Factors Associated with Underutilization of Antenatal Care in Odisha, India: A Cross-Sectional Analysis Using the Data from NFHS-5(2019-21)

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***Abstract*—World Health Organization (WHO) revised its guidelines in 2016 to recommend a minimum of eight Antenatal Care contacts to ensure a positive pregnancy experience, despite recommendations, adherence to this schedule remains low among women in low and middle-income countries. In light of these updated standards, understanding the factors that influence ANC utilization becomes crucial for informing targeted interventions and policy reforms. Unit level data from the latest 5th round of the National Family and Health Survey (NFHS) has been used for this study. This analysis includes the most recent live births among women aged 15-49 years over the past five years (N = 7141) This study has taken adequate ANC visits that is *eight and more than eight visits to the health care facility as the outcome variable*. Based on Andersen's behavioral model, ten factors have been identified as potential explanatory variables. Multivariate analysis in this study indicates that women with lower levels of formal education from poorer households and residing in rural areas have higher odds of inadequate antenatal care visits. The logistic model shows that Mother's Education, Household Wealth Index, Birth Order, Distance, Insurance, and Pregnancy Intention are significant predictors of the outcome while Caste, Religion, and Sector are not statistically significant. Considering the WHO's new guidelines, our analysis reveals a serious underutilization of ANC. This study suggested, infrastructure development, education and poverty reduction initiatives should be pursued in order to enhance maternal health and access to prenatal care services.**

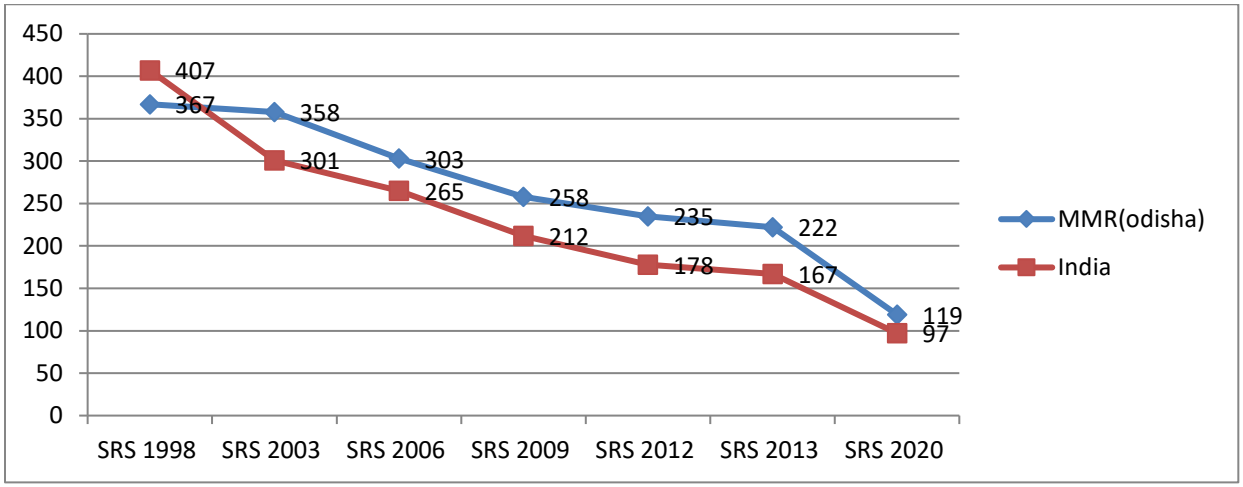
***Index Terms*—Antenatal Care, NFHS, Multivariate analysis, Logistic model**

I. INTRODUCTION

The World Health Organisation defines maternal mortality as the annual count of female deaths attributable to pregnancy or its management, irrespective of the timing or location of the pregnancy, excluding accidental or incidental causes during pregnancy and childbirth or within 42 days of termination of pregnancy (WHO). Between 2016 and 2020 around 2,87,000 women died from maternal causes worldwide, that is about 800 deaths per day or about one every two minute(WHO 2023).The United Nations Development Goals (SDGs)aim to reduce worldwide maternal death to less than 70/100,000 live births by 2030, with no nation having an MMR of more than 140/100,000. As a result India is well on its way to meeting these goals(UN 2019).Despite these advancements, the nation still accounts for 12% of all maternal deaths worldwide second only to Nigeria (MMEIG-2023).

In line with India, Odisha has made significant progress in reducing its Maternal Mortality Ratio (MMR) over the past decades. According to the Sample Registration System (SRS) data, the state's MMR declined from 367 per 100,000 live births in 1998 to 222 in 2012. Further, improvements were noted, with the MMR decreasing to 150 during 2016–18, and reaching 119 by 2018–20(SRSs)(Figure 1).Data reveals that both India and Odisha are still lagging behind in achieving the Sustainable Development Goal (SDG) target of reducing the Maternal Mortality Ratio (MMR) to 70 per 100,000 live births.

Figure No.1 Maternal Health status in India and Odisha



(Source: SRSs)

Many of these deaths are preventable with proper access to quality healthcare and effective intervention during the preconception, antenatal, delivery and post-natal periods (Bhutta et.al, 2014; Raatikainen et.al, 2007). Antenatal care (hence ANC) is vital for the well-being of pregnant women and their infants. It involves various essential components including regular monitoring of maternal health and early intervention to address potential risks(Singh et al,2023,Thakkar et al,2023,Kumar G et al,2019)

Recognizing the critical role of adequate antenatal care in improving mothers' survival and health outcomes, the World Health Organisation(WHO) has developed comprehensive guidelines outlining evidence–based intervention proven to enhance maternal and neonatal well-being(Tikmani et al,2019). Introduced in 2002, the WHO's Focused Antenatal Care(FANC) model recommended that pregnant women should attend a minimum of four comprehensive antenatal visits with a qualified healthcare provider during pregnancy(WHO,2016). Ideally, the first visit should occur in the first trimester, the second in the second trimester and the third and fourth during the third trimester (Purbey, Aet.al 2025). To accelerate progress toward achieving the Sustainable Development Goals(SDGs) related to maternal mortality by 2030,the WHO has also established a global target of 90% coverage for pregnant women receiving four or more antenatal care by 2025(Singh et al,2019).In India, since the initiation of national health survey in 1992,there has been a consistent upward trend in adequate antenatal care utilization, with an increasing proportion of women reporting at least four ANC visits with a health care provider(Kumar et al,2019; Ali, B.et.al 2020; Hamal, M,2020).

By adopting Andersen's Behavioral Model of Health service use, this study aims to examine the determinants of utilization of antenatal care in India (Andersen, R. M. 1995) . Figure1 shows, the conceptual framework provides a systematic approach to identify and to organize our analysis around external environmental factors, predisposing characteristics, enabling and need-based factors. For this study, underutilization or inadequate ANC is defined as receiving fewer than eight ANC visits provided by skilled healthcare professionals (WHO,2016).

While previous research (Prusty et.al, 2015, Mahapatra, 2015, Ghosal et.al 2024)explored the determinants of antenatal care (ANC) in India as well as in Odisha, much of it is based on earlier WHO guidelines that considered four ANC visits as adequate (WHO,2016). They also recommend future research to consider the new WHO recommendation and also the DHS-7 guideline recommends future surveys to adopt this indicator. So this study aims to understand if India would have been implemented this new indicator, what factors at the individual and community level, would affect the outcome at state level(Odisha). Again several previous studies (Rout,2015; Chakrabarti,2021;N.Mor,2025) have investigated the determinants of ANC utilization in Odisha, there remains a need to analyse more recent

data to capture current trend and identify persistence gap in ANC coverage and use. Hence this study use the data from the 2019-2021 Demographic and Health Survey (DHS) also known as the National Family Health Survey(NFHS-5) to explore which factors are contributing to the underutilization of ANC in Odisha. Finding from this articles can be used to inform policymakers and healthcare practitioners to measure the barriers to full ANC utilization and facilitate the design of intervention to address these barriers.

Concept and Indicators

Maternal health has been defined as safe motherhood, ensuring all women to receive the care they need to be safe and healthy through pregnancy and childbirth (Family Care International 2000).

The preventive and protective measures taken to save the mother from the problems arising from pregnancy and childbirth (and also abortion) are termed as Maternal healthcare. It thus, covers antenatal checkup, provision of Tetanus Toxoid (TT) vaccine during pregnancy, provision Iron and Folic Acid (IFA), institutional delivery, assistance of health personnel during delivery and post natal care (PNC).

There are some indicators through which generally Maternal health status of an area is measured. Those indicators are: level of availing of Antenatal, natal (delivery assisted by a doctor/nurse/ LHV/ANM/other health personnel, Institutional births) and post natal care, Women Body Mass index (BMI), Upper arm circumference, anaemic and maternal mortality ratio (MMR) are used to measure the Maternal health status but MMR is widely used to measure the health status of an area and it is defined as the number of maternal deaths per 100, 000 live births.

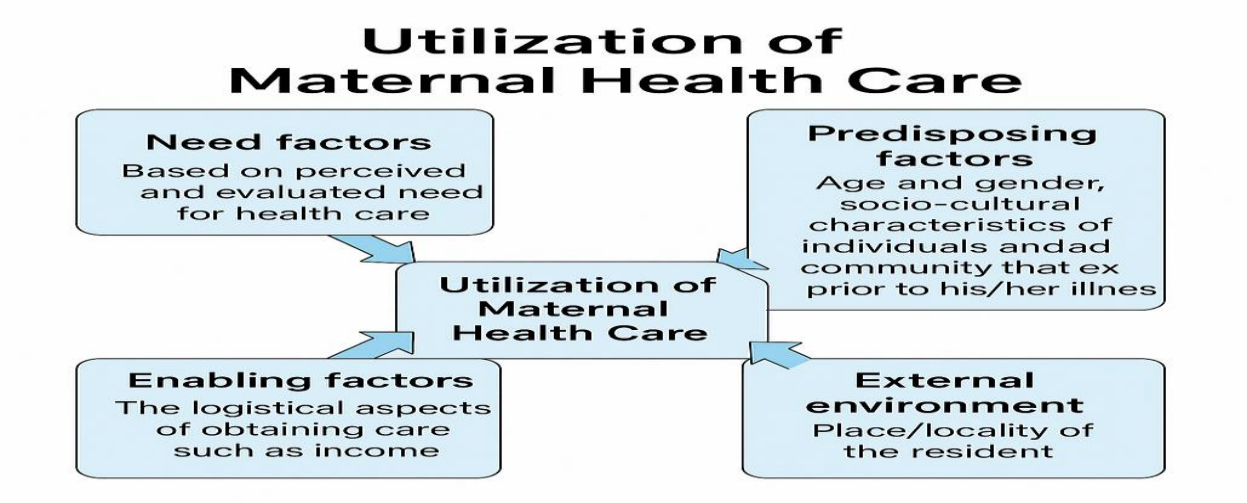
Antenatal care refers to the medical attention and support women receive between the onset of pregnancy and childbirth. In this study, the primary outcome examined is the number of visits made to a healthcare facility during this period.

CONCEPTUAL FRAMEWORK

This study adopts the *health behaviour model* (Aday and Andersen 1974) to discover conditions that either facilitate or obstruct utilization of maternal health care(ANC visits). The health behavioural model states that health care utilisation begins with the perception of morbidity, once, the morbidity has been perceived, four categories that determine the utilization of medical health services: 1. *Need Factors*: It is based on perceived and evaluated need for health care. 2. *Predisposing* factors such as the individual's age and gender, socio-cultural characteristics of individuals and community that exist before his/her illness. 3. *Enabling factors*: The logistical aspects of obtaining care such as income, health insurance 4. *External environment:* place/locality of the resident.

By adapting Andersen's Behavioral Model of Health Service Use, this study explores factors contributing to the utilization of antenatal care in India. As illustrated in Figure 2, the conceptual framework guides our analysis across four domains: external environmental factors, predisposing characteristics, enabling resources, and need factors.

Figure 2



The figure illustrates a conceptual framework for understanding the utilization of maternal health care. It identifies four major categories of influencing factors that shape whether and how individuals access maternal health services:

1. Need Factors: These are the perceived or medically evaluated health requirements of an individual. They reflect how much a person feels they need healthcare or how much a healthcare provider determines they require it. In maternal care, this might involve recognizing pregnancy complications or preventive checkups. 2. Predisposing Factors : These relate to individual and community characteristics that exist before a health issue arises. They include: Age, Gender, Cultural beliefs, Education, Social attitudes toward health and illness. These factors shape attitudes and behaviors toward seeking maternal care. 3. Enabling Factors:These involve the practical ability to obtain health services. Examples include:Household ,Income, Availability of health insurance, Access to transportation, Healthcare facility proximity Even if a woman recognizes a need and is willing to seek care, these factors determine whether she can access it. 4. External Environment: This refers to the place or locality where a person resides. It includes: Urban vs rural setting, quality and quantity of local health infrastructure, Government support and policies. These environmental conditions can significantly facilitate or limit access to maternal health services.

Together, these four interconnected components influence the extent to which maternal health care services are utilized. This framework is useful in designing policies, identifying barriers, and targeting interventions.

While previous research (Dehuri et.al 2016; Gopalakrishnan et.al,2015, Sahoo et.al 2017; S Pati et.al,2020) explored the determinants of antenatal care (ANC) in India as well as in Odisha, much of it is based on earlier WHO guidelines that considered four ANC visits as adequate. They also recommend future research to consider the new WHO recommendation and also the DHS-7 guideline recommends future survey to adopt this indicator. So this study aims to understand if India would have been implementing this new indicator, what factors in individual and community level would affect the outcome at state level(Odisha) .There is now a critical need to re-examine this topic using recent data and updated guidelines. To address this gap, we analyse data from the 2019–2021 Demographic and Health Survey (DHS-7), also known as the National Family Health Survey (NFHS-5), following the latest WHO recommendation of a minimum of eight ANC visits (WHO,2016). Our findings, aim to identify current service gaps and the factors influencing ANC utilization trends, thereby providing valuable insights for policymakers and healthcare providers to design targeted interventions and improve maternal health outcomes across states and country.

II. OBJECTIVE

The main objective of this study is to examine the socio-economic determinants of utilization of adequate antenatal care in Odisha.

DATA SOURCE AND METHODOLOGY

This study is a cross-sectional study using data from the fifth round of India's National Family Health Survey (NFHS-5), carried out between 2019 and 2021. This large-scale survey, also known as the Demographic Health Survey, was led by the International Institute for Population Sciences (IIPS). It collected information from a representative sample of 639,699 households across India.

In case of Odisha NFHS-5 fieldwork was conducted in all 30 districts of the state from 19th January 2020 to 21st March 2020 prior to the lockdown and from 30th November 2020 to 31st March 2021, by the Indian Institute of Health Management Research (IIHMR). The rural sample was selected through a two-stage sample design with villages as the Primary Sampling Units (PSUs) at the first stage (selected with probability proportional to size), followed by a random selection of 22 households in each PSU at the second stage. In urban areas, there was also a two-stage sample design with Census Enumeration Blocks (CEB) selected at the first stage and a random selection of 22 households in each CEB at the second stage. At the second stage in both urban and rural areas, households were selected after conducting a complete mapping and household listing operation in the selected first-stage units. Information was collected from 26,467 households, 27,971 women age 15-49 and 3,865 men age 15-54. [IIPS-2021] The original women's data from the survey were reorganized and standardized by assigning common (uniform) variable names. This process created a

cleaned and structured dataset called the Individual Recode dataset (IAIR7CFL). We used this version of the data for our study. Odisha data set was filtered from India data set, using STATA. The NFHS dataset provides information on birth indices ranging from the first to the most recent birth. This study, focuses exclusively on recent births and antenatal care (ANC) utilization in NFHS -5 period. We have restricted the analysis to births classified under birth index one (bidx_1) in the data set. Hence, this analysis utilized data from women who participated in the NFHS-5 and reported a recent live birth. Out of 27,971 women 19,482 has recent live birth and among them 7,141women had paid at least one antenatal visit to health care facility. These 7,141 women formed the final sample for this study

Ethical clearance: This study was a secondary analysis of de-identified data **(**all personal information that could be used to identify an individual has been removed) from a dataset or record from the NFHS dataset for India, which is readily available in the public domain. Informed consent was obtained from original survey participants and survey protocol was approved by institutional review board at the International Institute for Population Sciences, Mumbai.

OUTCOME AND EXPLANATORY VARIABLES

The outcome variable in this study is adequate antenatal care (ANC) visits, defined in accordance with WHO standards as receiving eight or more antenatal visits from skilled healthcare professionals (2016 WHO ANC Model). To facilitate analysis, ANC visits were recoded into a dichotomous variable with two categories: *adequate ANC* (≥8 visits) and *inadequate ANC* (<8 visits). For women who reported multiple live births during the five-year survey reference period, data from the most recent pregnancy is used to ensure consistency.

Guided by the Andersen Behavioral Model, prior ANC research, and domain knowledge, we identified 10 explanatory variables for inclusion in our analysis. These are: place of residence(sector), maternal age, religion, caste, maternal education level, household wealth index, birth order, health insurance coverage, perceived distance to a health facility and pregnancy intention (Ogbo FA et.al, 2019;Titaley CR et.al,2010; Mbuagbawet.al,2015).

Consistent with Andersen's framework, these variables were organized into four domains: external environment, predisposing characteristics, enabling factors, and need factors (ref figure 1)

Table 1: Description of Outcome and explanatory variables

Variable Name	Type	Description	Expected Relation with Dependent Variable	Probable Values/Range
Dependent Variable				
ANC_visit( )	Binary	0 – Inadequate ANC, 1 – Adequate ANC	—	0 to 1
Independent Variables				
A. Predisposing Factors				
1.Age (v013)	Categorical	Mother's age in 5- year groups 15-19 20-24 25-29 30-34 35-39 40-44 45-49	Negative	15 to 49

Variable Name	Type	Description	Expected Relation with Dependent Variable	Probable Values/Range
2.Mother_Education (v106)	Categorical	0 – No education, 1 – Primary, 2 – Secondary, 3 – Higher	Positive	0 to 3
3.Religion (v130)	Categorical	1 – Hindu, 2 – Muslim, 3 – Christian, 4 – Others	Negative	1 to 4
4.Caste	Categorical	1.SC 2.ST 3.OBC 4.Other 5.Don't know	Positive	1 to 5
B. Need Factor				
5.Birth_Order (bord_01)	Ordered	1 – 1st, 2 – 2nd–3rd, 3 – 4th–5th, 4 – ≥6th	Negative	1 to more than 6
6.Preg_Intention (m10_1)	Categorical	0 – Not wanted, 1 – Wanted	Positive	0 to 1
C. External Environment				
7.Sector (v025)	Binary	1 – Rural, 2 – Urban	Positive	1 to 2
D. Enabling Factors				
8.Household_WealthIndex (v190)	Categorical	1 – Poorest, 2 – Poorer, 3 – Middle, 4 – Richer, 5 – Richest	Positive	1 to 5
9.Insurance (v481)	Binary	0 – Not covered, 1 – Covered	Positive	0 to 1
10.Distance (v467d)	Categorical	0 – No problem, 1 – Big problem, 2 – Not a big problem	Negative	0 to 2

The table 3 presents a comprehensive overview of the variables used in the analysis of antenatal care (ANC) utilization. The dependent variable is *ANC visit*, which is binary and indicates whether a woman received adequate antenatal care (1) or not (0).

The independent variables are categorized into four groups based on the conceptual framework:

1. Predisposing Factors: Include socio-demographic variables such as the mother's age (categorized in 5-year groups), respondent highest education level, classified as no education to higher education, religion of the respondent is categorized as Hindu, Muslim, Christian and other and caste is categorized as SC,ST,OBC,Others and don't know.These variables represent baseline characteristics that may influence health-seeking behavior. A positive relationship is expected for education, whereas religion and age may show a negative association with ANC utilization.
2. Need Factor: Captured by the birth order of the child and pregnancy intention. Higher birth order is expected to be negatively associated with adequate ANC visits, whereas pregnancies that were wanted are likely to show a positive relationship.
3. External Environment: The sector of residence (urban or rural) reflects the contextual environment. Urban residence is expected to be positively associated with ANC utilization due to better access to health facilities.
4. Enabling Factors: These include household wealth index, Insurance coverage, and perceived distance to the health facility. Higher wealth and Insurance coverage are expected to facilitate greater use of services, while greater distance is considered a barrier and may negatively impact ANC utilization.

Each variable is described by type, coding, expected effect on the dependent variable, and the range in the dataset.

STATISTICAL ANALYSIS

Statistical approach in this study is similar to previous published research (Ogbo FA et al, 2019; Kumar G et.al 2019; Titaley CR et.al, 2010). At first, a descriptive analysis was done to report survey frequencies and prevalence of adequate ANC visits. Then the association between independent variables and adequate ANC visits was analysed by the help of binary logistic regression. Variables exhibiting a p-value of <0.20 in the initial univariate analysis were incorporated into the final multivariate model.

Variables exhibiting a p-value of <0.20 in the initial univariate analysis were incorporated into the final multivariate model. We considered association in the multivariate logistic regression analysis statistically significant when the p-value was less than 0.05. Results are presented as crude and adjusted odd ratio with 95% confidence intervals(CI).

This analysis was performed using STATA© 17.0. To check the over and under representation of sample, we used Stata's svyset command to account for sample weight, clustering, and stratification because the survey had a multi-stage sampling design.

III. RESULTS AND DISCUSSION

Distribution of ANC utilization of the 7,141 women in our weighted sample, 72.36% (95% CI: 70.16-72.26%) had an inadequate number of antenatal care visits (Table 2). The prevalence of inadequate ANC visits was highest among those reporting a birth order of 6 or greater (89.82%); those lacking any formal education (80.60%); or those belonging to the poorest quintile (79.25%) (Table 2). Women who belonged to the wealthiest quintile (37.78%), attended higher education (37.65%), or lived in an urban setting (31.75%) had the highest prevalence of adequate ANC visits (Table 3).

Table. 2 Frequency and prevalence of ANC utilization, NFHS-5

Variable		
Number of ANC visits	N	Prevalence Rate [95% CI]
Inadequate, <8	5,167	72.36 [70.16-72.61]
Adequate, ≥8	1,974	27.64 [27.73-29.83]
Total	7,141	

(Calculated by the author from NFHS-5 data set)

Factors associated with ANC utilization from a multivariate analysis

Table No.3: Distribution of ANC Utilization and Characteristics of Women who gave Birth in the last 5 Years (NFHS-5)

Variable	N	Inadequate ANC (%)	Adequate ANC (≥ 8visits) (%)
External Environment			
Rural	6049	4422 (73.11)	1627 (26.89)
Urban	1092	745 (68.22)	346 (31.78)
Predisposing Characteristics			
Maternal Age			
15–19	179	135 (75.33)	44 (24.67)
20–24	1922	1421 (73.93)	501 (26.07)
25–29	2846	2038 (71.64)	807 (28.36)
30–34	1506	1063 (70.64)	442 (29.36)
35–39	538	386 (71.96)	150 (28.04)
40–44	129	107 (82.91)	22 (17.09)
45–49	20	14 (70.55)	6 (29.45)
Religion			
Hindu	6669	4816 (72.22)	1852 (27.78)
Muslim	168	117 (69.60)	51 (30.40)
Christian	271	201 (74.24)	69 (25.76)
Others	32	32 (100.00)	0 (0.00)
Caste			
SC	1477	1050 (71.15)	426 (28.85)
ST	1962	1544 (78.70)	417 (21.30)
OBC	2369	1662 (70.17)	706 (29.83)
Other	1199	823 (68.62)	376 (31.38)
Don’t know	27	23 (88.48)	4 (11.52)
Education Level (Highest Attained)			
No education	1328	1070 (80.60)	257 (19.40)
Primary	923	670 (72.60)	252 (27.40)
Secondary	4187	2988 (71.38)	1198 (28.62)
Higher	703	438 (62.35)	265 (37.65)
Enabling Factors			
Household Wealth Index			
Poorest	2503	1983 (79.25)	519 (20.75)
Poorer	1758	1247 (70.98)	510 (29.02)
Middle	1343	931 (69.38)	411 (30.62)
Richer	967	649 (67.17)	317 (32.83)
Richest	570	354 (62.22)	215 (37.78)

Health Insurance Coverage			
Not covered	5276	3873 (73.43)	1401 (26.56)
Covered	1866	1293 (69.31)	572 (30.69)
Distance to Health Facility			
No problem	2452	1610 (65.67)	841 (34.33)
Big problem	2325	1836 (78.95)	489 (21.05)
Not a big problem	2363	1720 (72.82)	642 (27.18)
Need Factors			
Pregnancy Intention			
Not wanted	618	473 (76.58)	144 (23.42)
Wanted	6523	4693 (71.96)	1828 (28.04)
Birth Order			
1st	2884	2010 (69.76)	872 (30.24)
2nd–3rd	3719	2711 (72.90)	1007 (27.10)
4th–5th	442	352 (80.82)	84 (19.07)
>6th	96	86 (89.82)	10 (10.18)

(Calculated by the author from NFHS-5 data set)

IV. DISCUSSION

The table titled "Distribution of ANC Utilization and Characteristics of Women Who Gave Birth in the Last 5 Years (NFHS-5) provides a detailed breakdown of antenatal care (ANC) utilization—specifically, whether women received less than 8 ANC visits (inadequate) or 8 or more ANC visits (adequate) based on various demographic, socioeconomic and health-related characteristics. Here is a detailed explanation of the data:

Residence: Of the 6,049 women in rural areas, 73.11% had inadequate ANC, while 26.89% achieved adequate ANC. In urban areas (N=1,092), 68.22% had inadequate ANC, and 31.78% had adequate ANC. Urban women were more likely to receive adequate ANC, possibly due to better access to healthcare facilities.

Maternal Age: ANC utilization varied by age. Women aged 40–44 (n=129) had the highest rate of inadequate ANC (82.91%) and the lowest adequate ANC (17.09%). Women aged 30–34 (N=1,506) had the highest adequate ANC rate (29.36%). Younger women (15–19) showed high inadequate ANC (75.33%), indicating potential barriers in early motherhood.

Religion: Hindu women (N=6,669) had 72.22% inadequate and 27.78% adequate ANC. Muslim women (n=168) had slightly better adequate ANC (30.40%). Christian women (N=271) had 74.24% inadequate ANC, while women of other religions (N=32) had 100% inadequate ANC, suggesting significant disparities.

Caste: Scheduled Tribes (ST) (n=1,962) had the highest inadequate ANC (78.70%) and lowest adequate ANC (21.30%). Other Backward Classes (OBC) (n=2,369) and Other castes (N=1,199) had higher adequate ANC (29.83% and 31.38%, respectively), indicating caste-based inequities.

Education: Women with no education (N=1,328) had the highest inadequate ANC (80.60%) and lowest adequate ANC (19.40%). Those with higher education (N=703) had the lowest inadequate ANC (62.35%) and highest adequate ANC (37.65%), underscoring education's role in healthcare access.

Household Wealth Index: Wealth significantly influenced ANC utilization. The poorest quintile (N=2,503) had 79.25% inadequate ANC and 20.75%

adequate ANC, while the richest quintile (N=570) had 62.22% inadequate and 37.78% adequate ANC, reflecting economic barriers.

Health Insurance Coverage: Women with health insurance (N=1,866) had lower inadequate ANC (69.31%) and higher adequate ANC (30.69%) compared to those not covered (N=5,276; 73.43% inadequate, 26.56% adequate), suggesting insurance facilitates access.

Distance to Health Facility: Women reporting no problem with distance (N=2,452) had the lowest inadequate ANC (65.67%) and highest adequate ANC (34.33%). Those facing a big problem (N=2,325) had 78.95% inadequate ANC, highlighting geographic barriers.

Pregnancy Intention: Women with unwanted pregnancies (N=618) had higher inadequate ANC (76.58%) and lower adequate ANC (23.42%) compared to those with wanted pregnancies (N=6,523; 71.96% inadequate, 28.04% adequate), indicating motivational factors.

Birth Order: First births (N=2,884) had the highest adequate ANC (30.24%). Higher birth orders (4th–5th: 80.82% inadequate; >6th: 89.82% inadequate) showed significantly lower adequate ANC, reflecting reduced care-seeking with subsequent pregnancies

The findings reveal significant disparities in ANC utilization. Rural residence, lower education, poverty, and higher birth orders are associated with inadequate ANC, while urban residence, higher education, wealth, and first births correlate with adequate ANC. Caste and religion also play roles, with ST women and those of minority religions facing greater barriers. Enabling factors like health insurance and proximity to health facilities significantly improve ANC uptake. These patterns align with the Andersen Behavioral Model, where external environment, predisposing characteristics, enabling factors, and need factors shape healthcare utilization

ANALYSIS AND INTERPRETATION BASED ON LOGISTIC REGRESSION

Previous multivariate analysis shows the link between each predicator variable and the outcome variable. It does not show the strength of association between outcome and predicators variables. In this analysis we used a Binary logistics regression analysis to know the degree of association. Regression technique is used to assess the strength of a relationship between one dependent variable and independent variable(s). Regression analysis helps in predicting how much variance is being accounted in a single response (dependent variable) by a set of independent variables.

Linear regression analysis requires dependent variable as a continuous variable but here the dependent variable (ANC visits, whether Inadequate or adequate) is in the form of dichotomous or in binary form (Inadequate=0, adequate =1). Due to this situation, binary logistic regression is used to measure the impact of one of more predictor variables on the outcome. Logistic regression analysis is a method to determine the reason-result relationship of independent variables with dependent variable. Since logistic regression calculated the probability of success over the probability of failure, the result of the analysis is in the form of an odds ratio. In logistics regression, the expected outcome is represented by 1 while the other is coded as 0.

Before running the analysis, the models are checked for multicollinearity [1] using the variance inflation factor (VIF). The VIF measures how much of the variance of the coefficient estimate is being by multicollinearity. VIF values greater than 10 indicate multicollinearity. The models used in this study satisfy this condition(mean VIF=1.29) and this indicates that covariates are not collinear. Therefore, no explanatory variable was dropped from the analysis. After checking for collinearity, we included all independent variables which were found to be significant in bivariate analyses.

Table No. 6 Multiple logistic regression of factors associated with underutilization of ANC visits in India, NFHS-5.

[1] Multicollinearity (or collinearity) occurs when two or more independent variables in the model are approximately determined by a linear combination of other independent variables in the model. The multicollinearity problem does not result in biased coefficient estimates, but does increase the standard error of the estimates and thus reduces the degree of confidence that one can place in them.

Table-4: The result of logistic Regression Analysis

WHO_newanc	Odds ratio	Robust std. err.	z	P>|z|	[95% conf.	interval]
Age	1.014548	.0064594	2.27	0.023	1.001967	1.027288
Caste	.9489443	.0263033	-1.89	0.059	.8987661	1.001924
Mother_Education	1.102669	.0412531	2.61	0.009	1.024708	1.186562
Household_WealthIndex	1.141322	.0317781	4.75	0.000	1.080707	1.205337
Birth_Order	.832972	.0427853	-3.56	0.000	.7531974	.921196
Distance	.8555986	.0292139	-4.57	0.000	.8002142	.9148162
Insurance	1.294087	.0778484	4.29	0.000	1.150159	1.456027
Religion	.9634956	.0588733	-0.61	0.543	.8547478	1.086079
Sector	.9814541	.0880358	-0.21	0.835	.8232235	1.170098
Pregn_Intention	1.244548	.1308821	2.08	0.037	1.012734	1.529423
_cons	.250646	.0578265	-6.00	0.000	.1594705	.3939501

(Calculated by the author from NFHS-5 data set)

This table shows the relationship between the predictor (independent variable) and the outcome.

OR = 1: Indicates no association between the two events. The odds are the same in both groups.

OR > 1: Suggests a positive association. The event is more likely to occur in the group where the other event is present.

OR < 1: Suggests a negative association. The event is less likely to occur in the group where the other event is present.

If the value of confidence interval is greater than 1 (both lower values and upper values are greater than 1) means there is direct relationship; that as the predictor variable increase, the odds of number of visits increase. If the value is less than one means the opposite relationship; that is predictor variable increase the odds of number of visits decrease.

Here in this analysis, Age was significantly associated with the outcome, with each year increase in age resulting in a 1.45% increase in the odds of [the outcome variable] (OR = 1.014, p = 0.023).

Caste was marginally significant (p = 0.059), with an odds ratio of 0.949, indicating a slight decrease in the odds of [the outcome variable] for individuals from certain caste backgrounds.

Mother's education had a positive and significant effect, with each additional unit of education increasing the odds of [the outcome variable] by 10.27% (OR = 1.103, p = 0.009).

Household Wealth Index was also positively associated with the outcome. A higher wealth index increased the odds of [the outcome variable] by 14.13% (OR = 1.141, p < 0.0001).

Birth order was negatively associated with the outcome. Each additional birth order number decreased the odds by 16.7% (OR = 0.833, p < 0.0001).

Distance had a significant negative effect. As distance increased, the odds of [the outcome variable] decreased by 14.4% (OR = 0.856, p < 0.0001).

Insurance coverage was positively associated with the outcome, with individuals with insurance having 29.41% higher odds of the ANC visits[the outcome variable] (OR = 1.294, p < 0.0001).

Religion was not significantly associated with the outcome (OR = 0.963, p = 0.543).

Sector (urban/rural) also showed no significant association (OR = 0.981, p = 0.835).

Finally, Pregnancy intention was positively associated with the outcome. Those with intended pregnancies had 24.45% higher odds of [the outcome variable] (OR = 1.245, p = 0.037).

The baseline odds, as indicated by the constant, were 0.251, suggesting that without the influence of any predictors, the likelihood of [the outcome variable] occurring is relatively low.

The model indicates that Mother's Education, Household Wealth Index, Birth Order, Distance, Insurance, and Pregnancy Intention are significant predictors of the outcome (WHO_newanc), while Caste, Religion, and Sector are not statistically significant.

V. FINDINGS AND CONCLUSION

The quality of India’s health care delivery system needs to be improved to meet the Sustainable

Development Goals. The present study identified different significant socio economic factors, factors associated with inadequate utilization of maternal health care. The quality of care given during the antenatal periods is an indicator that determines maternal and child health. Various studies support the present study findings that pre disposing, enabling, need and environmental factors are associated with number of visit to health care facility. (Singh, G. 2012; Prusty et al. 2015; Yadav, A. K. 2020; Purbey, et al. 2025). Appropriate training and counseling programs for parents and caregivers during the antenatal period is vital in reducing preventable risk factors and thereby reducing the both maternal and neonatal mortality rate. Also, it is essential to train healthcare professionals at all levels to identify the risk and plan appropriate strategies, programs, and treatment to reduce the risk of preventable maternal deaths and morbidities.

The study concluded that the Mother's Education, Household Wealth Index, Birth Order, Distance, Insurance, and Pregnancy Intention are significant predictors of the outcome (WHO_newanc), while Caste, Religion, and Sector are not statistically significant. Understanding antenatal risk factors is essential for healthcare providers to develop comprehensive risk assessment strategies aimed at reducing maternal morbidity and mortality within clinical settings. Enhanced awareness of these risk factors enables timely preventive interventions, thereby improving maternal health outcomes and supporting progress toward Sustainable Development Goal (SDG) 3, which aims to eliminate preventable maternal deaths. In addition to facility-based care, community-level interventions play a critical role. These should focus on educating families to provide appropriate care for pregnant and lactating women, while also equipping frontline health workers and healthcare professionals with the necessary skills to identify and address modifiable risk factors. Such an integrated approach is pivotal to achieving SDG 3 and advancing maternal health. In fact Maternal mortality is not a mystery. We know why it happens, and we have the tools to prevent it. The question, therefore, is not whether we can end preventable maternal deaths, but whether we will.

VI. STRENGTHS AND LIMITATIONS

Our analysis used data from the most recent iteration of a nationally representative survey sample, which is a noteworthy strength. We also explored the interaction between ANC utili zation and a diverse array of explanatory variables. . Our definition of adequate ANC utilization reflect the WHO's most recent guidelines, which recommend eight or more ANC visits [WHO 2016].

However, our study has many limitations. Notably, responses to NFHS-5 were self-reported, introducing possible recall bias. While we focused on antenatal care visits, our study did not consider other recommended health behaviors during the antenatal period such as iron supplementation and tetanus toxoid vaccination. We recommend additional research exploring quality of care during ANC visits– i.e. cover age and adequacy, timeliness of visits, clinical competency of recommendations made, and nature of patient-provider communication (Singh et.al 2019). Qualitative analysis exploring the experiences of women from different socio-demographic groups would help policymakers better understand the challenges that high-risk groups face when seeking antenatal care. Additional research utilizing the WHO's ANC monitoring framework to look beyond ANC visits and investigate barriers to a positive pregnancy experience is also needed.

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