinforces the relevance of considering both supply and demand factors of the ANC utilization and BPCR implementation in an integrated program strategy. Community mobilization, health promotion and engaging male partners and families to overcome demand-side barriers

should be completed alongside investments in strengthening the health system for improved ANC quality of care. ASHAs, as community health workers (CHWs), play a pivotal role in India, as a link between households and health facilities, to improve both the utilization of ANC and practice of BPCR. The results of the present study will help pinpoint most promising entry points for the integrated interventions in the context of Bihar.

Chapter 3: Methodology

3.1 Study Objectives

General Objective

To examine the distribution and determinants of antenatal care utilization and birth preparedness among pregnant women in rural Bihar.

3.1.1 Specific Objectives

1. To examine socio-demographic factors associated with antenatal care utilization and birth preparedness.
2. To determine the association between antenatal care and birth preparedness practices.

Rationale:

In rural Bihar, there is still geographical, socio-economic and health system disadvantages preventing equitable access to maternal health services. The differences in education, family resources, parity and contact of the women with frontline health workers can have an impact on whether the women will get adequate antenatal care and take the necessary steps towards birth preparedness. The mechanisms of these factors in rural Bihar setting are important during the discovery of groups in the population that may need more programmatic focus. Available evidence in Bihar has mostly been on the coverage of antenatal care or directly on various selected maternal health indicators. There is limited population-based analysis conducted to evaluate the level of birth preparedness especially when considering the use of antenatal care. As birth preparedness practices are usually encouraged throughout the antenatal contacts, the study of these two elements together could reveal the information concerning the continuum of the maternal health service use in rural areas.

The overall assessment based on the community and rural based data in Bihar would provide an opportunity to explain the difference in the antennal care usage and birth

preparedness level in different social-demographic groups. Thus, the proposed research will evaluate the percentage of antenatal coverage and birth preparedness, as well as the factors related to these variables in rural Bihar among women. The results are likely to lead to context-specific evidence to promote the interpretation of the service utilization tendencies and define the spheres in which the maternal health programmes in Bihar could use some reinforcement.

3.2 Study Design

This study utilizes secondary data of a community based cross-sectional household survey carried out in rural Bihar. The parent survey was used to get data on the maternal, newborn and child health indicators such as the antenatal care utilization and birth preparedness. To analyse coverage, distribution, and determinants at population level of the maternal health services, secondary analysis of large cross-sectional datasets is commonly applied. Similar methods have been used in previous studies that apply national and community datasets to determine the determinants of antenatal care utilization and preparation of birth.

3.3 Study Area

Parent research was done among the rural regions in all the nine administrative divisions of Bihar. These divisions are geographical and socio-economic heterogeneousness in the state. Representatives were provided by all the divisions and enhanced the external validity of the findings to rural Bihar. Other earlier research studies that have evaluated the use of maternal health services have also employed geographically representative research methods.

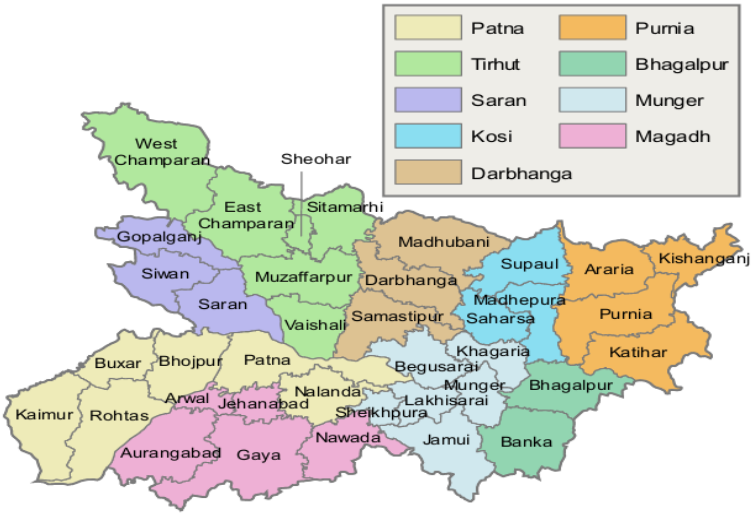


Figure 2.1**: Study Area**

3.4 Study Population

The target population of this study are the mothers of the infants aged 0-5 months who live in rural Bihar and gave birth to the child within one year before the survey (March 2026 to May 2026). This population was chosen in parent study to minimize the bias in recalling, but to capture the current antenatal care and birth preparedness behavior.

3.5 Sampling Design

The multistage stratified sampling of the parent survey was used. The simple random sampling method was used to choose blocks as Primary Sampling Units (PSUs) in all the nine administrative divisions in the first stage. Each division was selected 20 blocks, and this made 180 blocks in the state.

The Secondary Sampling Unit in the second stage was Anganwadi Centre catchment areas which were sampled according to proportional to size. Each block had two SSUs that were chosen to represent the population. Systematic sampling was applied in the process of selecting households in the third stage. A random starting household was taken and using the Anganwadi register the rest of the household taken were selected in a clockwise fashion until the number of eligible respondents was reached. This type of sampling design is similar to multistage sampling that is typically employed in surveys of maternal health and DHS-type surveys.

3.6 Sample Size and Analytical Sample

The parent survey sample has been calculated based on central maternal health pointers. Final estimation was done with the indicator that had the highest sample size which is 4+ antenatal care visits. Based on 95% confidence level, 80% power, 10% relative change and design effect of 1.25, an estimated sample of about 4,729 per division was to be used. The total sample size comprised of around 42, 600 women in nine divisions.

In terms of operations, the target population of 4,800 mothers of children aged 0-23 months was divided into three age groups (0- 5 months, 6-11 months, and 12-23 months) equally across the three divisions. In the current study, mothers of children under the age of 5 months only were taken into consideration. Therefore, 1, 600 mothers per division were considered, which has given a final analytic sample to be 14, 400 mothers in rural Bihar.

Although the survey was designed to cover a larger population, the present analysis included only respondents available in the released dataset. The final sample size may increase upon completion of data collection and data processing activities.

3.7 Literature Search Strategy

A structured literature search has been conducted by me to identify relevant studies on determinants of antenatal care utilization and birth preparedness. The search strategy was developed using Mesh terms and free-text keywords. The following Boolean search string was used:

(("Antenatal Care"[Mesh] OR "Prenatal Care"[Mesh] OR antenatal care OR ANC utilization) AND ("Birth Preparedness" OR "Complication readiness") AND ("Determinants" OR "Factors") AND ("Pregnant Women"[Mesh]) AND ("Rural

3.7.1 Population"[Mesh]) AND ("India"[Mesh] OR Bihar))

The search was conducted across PubMed, and Google Scholar. A total of 1,155 records were identified, of which 117 were screened for eligibility. Finally, 34 studies were included for synthesis.

3.8 Data Collection Platform

A structured questionnaire that was provided via Survey-CTO was used to gather the primary survey data. To minimize data entry errors, the tool had in-built validation checks which included range checks, skip patterns and mandatory fields. Synchronization to a centralized server was done daily to make sure that timely monitoring and quality control were carried out. The digital data collection platforms have been demonstrated to enhance quality of the data and minimize transcription errors in the large-scale surveys.

3.9 Data Management and Cleaning

Preliminary data cleaning will be done by exporting the data of Survey-CTO in Excel format. Early data processing involved the verification of duplicate records, missing records and out of range records. Consistencies in logic will be checked on the related variables including ANC registration, the number of ANC visits, and components of birth preparedness.

The data was first cleaned and then the dataset will load into the SAS software to undergo further validation and preparation. Frequency distributions will be prepared to find out abnormal values. Dependence and independent variables in cross-tabulations will be verified to be logical. Verification for implausible values which will be recorded, SAS was be used to derive variables. Binary indicators of the antenatal care utilization and birth preparedness will be developed. Institutional delivery preparedness index will come up with by mixing the important preparedness elements of composite birth preparedness index(34). The independent variables were also recorded into analytic meaningful

variables. Regression analysis is done on records that have have no information in the outcome variables.

3.10 Study Variables

Based on evidence of existing research following variables are selected for the study as covariates (31, 34, 36).

3.10.1 Dependent Variables

Antenatal Care Utilization

The use of antenatal care will be determined as one or more antenatal care visits and early registration during pregnancy. This definition has been extensively applied in past research of adequate antenatal care coverage.

Birth Preparedness

The measure of birth preparedness will do through a composite index that consisted of identification of place of delivery, preparing money to deliver, planning transport and having a birth companion. Composite measures of birth preparedness have been commonly used in previous studies.

3.10.2 Independent Variables

According to the existing literature the following explanatory variables were used:

a) **Socio-demographic variables**

   Maternal age, Education, Caste, Religion, Household wealth status.

b) **Obstetric variables**

   Parity, Previous pregnancy outcome.

c) **Health system variables**

   Interaction with frontline health workers or Counselling on birth preparedness.

These variables have proven to affect the use of antenatal care and birth preparedness in several studies (2, 6, 7, 28, 34).

3.11 Statistical Analysis

All analyses were conducted in SAS software. The characteristics of the population under study will be summarized using descriptive statistics. Significance intervals of 95 percent will be used for approximation in use of antenatal care and birth preparedness variables. Chi-square tests will be used to conduct bivariate analysis to determine relationship between dependent variables and independent variables. Crude odds ratios will be

determined. Variables with p-value below 0.20 will be considered in multivariate analysis. The use of multivariate logistic regression models will be used to fit the study on both antenatal care and birth preparedness. Adjusted odds ratios and confidence intervals will be reported. Multicollinearity and Goodness-of-fit model diagnostics will be assessed to measured and then model selection will be done. The p-value of less than 0.05 will be used as the statistical significance. This method of analysis is aligned with the past research conducted on the determinants of antenatal care use and preparedness to give birth based on cross-sectional survey data (4, 12).

3.12 Ethical Considerations

The research involved anonymized secondary data gathered by way of community-based household survey. The dataset did not have any personal identifiers. The implementing agency granted permission to perform secondary analysis. Secondary analysis will be conducted solely for research purposes.

Chapter 4

4.1 Results overview

In this chapter, the result of a cross-sectional study is presented, which focused on the distribution and determinants of antenatal care (ANC) use and birth preparedness and complication readiness (BPCR) among women in rural Bihar. The analysis was focus on the following two specific objectives: First, explore the socio-demographic factors related to ANC use and Birth Preparedness; Second, identify the relationship between ANC use and the practice of Birth Preparedness. Results of the findings are presented descriptively, bivariate association (Chi-square test) and multivariable logistic regression.

4.2 Socio-demographic and Obstetric Characteristics of the Study Population

Table 4.1 shows that the total study sample (N = 11,164) included women with a wide range of socio-demographic, obstetric, and health system characteristics, and that the crude prevalence of the two main outcome measures – four or more antenatal care visits and good composite birth preparedness – were variable across the sample. With respect to religion, most respondents were Hindu (85.9%; 95% CI: 85.23–86.52), while 14.1% were non-Hindu (95% CI: 13.48–14.77). It was found that Caste distribution showed significant difference with 73.3% of the sample being from Marginalised communities

(95% CI: 72.45–74.09) and 26.7% from non-Marginalised (95% CI: 25.91 – 27.55). This distribution reflects the social make-up of the rural Bihar wherein Scheduled Tribes, Scheduled Castes and Other Backward Classes are the majority population. Regarding age, the largest proportion of women fell in the 22–25 years category (43.1%; 95% CI: 42.22–44.06), followed by the above 25 years group (29.5%; 95% CI: 28.62–30.31) and the youngest category of 16–21 years (27.4%; 95% CI: 26.57–28.23). In terms of maternal education, 29.6% of women were illiterate (95% CI: 28.70–30.40), 20.0% had completed schooling up to Class 8 (95% CI: 19.24–20.73), and 50.5% had education above Class 8 (95% CI: 49.54–51.39). Paternal education showed that 28.2% of fathers were illiterate, 19.8% of fathers completed their education up to Class 8 and 52.0% fathers completed their education above Class 8. The household wealth index was divided into three tertiles: 33.3% in the lower tertile, 33.4% in the middle tertile and 33.3% in the upper tertile. Concerning obstetric history, 32.5% of women were primiparous (Parity 1), 50% had a parity ranging from 2 to 3, and 17.5% had a parity >3. The majority of women (85.9%) had experienced a previous live birth, with 14.1% having an adverse pregnancy outcome (any previous stillbirth, miscarriage or abortion).

4.2.1 Antenatal Care Indicators

In general, 97.7% (95% CI: 97.43-97.98) of women indicated that they had at least one ANC visit during their last pregnancy. Pregnancy registration was near-universal at 96.2% (95% CI: 95.83–96.54). Of all those registered, 63.1% (95% CI: 62.16–63.98) registered in the first trimester, and 36.9% registered in the second trimester or beyond. The main outcome of this study was the proportion of women who received the recommended number of ANC visits: the proportion of women receiving four or more ANC visits were 52.4% (95% CI: 51.44–53.31).

4.2.2 Frontline Health Worker Counselling

The counselling exposure reported by frontline health workers (FLW) was not uniform for the six indicators measured. For those in the sub-sample who had been advised on ANC (n = 1,463), only 9.2% (95% CI: 7.74–10.71) were advised on ANC, and those who were, received advice on institutional delivery of 17.1% (95% CI: 15.16–19.02). Among the larger sub-sample eligible for the BPCR-specific counselling questions (n = 7,328–7,341), 21.3% received advice on pre-identifying a vehicle (95% CI: 20.31–22.18), 18.9% received advice on money preparation (95% CI: 18.02–19.81), 14.1% received advice on companion arrangement (95% CI: 13.26–14.85), and only 10.1% received advice on blood donor identification (95% CI: 9.39–10.77).

4.2.3 Birth Preparedness Practices

For those planning to deliver in an institution (n = 7,205), the most complete BPCR component was the arrangement of money (67.4%), then the companion arrangement (66.6%), transport arrangement (44.6%), and the identification of blood donors (13.4%). In the overall situation, 41.0% of the women were classified as having adequate composite birth preparedness (BPCR index score ≥3 of 5 components; 95% CI: 40.11–41.94), and 59.0% as Not Adequate.

Table 4.1: Distribution of Socio-demographic, Obstetric, and Health System Characteristics with Crude Prevalence of ≥4 ANC Visits and Adequate BPCR

Description	Category	N	n	%	95 % CI
Religion	Non-Hindu	11,164	1,577	14.1%	13.48–14.77
	Hindu	11,164	9,587	85.9%	85.23–86.52
Caste	Marginalised	11,164	2,984	26.7%	25.91–27.55
	Non-Marginalised	11,164	8,180	73.3%	72.45–74.09
Age Category	16–21 years	11,164	3,059	27.4%	26.57–28.23
	22–25 years	11,164	4,816	43.1%	42.22–44.06
	Above 25 years	11,164	3,289	29.5%	28.62–30.31
Paternal Education	Illiterate	10,632	3,001	28.2%	27.37–29.08
	Upto Class 8	10,632	2,100	19.8%	18.99–20.51
	Above Class 8	10,632	5,531	52.0%	51.07–52.97
Household Wealth Index	Lower	11,164	3,720	33.3%	32.45–34.20
	Medium	11,164	3,724	33.4%	32.48–34.23
	High	11,164	3,720	33.3%	32.45–34.20
Maternal Education	Illiterate	11,164	3,299	29.6%	28.70–30.40
	Upto Class 8	11,164	2,231	20.0%	19.24–20.73
	Above Class 8	11,164	5,634	50.5%	49.54–51.39
Pregnancy Registration	Yes	11,164	10,738	96.2%	95.83–96.54
	No	11,164	426	3.8%	3.46–4.17
Month of Registration	After 1st Trimester	10,840	4,003	36.9%	36.02–37.84
	1st Trimester	10,840	6,837	63.1%	62.16–63.98
FLW: ANC advice	Yes	1,463	135	9.2%	7.74–10.71
	No	1,463	1,328	90.8%	89.29–92.26
FLW: Institutional delivery	Yes	1,463	250	17.1%	15.16–19.02
	No	1,463	1,213	82.9%	80.98–84.84
FLW: Vehicle advice	Yes	7,328	1,557	21.3%	20.31–22.18
	No	7,328	5,771	78.8%	77.82–79.69
FLW: Money advice	Yes	7,327	1,386	18.9%	18.02–19.81
	No	7,327	5,941	81.1%	80.19–81.98
FLW: Companion advice	Yes	7,341	1,032	14.1%	13.26–14.85
	No	7,341	6,309	85.9%	85.15–86.74
FLW: Blood donor advice	Yes	7,339	740	10.1%	9.39–10.77
	No	7,339	6,599	89.9%	89.23–90.61
Parity	Parity 1	11,164	3,629	32.5%	31.64–33.38
	Parity 2–3	11,164	5,579	50.0%	49.05–50.90
	Parity >3	11,164	1,956	17.5%	16.82–18.23

Description	Category	N	n	%	95 % CI
Previous Pregnancy Outcome	Live Birth Only	11,164	9,595	85.9%	85.30–86.59
	Adverse Outcome*	11,164	1,569	14.1%	13.41–14.70
Planned Place of Delivery	Home Delivery	11,164	385	3.5%	3.11–3.79
	Government Hospital	11,164	6,191	55.5%	54.53–56.38
	Private Hospital/Clinic	11,164	1,014	9.1%	8.55–9.62
	Not Planned	11,164	3,574	32.0%	31.15–32.88
Plan for Institutional Delivery	No	11,164	3,959	35.5%	34.57–36.35
	Yes	11,164	7,205	64.5%	63.65–65.43
Received any ANC	Yes	11,164	10,908	97.7%	97.43–97.98
	No	256	256	2.3%	2.02–2.57
Received ≥4 ANC visits	<4 visits	11,164	5,451	47.6%	46.69–48.56
	≥4 visits	11,164	5,713	52.4%	51.44–53.31
Transport Arrangement	No	7,205	3,994	55.4%	-
	Yes	7,205	3,211	44.6%	-
Money Arrangement	No	7,205	2,347	32.6%	-
	Yes	7,205	4,858	67.4%	-
Companion Arrangement	No	7,205	2,406	33.4%	-
	Yes	7,205	4,799	66.6%	-
Blood Donor Identification	No	7,205	6,237	86.6%	-
	Yes	7,205	968	13.4%	-
Composite BPCR	Not Adequate	11,164	6,584	59.0%	58.06–59.89
	Adequate	11,164	4,580	41.0%	40.11–41.94

Note: *Adverse Outcome includes stillbirth, miscarriage, and abortion. CI = Confidence Interval. FLW = Frontline Health Worker. BPCR = Birth Preparedness and Complication Readiness. Composite BPCR Adequate = index score ≥3 of 5 components. Dash () indicates CI not calculable due to table structure.

4.3 Bivariate Analysis

4.3.1 Bivariate Analysis: Determinants of Receiving ≥4 ANC Visits

Table 4.2 shows bivariate associations between independent variables and receiving four or more ANC visits among eligible women (N = 5,713). Most of the independent variables were found to be significantly related to 4+ ANC uptake. The utilization of the antenatal care was significantly related to religion ($\chi^2 = 5.58$, $p = 0.018$). Among women who had at least 4 ANC visits, 27.0% were non-Hindu and 73.0% were Hindu indicating that a larger proportion had ANC visits among Hindu women. Caste was significantly correlated with ANC utilization ($p < 0.001$) and Non-marginalised women were much less likely to achieve ≥4 ANC visits than were non-marginalised women (78.0% vs. 22.0%).

A statistically significant association was found between age and 4+ ANC visits ($\chi^2 = 17.78$, $p < 0.001$). Among women receiving adequate ANC, the 22–25 years age group

constituted the highest proportion (42.8%), followed by the 16–21 years group (29.1%) and the above 25 years group (28.2%). Maternal education was among the strongest bivariate predictors (χ^2 = 444.49, $p < 0.001$): women with above Class 8 education comprised 59.4% of those meeting the ≥4 ANC threshold, compared to only 20.9% with illiterate mothers and 19.7% with upto-Class-8 education. A similar pattern was observed for paternal education (χ^2 = 379.21, $p < 0.001$), with 61.0% of adequate ANC recipients having fathers with above Class 8 education.

A statistically significant association was found between age and 4+ ANC visits (χ^2 = 17.78, $p < 0.001$). The highest proportion of women receiving adequate ANC was in the age group 22-25 years (42.8%) and the second highest was in the age group 16-21 years (29.1%) with the remaining (28.2%) being above 25 years group.

Above Class 8 education was the strongest bivariate predictor (χ^2 = 444.49, $p < 0.001$) – women with above Class 8 education accounted for 59.4% of those who met the ≥4 ANC threshold, while women with illiterate mothers accounted for 20.9% and women with up to Class 8 education accounted for 19.7%. The same trend was seen in paternal education (χ^2 = 379.21, $p < 0.001$) with 61.0% of adequate ANC users having fathers with education beyond class 8. Household wealth was highly significantly associated with 4+ ANC utilization (χ^2 = 420.29, $p < 0.001$). Within women who had adequate ANC, 41.6% were in High tertile, 32.9% were in Medium tertile and only 25.5% were in Low tertile. There was a strong association between first-trimester registration and the adequate ANC group (χ^2 = 102.82, $p < 0.001$): 67.4% of women registered in the first trimester while 32.6% registered later. The bivariate association between FLW counselling indicators and 4+ ANC use results in two counsels being not significantly associated: during Godbharai session ; χ^2 = 0.70, $p = 0.404$) and institutional delivery advice (Q223_6D; χ^2 = 0.05, $p = 0.819$). Advice on vehicle pre-identification (χ^2 = 16.07, $p < 0.001$), preparation of money (χ^2 = 22.73, $p < 0.001$) and blood donor identification (χ^2 = 10.07, $p = 0.002$) were all significantly associated with increased 4+ ANC uptake.

Interestingly, there was no data available for this bivariate relationship for companion arrangement advice. The variable related most strongly with parity was χ^2 = 570.98, $p < 0.001$. Of women who had ≥4 ANC visits, 42.6% had Parity 1, 44.6% had Parity 2–3 and 12.7% had Parity >3. Previous pregnancy outcome was also significantly associated with ANC (χ^2 = 11.73, $p = 0.001$), as women who met ANC who had a prior live birth were 84.9%. At the bivariate level, there was a weak association between the composite BPCR index and 4+ ANC (χ^2 = 3.80, $p = 0.051$).

Table 4.2: Bivariate Analysis of Factors Associated with Receipt of ≥4 ANC Visits (n = 5,713)

Variable	Category	N	n (≥4 ANC)	%	95% CI	χ^2 (p-value)
Religion	Non-Hindu	5,713	1,541	27.0%	-	5.58 (0.018)
	Hindu	5,713	-	73.0%	-	
Caste	Marginalised	5,713	-	-	-	120.48 (<0.001)
	Non-Marginalised	5,713	-	-	-	
Age Category	16–21 years	5,713	1,660	29.1%	27.88–30.23	17.78 (<0.001)
	22–25 years	5,713	2,443	42.8%	41.48–44.05	
	Above 25 years	5,713	1,610	28.2%	27.01–29.35	
Paternal Education	Illiterate	5,453	1,139	20.9%	19.81–21.97	379.21 (<0.001)
	Upto Class 8	5,453	989	18.1%	17.11–19.16	
	Above Class 8	5,453	3,325	61.0%	59.68–62.27	
Wealth Index	Lower	5,713	1,456	25.5%	24.36–26.62	420.29 (<0.001)
	Medium	5,713	1,880	32.9%	31.69–34.13	
	High	5,713	2,377	41.6%	40.33–42.89	
Maternal Education	Illiterate	5,713	1,192	20.9%	19.81–21.92	444.49 (<0.001)
	Upto Class 8	5,713	1,126	19.7%	18.68–20.74	
	Above Class 8	5,713	3,395	59.4%	58.15–60.70	
Pregnancy Registration	Yes	5,713	-	97.1%	96.70–97.56	5.61 (0.018)
	No	5,713	-	2.9%	2.44–3.30	
1st Trimester Registration	After 1st Trimester	5,594	3,939	32.6%	31.34–33.80	102.82 (<0.001)
	1st Trimester	5,594	6,685	67.4%	66.20–68.66	
FLW: ANC advice	Yes	749	129	8.4%	6.42–10.40	0.70 (0.404)
	No	749	1,302	91.6%	89.60–93.58	
FLW: Inst. delivery advice	Yes	749	240	16.6%	13.89–19.22	0.05 (0.819)
	No	749	1,191	83.4%	80.78–86.11	
FLW: Vehicle advice	Yes	3,767	1,536	23.2%	21.83–24.52	16.07 (<0.001)
	No	3,767	5,666	76.8%	75.48–78.17	
FLW: Money advice	Yes	3,767	1,368	21.1%	19.80–22.41	22.73 (<0.001)
	No	3,767	5,832	78.9%	77.59–80.20	
FLW: Blood donor advice	Yes	3,776	734	11.3%	10.25–12.26	10.07 (0.002)
	No	3,776	6,478	88.7%	87.74–89.75	
Parity	Parity 1	5,713	2,435	42.6%	41.34–43.90	570.98 (<0.001)
	Parity 2–3	5,713	2,550	44.6%	43.35–45.92	
	Parity >3	5,713	728	12.7%	11.88–13.61	
Previous Pregnancy Outcome	Live Birth Only	5,713	9,375	84.9%	83.93–85.79	11.73 (0.001)
	Adverse Outcome	5,713	1,533	15.1%	14.21–16.07	
Birth Preparedness Index	Not Adequate	5,713	3,858	34.5%	33.28–35.75	3.80 (0.051)
	Adequate	5,713	7,050	65.5%	64.25–66.72	

Note: n = number of women receiving ≥4 ANC visits within each sub-group. χ^2 = Pearson chi-square statistic. p-values < 0.05 considered statistically significant. FLW = Frontline Health Worker. CI = Confidence Interval.

4.3.2 Bivariate Analysis: Determinants of Adequate Birth Preparedness

Bivariate associations between independent variables and adequate composite birth preparedness (n = 4,580 with adequate BPCR) are shown in Table 4.3. Findings show significant differences between socio-demographic, obstetric and health system parameters. There was not a significant association of birth preparedness to religion (χ^2 = 2.74, p = 0.098). There was, however, a significant association between caste (chi² = 16.41, p < 0.001): 75.3% of women with adequate BPCR were from Non-Marginalised communities (95% CI: 74.06-76.55) compared to 24.7% from Marginalised communities. BPCR was significantly associated with age (χ^2 = 141.14, p < 0.001): The proportion of women with adequate birth preparedness was lowest at the 16–21 years age group (27.8%), increased to 33.5% in the age group 22–25 years, and was highest in the age group above 25 years (38.8%).

Maternal education was significantly associated with adequate BP (χ^2 = 158.06, p < 0.001). 57.2% of the women who were classified as having adequate BPCR had education beyond Class 8, 19.0% had education up to Class 8, and 23.9% were illiterate.

The wealth index in the same bivariate table showed similar results (χ^2 = 158.06, p < 0.001) with the High wealth tertile accounting for 57.2%, and the Low tertile accounting for 23.9%. Similarly, there was an association with paternal education (χ^2 = 122.43, p < 0.001), women with adequate BPCR had fathers more than 8th class educated (57.9%). The first trimester registration was significantly correlated with adequate BPCR (χ^2 = 8.25, p = 0.004): 64.7% of the women with adequate BPCR registered in the first trimester. The registration for pregnancy, however, was not significantly related to BPCR (χ^2 = 0.18, p = 0.671). Each of the six FLW counselling indicators was significantly and strongly related to adequate BPCR (all p < 0.001).

The highest chi-square (χ^2) was for FLW pre-identification (χ^2 = 214.39), followed by advice on money preparation (χ^2 = 185.12), arrangement of companion (χ^2 = 178.42), blood donor identification (χ^2 = 116.22), institutional delivery (χ^2 = 35.40), and ANC during Godbharai (χ^2 = 35.61). Among women who were prepared, parity 2–3 (51.2%), parity 1 (32.7%) and parity >3 (16.1%) were significantly associated with parity (χ^2 = 11.92, p = 0.003). There was no significant association between adequate BPCR and previous pregnancy outcome (χ^2 = 0.06, p = 0.811). The bivariate table of the association between ≥4 ANC visits and BPCR (as presented) could not be meaningfully interpreted because all women with adequate BPCR were recorded as having ≥4 ANC visits.

Table 4.3: Bivariate Analysis of Factors Associated with Adequate Birth Preparedness (Composite BPCR Index) (n = 4,580)

Variable	Category	N	n (Adequate)	%	95% CI	χ^2 (p-value)
Religion	Non-Hindu	4,580	1,577	13.5%	12.48–14.46	2.74 (0.098)
	Hindu	4,580	9,587	86.5%	85.54–87.52	
Caste	Marginalised	4,580	2,984	24.7%	23.45–25.94	16.41 (<0.001)
	Non-Marginalised	4,580	8,180	75.3%	74.06–76.55	
Age Category	16–21 years	4,580	1,272	27.8%	26.48–29.07	141.14 (<0.001)
	22–25 years	4,580	1,532	33.5%	32.08–34.82	
	Above 25 years	4,580	1,776	38.8%	37.37–40.19	
Paternal Education	Illiterate	4,411	1,020	23.1%	21.88–24.37	122.43 (<0.001)
	Upto Class 8	4,411	836	19.0%	17.80–20.11	
	Above Class 8	4,411	2,555	57.9%	56.47–59.38	
Wealth Index	Lower	4,580	1,094	23.9%	22.65–25.12	158.06 (<0.001)
	Medium	4,580	867	18.9%	17.80–20.06	
	High	4,580	2,619	57.2%	55.75–58.62	
Maternal Education	Illiterate	4,580	1,094	23.9%	22.65–25.12	158.06 (<0.001)
	Upto Class 8	4,580	867	18.9%	17.80–20.06	
	Above Class 8	4,580	2,619	57.2%	55.75–58.62	
Pregnancy Registration	Yes	4,580	10,738	96.1%	95.53–96.65	0.18 (0.671)
	No	4,580	426	3.9%	3.35–4.47	
1st Trimester Registration	After 1st Trimester	4,471	4,003	35.3%	33.94–36.74	8.25 (0.004)
	1st Trimester	4,471	6,837	64.7%	63.26–66.06	
FLW: ANC advice	Yes	715	135	13.9%	11.31–16.38	35.61 (<0.001)
	No	715	1,328	86.2%	83.62–88.69	
FLW: Inst. delivery advice	Yes	715	250	23.1%	19.99–26.17	35.40 (<0.001)
	No	715	1,213	76.9%	73.83–80.01	
FLW: Vehicle advice	Yes	3,372	1,557	28.8%	27.30–30.35	214.39 (<0.001)
	No	3,372	5,771	71.2%	69.65–72.70	
FLW: Money advice	Yes	3,371	1,386	25.7%	24.19–27.13	185.12 (<0.001)
	No	3,371	5,941	74.3%	72.87–75.81	
FLW: Companion advice	Yes	3,377	1,032	19.9%	18.58–21.28	178.42 (<0.001)
	No	3,377	6,309	80.1%	78.72–81.42	
FLW: Blood donor advice)	Yes	3,376	740	14.2%	13.01–15.37	116.22 (<0.001)
	No	3,376	6,599	85.8%	84.63–86.99	
Parity	Parity 1	4,580	1,497	32.7%	31.33–34.04	11.92 (0.003)
	Parity 2–3	4,580	2,347	51.2%	49.80–52.69	
	Parity >3	4,580	736	16.1%	15.01–17.13	
Previous Pregnancy Outcome	Live Birth Only	4,580	9,595	85.9%	84.84–86.86	0.06 (0.811)

Variable	Category	N	n (Adequate)	%	95% CI	χ^2 (p-value)
	Adverse Outcome	4,580	1,569	14.2%	13.14–15.16	
≥4 ANC Visits	Not Adequate (<4)	4,580	3,959	-	-	0.00 ()
	Adequate (≥4)	4,580	7,205	100.0%	-	

Note: n = number of women with adequate BPCR within each sub-group. χ^2 = Pearson chi-square statistic. p-values < 0.05 considered statistically significant. FLW = Frontline Health Worker. BPCR = Birth Preparedness and Complication Readiness.

4.4 Multivariable Logistic Regression Analysis

4.4.1 Determinants of Receiving ≥4 ANC Visits

After listwise deletion of cases, determinants of four or more ANC visits are presented in Table 4.4 and were analyzed by multivariable logistic regression. The following were entered into the model as bivariate variables: ANC. Parity was the most significant predictor of 4+ ANC utilization. Women with Parity 2 had 2.65 times the odds of receiving adequate ANC compared with primiparous women (aOR = 2.65; 95% CI: 2.39–2.94; $p < 0.001$), while women with Parity 3 or above had 3.46 times the odds (aOR = 3.46; 95% CI: 2.97–4.03; $p < 0.001$).

After controlling for other covariates, this finding indicated that higher parity women were significantly more likely to visit ANC and complete the recommended number of visits. After adjustment for other factors, religion was also a strong predictor alone: The odds of receiving ≥4 ANC visits were 25% higher for Hindu women than non-Hindu women (aOR = 1.25; 95% CI: 1.10–1.41; $p = 0.001$). On the other hand, the odds of adequate utilization of ANC services were significantly lower among Non-Marginalised caste status women than the Marginalised caste status women (aOR = 0.79; 95% CI: 0.71–0.87; $p < 0.001$). In the adjusted model, there was an inverse association that was unexpected with maternal education.

Compared with illiterate women, those educated up to Class 8 had lower odds of 4+ ANC visits (aOR = 0.68; 95% CI: 0.60–0.77; $p < 0.001$), as did those educated above Class 8 (aOR = 0.62; 95% CI: 0.55–0.70; $p < 0.001$). Paternal education also demonstrated a similar pattern, with marginally lower odds for fathers with up to Class 8 education compared to those who were illiterate (aOR = 0.87; 95% CI: 0.77–0.98; $p = 0.024$), and significantly lower odds for those with above Class 8 education (aOR = 0.65; 95% CI: 0.58–0.73; $p < 0.001$). Although unexpected, these findings are probably due to residual confounding from parity, caste and wealth information in the particular design of this data set and should be interpreted with caution. The adjusted model revealed an inverse

relationship between age and adequate ANC. Women aged 22–25 years had 22% lower odds of ≥4 ANC visits compared with the youngest group of 16–21 years (aOR = 0.78; 95% CI: 0.70–0.87; $p < 0.001$), and those above 25 years had 42% lower odds (aOR = 0.58; 95% CI: 0.51–0.66; $p < 0.001$).

The composite birth preparedness index was also independently and inversely associated with 4+ ANC utilization (aOR = 0.85; 95% CI: 0.78–0.92; $p < 0.001$), indicating that women who were well prepared for birth were less likely to have attended the recommended number of antenatal visits.

Table 4.4: Multivariable Logistic Regression Analysis for Determinants of Receiving ≥4 ANC Visits (n = 10,331)

Variable	Category	aOR	95% CI	p-value	Ref.
Parity	Parity 2 vs Parity 1	**2.65**	2.39–2.94	<0.001	Parity 1
	Parity 3 vs Parity 1	**3.46**	2.97–4.03	<0.001	
Caste	Non-Marginalised vs Marginalised	**0.79**	0.71–0.87	<0.001	Marginalised
Religion	Hindu vs Non-Hindu	**1.25**	1.10–1.41	0.001	Non-Hindu
Maternal Education	Upto 8 vs Illiterate	**0.68**	0.60–0.77	<0.001	Illiterate
	Above 8 vs Illiterate	**0.62**	0.55–0.70	<0.001	
Age Category	22–25 vs 16–21	**0.78**	0.70–0.87	<0.001	16–21 years
	Above 25 vs 16–21	**0.58**	0.51–0.66	<0.001	
Birth Preparedness Index	Adequate vs Not Adequate	**0.85**	0.78–0.92	<0.001	Not Adequate
Paternal Education	Upto 8 vs Illiterate	**0.87**	0.77–0.98	0.024	Illiterate
	Above 8 vs Illiterate	**0.65**	0.58–0.73	<0.001	

Note: aOR = Adjusted Odds Ratio. All variables entered simultaneously into the model. Reference categories as indicated. n = 10,331 after listwise exclusion of missing values. Hosmer–Lemeshow goodness-of-fit test applied.

4.4.2 Determinants of Adequate Birth Preparedness

The results from multivariable logistic regression of determinants of adequate composite birth preparedness are shown in Table 4.5. Several of the variables that were significant in the bivariate analysis were no longer significant after all the other variables were accounted for, underscoring the need to check for confounding. Four or more ANC visits was an independent predictor of birth preparedness in the adjusted model (aOR = 0.85; 95% CI: 0.78-0.92; $p < 0.001$). The direction of this association - an aOR below 1.0 with the reference being women with <4 ANC - indicates that women with adequate ANC were significantly less likely to be classified as having adequate BPCR in this model. This is an apparent paradox and is explored in greater depth in Chapter 5.

A positive and significant relationship was observed between maternal education and birth preparedness. Compared with illiterate women, those with education up to Class 8 had lower odds of adequate BPCR (aOR = 0.88; 95% CI: 0.78–1.00; $p = 0.044$), while those with education above Class 8 had markedly lower odds (aOR = 0.70; 95% CI: 0.63–0.79; $p < 0.001$). Similarly, with paternal education, those fathers with upto-Class-8 education had lower odds of adequate BPCR (aOR = 0.88; 95% CI: 0.78–0.99; $p = 0.040$) and those fathers with above-Class-8 education had lower odds of adequate BPCR (aOR = 0.77; 95% CI: 0.69–0.87; $p < 0.001$) compared to those fathers who were illiterate.

The association of adequate BPCR with Age was independent and inverse. Women aged 22–25 years had 12% lower odds of adequate birth preparedness than those aged 16–21 years (aOR = 0.88; 95% CI: 0.79–0.98; $p = 0.016$), and those above 25 years had 13% lower odds (aOR = 0.87; 95% CI: 0.77–0.99; $p = 0.032$). However, in the adjusted model, parity, caste and religion were not significantly associated with adequate BPCR (all $p > 0.05$).

Table 4.5: Multivariable Logistic Regression Analysis for Determinants of Adequate Birth Preparedness (n = 11,164)

Variable	Category	aOR	95% CI	p-value	Ref.
Parity	Parity 2 vs Parity 1	**0.92**	0.83–1.01	0.086	Parity 1
	Parity 3 vs Parity 1	**0.93**	0.80–1.08	0.329	
≥4 ANC Visits	Adequate vs Not Adequate	**0.85**	0.78–0.92	<0.001	<4 visits
Caste	Non-Marginalised vs Marginalised	**0.96**	0.87–1.06	0.416	Marginalised
Religion	Hindu vs Non-Hindu	**0.95**	0.84–1.08	0.431	Non-Hindu
Maternal Education	Upto 8 vs Illiterate	**0.88**	0.78–1.00	0.044	Illiterate
	Above 8 vs Illiterate	**0.70**	0.63–0.79	<0.001	
Age Category	22–25 vs 16–21	**0.88**	0.79–0.98	0.016	16–21 years
	Above 25 vs 16–21	**0.87**	0.77–0.99	0.032	
Paternal Education	Upto 8 vs Illiterate	**0.88**	0.78–0.99	0.040	Illiterate
	Above 8 vs Illiterate	**0.77**	0.69–0.87	<0.001	

Note: aOR = Adjusted Odds Ratio. All variables entered simultaneously. Reference categories as indicated. p-values < 0.05 considered statistically significant.

4.5 Summary of Chapter Findings

The descriptive analysis showed that 52.4% of the women had four or more ANC visits and 41.0% had adequate birth preparedness. Results of the bivariate analyses showed that there were significant relationships between ANC utilization and religion, caste, age, maternal education, paternal education, household wealth, parity, previous pregnancy outcome, first-trimester registration and various FLW counselling indicators. Previous pregnancy outcome, religion and FLW counselling indicators were not significantly associated with birth preparedness, and the latter had some of the strongest bivariate association with BPCR. The multivariable models revealed that education (both maternal and paternal), age, and ANC utilization were independently significant for birth preparedness; parity, religion and caste were independently significant for ANC

utilization. It is important to highlight the unexpected inverse relationship between education and ANC and the relationship between ANC and BPCR in the adjusted models, which needs to be discussed in the context of the study.

CHAPTER 5: DISCUSSION

5.1 Overview of the Study Findings

The purpose of this study was to describe the distribution and factors influencing utilization of antenatal health care (ANC) services and level of preparedness for birth complications (BPCR) among the mothers in the rural areas of Bihar to explore the relationship between ANC utilization and current neonatal preparedness practices. The result showed that although over half the women visited ANC more than four times, less than half were at good birth preparedness. The mother's level of education, family wealth, parity and frontline health worker (FLW) counselling were found to be important factors that influenced both ANC utilization and BPCR. Moreover, good uptake of ANC was identified as a good predictor of birth preparedness, showing how antenatal care can be a platform to improve safe motherhood practices.

5.2 Antenatal Care Utilization and Its Determinants

The present study focuses on the utilization and determinants of antenatal care (ANC) utilization for women in rural areas of Bihar. The results show that a This study analyzed the distribution and factors for lower utilization of ANC visits and lower levels of preparation for birthing complications among women in rural Bihar as well as examined the relationship between utilization of ANC visits and birth preparedness practices. The results showed that most of the women (>50%) had attended four or more ANC visits but less than half (40%) were birth ready. Key factors affecting ANC and BPCR uptake were identified as the maternal education level, household economic status, parity, and counselling by frontline health workers (FLW). Furthermore, the number of ANC utilisations was determined to be a good predictor of child preparedness as ANC serves as a major platform to support/encourage safe motherhood practices.

While a substantial proportion of women reported receiving antenatal care, the proportion of women who received adequate ANC care (four or more visits to ANC) was suboptimal. This is like the previous studies on maternal health access in Bihar and other low-resource situations in India, which have found that there is a persistent gap in the use of maternal health services despite high levels of service provision (3, 25).

Maternal education was one of the strongest factors associated with ANC utilization. Women who completed high school or higher tended to get ANC at higher rate than those who were not literate. The finding is consistent with the education being a predictor of maternal healthcare utilization reported from different studies in India, Bangladesh, and Sub-Saharan Africa (1, 2, 4)). As healthcare systems become more complex and the reduction of data leads to fewer resources, educated women have a greater understanding of the risks of pregnancy, and increased autonomy in care decisions. Household socioeconomic status was also significantly related to ANC use. There was higher utilization of recommended ANC services among women in wealthier households compared to those in the poor households. This has also been observed in the context of the National Family Health Survey which showed that economic status of women was a significant predictor of maternal health access (2, 3).

Indirect health care costs and the ability to seek timely health care, especially in remote areas, may be hampered by financial considerations. Utilization of ANC was negatively associated with parity. The second- and third-time mothers were less likely to come for the 4+ recommended ANC visits compared to the first time mothers. This finding is like those previous studies conducted in Ethiopia and in rural India where multiparous women were reported to think that they have oiled experience and so, were less likely to have routine antenatal visits (5, 28).

The study also revealed the critical need of frontline health workers to incentivize active utilization of ANC. There was a higher level of adequate use of antenatal services amongst women who reported receiving counselling and support from front line workers. This has been found to be true in Uttar Pradesh and Bihar, highlighting the important role of Accredited Social Health Activists (ASHAs) in counselling pregnant women, visitations, and referrals in accessing maternal health services (8, 25). The results underscore the need to enhance community-based health systems to enhance uptake of maternal health care.

5.3 Birth Preparedness and Complication Readiness and Its Determinants

Birth Preparedness and Complication Readiness (BPCR) is recognized as an important strategy for reducing delays in seeking and obtaining obstetric care. The present study found that adequate birth preparedness was not universal among women in rural Bihar, indicating continued vulnerability to maternal and neonatal complications.

Maternal education was significantly associated with better birth preparedness practices. Women with higher levels of education were more likely to identify a health facility, arrange transportation, save money for emergencies, and make other necessary preparations for childbirth. Similar findings have been reported from studies conducted in West Bengal, Karnataka, Ethiopia, and Ghana, where education consistently emerged as a strong predictor of BPCR (19, 27, 34).

Household wealth status also demonstrated a positive association with birth preparedness. Women from higher wealth categories were more likely to undertake adequate preparation for childbirth compared with women from poorer households. Financial preparedness constitutes a major component of BPCR, and resource limitations may restrict families' ability to arrange transportation, emergency funds, and institutional delivery plans. Comparable findings have been reported by Saaka and Alhassan and Ahmed et al. (14, 16), who observed lower preparedness levels among economically disadvantaged women.

Counselling received during pregnancy emerged as another important determinant of BPCR. Women who received counselling regarding danger signs, institutional delivery, and emergency planning exhibited significantly higher preparedness levels. This finding supports evidence from Ethiopia and Uganda showing that counselling during pregnancy improves awareness and preparedness behaviours (14, 16, 18). Effective counselling can enhance women's understanding of obstetric risks and encourage proactive planning for childbirth.

The findings further suggest that birth preparedness is influenced not only by individual characteristics but also by broader health system interactions. Access to quality maternal health information through frontline health workers and routine antenatal services appears essential for improving preparedness behaviours among rural women.

5.4 Association Between Antenatal Care Utilization and Birth Preparedness

The association between antenatal care utilization and birth preparedness is examined. Association between use of antenatal care services and preparedness for birth is explored. The present investigation found that the rate of utilization of ANC is closely linked with birth preparedness. The women who utilized the adequate ANC were significantly more likely to report adequate birth preparedness than women who had inadequate ANC utilization. This is directly relevant to the second study objective and aligns with the

conceptual framework of the interaction between ANC services and preparedness for childbirth and obstetric emergencies. Previous studies conducted in Ethiopia, Uganda, Thailand, and India have also revealed positive associations between ANC attendance and BPCR practices (11, 12, 20). ANC visits are important windows for health care providers to share information with women on danger signs, planning for the delivery, required transport arrangements, financial planning, and the significance of skilled birth attendance.

Women who attend ANC more often will therefore get more health information and counselling, which could enable them to be better prepared to engage in preparedness behaviours. The observed association underlines overall the role of ANC, which is not just clinical monitoring. Antenatal care is a starting point of maternal care, and an opportunity for women to become receptive to all information and support related to birth preparation. Thus, the goals of improving ANC coverage and quality can simultaneously help to enhance maternal and child preparedness for birth, and lead to better maternal and neonatal outcomes. The implications of the findings are important for the programmatic planning of Bihar. Improving quality of ANC, providing full counselling at ANC visits, and boosting engagement of frontline workers can have a positive effect on service use and readiness for childbirth.

These concurrent strategies are likely to be especially helpful for some socioeconomically disadvantaged groups, given their relatively poor maternal health outcomes. In summary, the results of the present study would confirm that maternal education, socioeconomic status, parity, and interaction with health workers are important factors affecting both ANC utilization and birth preparedness. Moreover, good ANC use is associated with good preparation for birth, highlighting the need to improve maternal health provisioning throughout the entire healthcare spectrum in rural Bihar.

5.5 Programmatic and Policy Implications

The insights from this study have significant implications for maternal health programmes in Bihar. Strategies should be aimed at enhancing use of ANC in groups with low utilisation of ANC services such as socioeconomically disadvantaged women, women with low educational level, and the high parity women. Second, it could be a cost effective intervention to boost utilization of ANC services and preparedness during pregnancy. Third, the maternal health programmes need to incorporate structured BPCR counselling within normal ANC sessions, to make sure women are well-prepared for

childbirth and complications. Finally, specific interventions to tackle geographic and financial barriers can help close inequalities in access to maternal care and maternal health outcomes in rural Bihar.

5.6 Strengths and Limitations

This study has several notable strengths. It draws upon a large, community-based sample (N = 11,164) from rural Bihar, with a multi-stage probability sampling design that ensures broad representativeness. The use of standardized, NFHS-aligned instruments enables comparability with national survey data. The simultaneous examination of both ANC utilization and BPCR within a single analytical framework, including six FLW counselling indicators, is a methodological contribution not widely replicated in Bihar-specific maternal health research.

The cross-sectional design does not permit causal inference, and reverse causality cannot be excluded. Recall bias may affect reporting of ANC services received and FLW counselling contacts, particularly for women whose deliveries occurred earlier in the eligibility window. The sub-sample sizes for certain FLW counselling variables were considerably smaller than the full sample (e.g., n = 1,463 for Godbharai-session variables), which may limit the power of bivariate tests for these indicators. The BPCR composite index was computed only among women who had planned for institutional delivery, which may introduce selection bias and restrict the generalizability of BPCR findings to the full sample. Additionally, the study was restricted to the rural population of Bihar, limiting generalizability to urban areas and other states.

A limitation of the present study is that the analysis was based on an interim dataset, as data collection and/or data processing were ongoing at the time of data extraction. Consequently, the study findings are based on the available sample and may differ slightly from estimates derived from the final complete dataset.

CHAPTER 6: Conclusion and Recommendations

6.1 Conclusion

This study analyzed the distribution of antenatal care utilization and birth preparedness and complication readiness as well as the determinants of the same among the women in rural Bihar based on the large dataset of the community-based study designed similar to the methodology implemented in the National Family Health Survey (NFHS). The study included two specific objectives; one to look into the socio-demographic factors affecting

ANC utilization and birth preparedness; and the other to investigate how ANC utilization was related to the practices of birth preparedness. Access to acceptable ANC (4+ visits) and good composite birth preparedness (women reporting having 4+ visits and a plan for the 4th visit) was 52.4% and 41.0%, respectively. Although there was almost total reach of the initial ANC contacts (97.7 %), many women were not able to complete the recommended number of visits, indicating a lack of continuity in antenatal care in rural Bihar. Counselling by frontline health workers (FLHWs) was also very limited by all six indicators assessed: blood donor advice coverage was 10.1% of women, which is a critical challenge as blood is very important to manage obstetric emergencies. The utilization of the ANC was independently and significantly related to parity, religion and caste.

Hindu women and women of higher parity had higher odds for adequate ANC while Marginalised women had lower odds. The inverse relationships of education with both ANC and BPCR in the adjusted models is interesting and probably due to the complex structural relationships between education and the private sector, as well as the underlying composition of the BPCR index – not a protective effect of the lower levels of education. The utilization of ANC was independently associated with birth preparedness (aOR = 0.85; 95% CI: 0.78–0.92; $p < 0.001$) but the direction is to be interpreted carefully. Together, the results indicate the multifactorial nature of maternal health-seeking behaviour within the rural context of Bihar, and show how integrating community health workers into the pathway to improved maternal health is the most operationally-flexible avenue for achieving this.

6.2 Recommendations

6.2.1 Policy Level

The existing Godbharai session protocol adopted by the Government of Bihar must be revised to always include specific competency based counselling services for all the 6 components of BPCR, including blood donor identification as a service. In addition to the indicators of ANC visits, State maternal health guidelines should set measurable targets for counselling coverage for BPCR. The disparities between the regions on the indicators of ANC and BPCR must be disaggregated by religion and caste and there should be an accountability mechanism for the districts which have disproportionately low levels of coverage in the Marginalised and Non-Hindu community in the state's equity framework.

6.2.2 Health System Level

Every visit to ANC should be used to measure the counselling content provided, rather

than focusing on the number of visits, and the quality of the content of the ANC services should be strengthened in rural Bihar. All health facilities are advised to have a structured checklists to confirm that the BPCR counselling has been delivered (financial planning, pre-identification of transport, identification of blood donors and arranging for a companion) during every visit. It is important that facilities upskill ASHA and ANM workers to provide the complete counselling package, as part of the BPCR, with adequate training, supervision and job aids.

6.2.3 Community Level

ASHA workers, as the first point of contact for women and the health system in rural Bihar, should be provided with structured BPCR communication materials and rewarded for BPCR counselling through performance-based payments that are specific to BPCR counselling. Enhanced community-based mobilization in the form of self-help groups, Mahila Arogya Samitis and other platforms available at the panchayat level should be used to spread the awareness message of birth preparedness and drive early registration for ANC among marginalized communities and non-Hindu households.

6.2.4 Programmatic Level

All national and state maternal health programmes such as JSY, PMSMA and the ASHA programme are supposed to include the promotion of BPCR as an explicit and measurable programmematic delivery. The Godbharai format of sessions must be explored and improved to make it more effective as a BPCR counselling platform, such as by community-capacitators building capacity and validated counselling aids in local languages. This is especially the case in the plan for blood donor mobilization, which also had the lowest counselling coverage (10.1%) and lowest preparedness rate (13.4%) among all the components of BPCR, and should be considered as a separate programmatic activity, not just an extension of the current BPCR activities. Supporting multiparity-specific outreach, it was established that although higher parity was associated with the utilization of ANC services, it was not associated with the utilization of BPCR, therefore, there is a need for multiparity-specific outreach to ensure that multiparous women, who were more likely to be complacent about their ANC utilization given prior uncomplicated deliveries, receive focused counselling during ANC contacts on emergency readiness and complication identification.

6.2.5 Future Research

Longitudinal or cohort study design should be used for future research to allow causal

inferences for the relationship between ANC and BPCR. Qualitative studies are also required to understand the mechanisms that bring the paradoxical inverse education–ANC correlation and the correlation between education–BPCR in the adjusted models, especially in the context of the private sector utilization of educated households. Research on preparedness should build and test BPCR indices that reflect a wider set of preparedness actions such as private-sector and insurance-based preparedness; so that a composite score can reflect preparedness over the entire socio-economic spectrum. Bihar requires geographic analyses at district and division level to provide pockets of low coverage to be targeted for intensification efforts. Finally, quasi-experimental quality-improvements in Godbharai would provide the evidence base to guide evidence-based policy reform.

Supplementary

A.1 Evidence Table

av.xlsx

A.2 Indicator Matix

av.xlsx

A.3 SAS code

sas_code_ayush.docx

Bibliography

1. Sakib MMH, Alam MK, Yasmin N, Rois R. Unveiling the sociodemographic and socioeconomic determinants of antenatal care utilization in Bangladesh: insights from the 2017-18 BDHS. Journal of health, population, and nutrition. 2025;44(1):159.
2. Kumar G, Choudhary TS, Srivastava A, Upadhyay RP, Taneja S, Bahl R, et al. Utilisation, equity and determinants of full antenatal care in India: analysis from the National Family Health Survey 4. BMC pregnancy and childbirth. 2019;19(1):327.
3. Girotra S, Malik M, Roy S, Basu S. Utilization and determinants of adequate quality antenatal care services in India: evidence from the National Family Health Survey (NFHS-5) (2019-21). BMC pregnancy and childbirth. 2023;23(1):800.
4. Bain LE, Aboagye RG, Dowou RK, Kongnyuy EJ, Memiah P, Amu H. Prevalence and determinants of maternal healthcare utilisation among young women in sub-Saharan Africa: cross-sectional analyses of demographic and health survey data. BMC public health. 2022;22(1):647.
5. Abebe TA, Debelew GT. Maternal health care services utilization and associated factors among pregnant women in Kersa district, Jimma zone, Southwest Ethiopia. PloS one. 2025;20(5):e0323977.
6. Demissie DB, Molla G, Tiruneh Tiyare F, Badacho AS, Tadele A. Magnitude, disparity, and predictors of poor-quality antenatal care service: A systematic review and meta-analysis. SAGE open medicine. 2024;12:20503121241248275.
7. Tibenderana JR, Kessy SA, Mlaponi DF, Mtenga JE, Gimonge J, Mwaitete NL, et al. The adequacy of ANC components received and associated factors among women of reproductive age in Tanzania. PloS one. 2024;19(11):e0301570.
8. Singh R, Neogi SB, Hazra A, Irani L, Ruducha J, Ahmad D, et al. Utilization of maternal health services and its determinants: a cross-sectional study among women in rural Uttar Pradesh, India. Journal of health, population, and nutrition. 2019;38(1):13.
9. Rustagi R, Basu S, Garg S, Singh MM, Mala YM. Utilization of antenatal care services and its sociodemographic correlates in urban and rural areas in Delhi, India. European journal of midwifery. 2021;5:40.
10. Habeeb SA, Abdel Basit IM, Salim AM, Qazwani M, Suwaydi HAM, Shubaili AIA, et al. Determinants of antenatal care utilization among Saudi females: application of Andersen's behavioral model: a cross-sectional study. BMC pregnancy and childbirth. 2025;25(1):1161.
11. Mohammed S, Worku A, Girma E. Receiving quality antenatal care service increases the chance of maternal use of skilled birth attendants in Ethiopia: Using a longitudinal panel survey. PloS one. 2022;17(12):e0279495.
12. Atta R RS, Aziz R, Sundas K, Mushtaq QA, Ahmad M. Association between antenatal care visits and birth preparedness among pregnant women. Journal of Sheikh Zayed Medical College. 2025;15(02).
13. Tejineh MS, Lumadi T. Pregnant women and health professionals' perceptions toward birth preparedness and complication readiness in Oromia,

Ethiopia. Therapeutic advances in reproductive health. 2025;19:26334941251345951.
14. Saaka M, Alhassan L. Prevalence and predictors of birth preparedness and complication readiness in the Kassena-Nankana district of Ghana: an analytical cross-sectional study. BMJ open. 2021;11(3):e042906.
15. Kiataphiwasu N, Kaewkiattikun K. Birth preparedness and complication readiness among pregnant women attending antenatal care at the Faculty of Medicine Vajira Hospital, Thailand. International journal of women's health. 2018;10:797-804.
16. Ahmed AM, Ahmed MA, Ahmed MH. Birth preparedness and complication readiness among recently delivered women in Hargeisa town, Somaliland: A community-based cross-sectional study. PloS one. 2024;19(4):e0302168.
17. Adu-Gyamfi M, Adoma PO, Acquah F, Tarkang EE. Birth preparedness and complication readiness among pregnant women: A facility-based Cross-sectional Study. AJPM Focus.
18. Opus B, Namatovu JF, Besigye IK, Okuuny V, Onyango JT. Determinants of birth preparedness and complications readiness among mothers attending the antenatal care clinic at Katakwi General Hospital, Eastern Uganda: a cross-sectional study. The Pan African medical journal. 2025;50:107.
19. Demsash AW, Bekana T, Kassie SY, Shibabaw AA, Dube GN, Walle AD, et al. Birth preparedness and pregnancy complication readiness and associated factors among pregnant women in Ethiopia: A multilevel analysis. PLOS global public health. 2024;4(5):e0003127.
20. Ali MA, Geremew H, Abate A, Bamlaku Golla E, Simegn MB, Kumbi H, et al. Complete continuum of care for maternal health services and determinants among mothers who gave birth in the last year in Chiro City, Eastern Ethiopia: a community-based cross-sectional study (2024). Frontiers in global women's health. 2024;5:1404001.
21. Alamrew A, Sisay A, Ayele M, Shitie Lake E, Kumie G, Hailu Mossie H, et al. Determinants of birth preparedness and complication readiness practice among reproductive-age women in Africa a systematic review and meta-analysis. BMC public health. 2024;24(1):3154.
22. Alamrew A, Ayele M, Shitie Lake E, Mulugeta C, Kumie G, Birara Zemariam A. Predictors of Birth Preparedness and Complication Readiness Practices Among Pregnant Women in Ethiopia, a Systematic Review and Meta-Analysis. International journal of public health. 2024;69:1607296.
23. Swain D, Parida SP, Jena SK, Das M, Das H. Impact of Community-Based Continuous Training on Promoting Birth Preparedness and Pregnancy Outcome in Rural Odisha, India: An Interventional Study. Journal of obstetrics and gynaecology of India. 2019;69(6):520-8.
24. Mola M, Arefeyine M, Abegaz Z, Kebede N. Birth preparedness, complication readiness, and associated factors among pregnant women in South Wollo Zone, Northeast Ethiopia. AJOG global reports. 2023;3(3):100255.
25. Dandona R, Kumar GA, Majumder M, Akbar M, Prasad Dora SS, Dandona L. Poor coverage of quality-adjusted antenatal care services: a population-level assessment by visit and source of antenatal care services in Bihar state of India. The Lancet regional health Southeast Asia. 2024;25:100332.
26. Dehury RK, Samal J. Maternal Health Situation in Bihar and Madhya Pradesh: A Comparative Analysis of State Fact Sheets of National Family Health

Survey (NFHS)-3 and 4. Journal of clinical and diagnostic research : JCDR. 2016;10(9):Ie01-ie4.
27. Shree N, Dutt D, Dasgupta A, Paul B, Bandyopadhyay L, Ghosh P, et al. A Study on Birth Preparedness and Complication Readiness among Women Attending Antenatal Clinics in a Rural Area of Hooghly District, West Bengal. 2023;16(6):837-45.
28. Manulata, Swain D. Utilization of Antenatal Healthcare Services, Associated Factors, and Pregnancy Outcomes Among Postnatal Women Who Delivered in Selected Rural Healthcare Centers in Odisha, Southeastern India. Cureus. 2025;17(2):e78591.
29. Pandey P, Srivastava RK, Kumari K, Pandey M. Status of Birth Preparedness and Complication Readiness of Pregnant Women and Recently Delivered Women in Rural Varanasi: Assessment of Current Scenario. 2022;47(2):249-52.
30. Sharma S, Sarathi Mohanty P, Omar R, Viramgami AP, Sharma N. Determinants and Utilization of Maternal Health Care Services in Urban Slums of an Industrialized City, in Western India. Journal of family & reproductive health. 2020;14(2):95-101.
31. Nath Jha S, Das S, Dey A, Roy R. Assessment of antenatal care received and its association with different factors among the postnatal mothers: A cross-sectional study. Journal of family medicine and primary care. 2025;14(8):3401-5.
32. Tafasa SM, Bekuma D, Fikadu W, Gelassa FR, Jebena DE, Zerihun E, et al. Birth preparedness, complication readiness and associated factors among pregnant women attending public health facilities in Chelia District, Central Ethiopia (2022): a cross-sectional study. BMJ open. 2024;14(11):e084945.
33. Mesele M, Anmut W. Birth preparedness and complication readiness practice among women attending antenatal care follow up in Yirgalem general hospital, southern Ethiopia. PLOS global public health. 2022;2(8):e0000864.
34. Akshaya KM, Shivalli S. Birth preparedness and complication readiness among the women beneficiaries of selected rural primary health centers of Dakshina Kannada district, Karnataka, India. PloS one. 2017;12(8):e0183739.
35. Tafasa SM, Bekuma D, Fikadu W, Gelassa FR, Jebena DE, Zerihun E, et al. Birth preparedness, complication readiness and associated factors among pregnant women attending public health facilities in Chelia District, Central Ethiopia (2022): a cross-sectional study. 2024;14(11):e084945.
36. Kharkongor R, Garod M, Jamir T, Albert S. Birth preparedness & complication readiness of pregnant women in Meghalaya, India. The Indian journal of medical research. 2025;162(6):779-85.

Ayush V D2

ORIGINALITY REPORT

12%	7%	8%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Mengesha, Solomon Tejineh. "Strategies for Improving Birth Preparedness Among Pregnant Women Attending Antenatal Care Clinics at Public Healthcare Facilities of Arsi Zone in Oromia, Ethiopia", University of South Africa (South Africa) Publication	1%
2	Agbo, Adanna I.. "Exploring the Factors Associated with the Use of Skilled Birth Attendants at Delivery in Rural South East Nigeria.", Morgan State University, 2021 Publication	1%
3	Masoi, Theresia John. "The Effectiveness of an Interactive Messaging Alert System on Knowledge of Obstetric and Newborn Danger Signs, Service Utilization, Birth Preparedness and Complication Readiness Among Pregnant Women in Dodoma Municipal: A Quasi-Experimental Study", University of Dodoma (Tanzania) Publication	<1%
4	pdfs.semanticscholar.org Internet Source	<1%
5	Singh, Lakhan. "An Investigation into Factors Affecting Obstetric Care in Rural Allahabad District of Uttar Pradesh.", International Institute for Population Sciences University, 2021 Publication	<1%