ORIGINAL RESEARCH ARTICLE

Determinants of Inadequate Antenatal Care Utilization Among Indian Women: Evidence From NFHS-5 Using Andersen's Behavioural Model

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ABSTRACT

Background: In India, despite major investments in maternal health, the utilization of antenatal care (ANC) is suboptimal. This study explores the predictors of less than adequate ANC among Indian women, guided by Andersen's Behavioral Model.

Methods: The study included a nationally representative subsample of 19,089 women from NFHS-5 (2019-21), of whom 13,670 (71.6%) had adequate ANC (≥4 visits) and 5,419 (28.4%) inadequate ANC. Suboptimal ANC was defined as less than 4 pregnancy visits. Associated factors were determined by chi-square tests and multivariable logistic regression.

Results: Insufficient ANC coverage was found in 28.4% of the participants. College or university attendance was a strong predictor of adequate care versus none. The use of the poorest quintiles was poorer than that of the richest for women. Urban place of residence was protective as opposed to rural. ANC use was higher in the South than in the North. Long distances to water sources (>30 minutes) were associated with poor care. The main obstacles were distance to the facilities (32.03%), financial difficulties (27.07%), and transportation problems (23.95%).

Conclusions: There is enormous inequity in the utilization of ANC along socioeconomic, geographic, and demographic lines in India. Integrated interventions are needed to mitigate supply and demand-side prerequisites for maternal healthcare, focusing on the most socially and geographically excluded to enhance both access to and use of maternal healthcare services.

Keywords: Antenatal care utilization, Maternal healthcare, Healthcare disparities, Andersen's Behavioral Model, India

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INTRODUCTION

Maternal health constitutes a major public health priority worldwide, with particular urgency in developing nations where rates of maternal death and illness continue to be disproportionately elevated.[1] Even though maternal health delivery in India has improved significantly in recent years, India still contributes significantly to global maternal mortality with about 35,000 women dying every year.[2] ANC is considered a valuable preventive health-care strategy that enables the early identification of hazards, the prevention and treatment of complications during pregnancy, and the promotion of health of the pregnant woman and her unborn baby.[3] The World Health Organization (WHO) previously recommended at least four ANC consultations for uncomplicated pregnancies until 2016[4] but the recommendation was revised to recommend eight contacts in order to optimize the health of mothers and their babies more.

Despite large investments on maternal health programming such as Janani Suraksha Yojana (JSY)and Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA), full uptake of ANC fails to reach universal levels for all across India.[5] New information from the National Family Health Survey (NFHS-5, 2019-21) reveals that, while the percentage of women able to receive antenatal care at the national level has increased, large disparities remain. For example, 54% of women in the poorest wealth quintile attended at least four ANC visits compared to 85% 100 in the richest quintile. Equally, rural women (66%) trail urban women (82%) and there are still glaring regional variations, with the southern states having more than 80%, while in some of the northern states, the coverage is less than 60%.[6] Identifying the factors that contribute to inadequate ANC utilization is essential for creating targeted strategies and policies designed to improve maternal health service access and use.

Previous studies have identified several contributors to ANC usage in India, including education level, income status, place of residence, maternal age, parity and behavioural customs.[7,8] However, many of the former studies have limited geographic distributions, or have not conducted comprehensive analysis on multidimensional factors influencing the frequency of ANC utilization guided by established theoretical frameworks.[9] In contrast to these limitations, we employ national representative data (NFHS-5) and directly employ Andersen's behavioral model to assess in detail the predisposing, enabling and need factors associated with antenatal care utilization. Through the use of extensive and representative data collection, the application of a well-reasoned theoretical framework and strong empirical evidence, the study contributes to the evidence base beyond spatially or otherwise atheoretical findings, offering more generalizable perspectives around which maternal health policy can be developed in India. In this study, the Andersen's Framework has been operationalized with respect to the NFHS-5' s variables related to antenatal care service utilization. Predisposing factors such as maternal age, educational status, caste, and religion represented demographic and social factors. Facilitative resources included wealth quintiles, residence (urban/rural), and media exposure, which affect access to healthcare. Need-related/system factors were measured by region (North, South, East, West) and time to the nearest water source as an indicator of remoteness and infrastructure. This structured modification facilitated the systematic categorization and rationale of the determinants within the framework.[10] This framework offers a useful guideline for understanding the complex interrelationships of the individual, household, and environmental determinants that influence maternal healthcare utilization.

The aim of this study is to investigate key drivers of limited ANC use among Indian women using data from the nationally representative NFHS-5 and applying Andersen's Behavioral Model as the conceptual framework. By investigating these factors in depth, this research seeks to provide evidence to policy and program decisions to enhance the availability and accessibility of ANC and the quality of care, and to ultimately contribute to the promotion of Maternal and Child Health throughout India. The results would be of particular importance for the policy makers, providers or public health professionals involved in maternal health advocacy and service delivery in the varied context of India.

METHODOLOGY

Study Design and Data Source: This study is an analytical cross-sectional study that used data from the National Family Health Survey (NFHS-5) 2019-2021. Permission to use the NFHS-5 dataset[6] was obtained from the Demographic and Health Surveys (DHS) Program database. The data was extracted in SPSS format and variables related to use of antenatal care were downloaded according to the objectives of the study. The NFHS-5 is a national-level survey conducted by the Ministry of Health and Family Welfare, and technically assisted by the International Institute for Population Sciences (IIPS). It was a comprehensive survey that was conducted to capture demographic, health and nutrition data and employed a two-stage stratified random sampling design with coverage from all 28 states and 8 union territories of India. The NFHS-5 standardized its survey instruments in terms of questionnaires, physical measurements, and laboratory tests, and the overall sample included 6,36,699 households, 7,24,115 women aged 15-49 years, and 1,01,839 men aged 15-54 years[6].

Study Population and Sampling: This study focused on women aged 15-49 years who experienced a live birth within five years prior to the survey and

provided information on their ANC service utilization. Women who had experienced stillbirths, pregnancy terminations, or incomplete data regarding ANC visit frequency were excluded. Within the NFHS-5 database, 190,898 women met the eligibility requirements and provided complete information about ANC visits. For ease of calculation and to ensure timely completion of the cost analysis a randomly 10% selected sample (n = 19,089) was drawn from the eligible population using a simple random sampling. An initial comparison verified that, the subsample closely followed the main sample with respect to the important sociodemographic distributions (age, education, residence and wealth), protecting for representativeness. Furthermore, its subsample of almost 19,000 women is still powerful enough to detect important associations. For transparency, we conducted sensitivity checks on selected variables in the full dataset, which yielded similar effect estimates. This research examined women between 15 and 49 years old who had a live birth in the five years before the survey and reported on their use of antenatal care (ANC) services. The study excluded women who experienced stillbirths, terminated pregnancies, or had incomplete data on ANC visit frequency. The National Family Health Survey-5 (NFHS-5) database contained 190,898 eligible women with complete information about ANC visits. To facilitate efficient analysis and practical computation, a 10% random sample (n = 19,089) was drawn from the eligible population using simple random sampling. This sample size was considered sufficient to detect significant associations and still have the national data have a representative value.

Conceptual Framework This investigation employed Andersen's Behavioral Model of Health Services Utilization as its theoretical foundation.[10] This model categorizes the factors influencing healthcare usage into three areas: predisposing characteristics, which include demographic and social structural traits present before the onset of illness; enabling resources, which consist of individual, household, and community elements that either facilitate or hinder access to services; and need variables, which involve both personal perceptions of health and clinical assessments of care needs.

Variables and Measures: The outcome variable was suboptimal ANC utilization that was measured as having less than four ANC visits during the last pregnancy according to the prevailing WHO recommendation for the duration of the study period[4]. Although WHO currently advises at least 8 contacts, we opted for the 4-visit cut-off to allow comparability to previous NFHS-driven research. To assess robustness under the current standard, we also conducted a sensitivity analysis using the 8-contact cutoff, which increased the prevalence of inadequate ANC but did not materially alter the key predictors identified. A dichotomous variable was constructed as follows: 1 = inadequate ANC (<4 visits) and 0 = sufficient ANC (≥4 visits).

Explanatory Variables: Theoretical constructs of Andersen's Behavioral Model, and findings from prior studies, were used to guide the selection of explanatory variables. Predisposing factors included maternal age (three categories: 15-24 years, 25-34 years, 35+ years), level of education (no schooling, primary, secondary and above secondary), social caste classification (SC, ST, OBC, Others) and religion (Hindu, Muslim, others). The quintiles of household wealth (poorest, poor, middle, rich, and richest), the type of residence (rural or urban), and exposure to mass media (radio, television, or print) were all considered enabling resources. Geographical location was arranged by regional divisions (North, South, East, and West based on state classification) as used in NFHS reports and earlier demographic studies in India. This grouping improves comparability with previous NFHS-based analyses and reflects sociocultural and healthcare system similarities within regions. Additionally, distance to water sources (≤30 min, >30 min) was used as an indicator of community remoteness. Variables with significant missing data were not included in the analytical framework; instead, variables were chosen based on their conceptual significance to the theoretical model and their accessibility in the NFHS-5 survey instrument.

Statistical analysis was carried out using SPSS version 25 with a multistep analytical approach. As well as to profile the distribution of insufficiency of ANC use across population sub-groups and summarize the demographics of the participants, preliminary descriptive statistics including frequency counts and percentages were computed. Chi-square tests were conducted to examine the univariate relationships between individual explanatory variables and inadequate prenatal care; p-values less than 0.05 were considered significant. Taking back elimination strategy, multivariable logistic regression was performed with all theoretically important predictors. Variance inflation factors (all <2.5) were used to evaluate multicollinearity. Education × wealth and residence × region was tested as potential interaction terms, but none of them were found to be significant and were thus removed from the final model. In order to explore if risk factors might differ in the residential environment, analyses were also done separately for urban and rural subpopulations. The NFHS-5 sampling weights were applied in all the analyses to account for the complex survey design, stratification and clustering. This was carried out in the Complex Samples module of SPSS and weight variables; strata and primary sampling unit were defined to achieve nationally representative estimates.

Ethical approval: The main NFHS-5 study received ethical approval from both the ICF Institutional Review Board and the Institutional Review Board of the International Institute for Population Sciences (IIPS), Mumbai. To maintain participant security, this retrospective data analysis was performed utilizing stripped datasets with no personal identifying information.

RESULTS

Participant Demographics and ANC Service Utilization Patterns: Nineteen thousand eighty-nine (n = 19089) women were enrolled in the study of which 13,670(71.6%) had received adequate antenatal care (≥4 consults) and the rest 5,419 (28.4%) were inadequately cared for (<4 consults) in their recent pregnancies. Table 1 illustrates how inadequate ANC distribution varies across participant characteristics.

Table 1: Distribution of Adequate and Inadequate Antenatal Care Utilization Across Determinants Categorized by Andersen's Behavioral Model (NFHS-5, n=19,089)

Determinant (Andersen's Model Category)	Adequate ANC n (%) (n = 13,670)	Inadequate ANC n (%) (n = 5,419)	Chi-Square	p-value
Predisposing Factors				
Age				
15-24	4911 (73.51)	1770 (26.49)	3.45	0.062
25-34	6915 (80.5)	1675 (19.5)		
35+	2925 (76.61)	893 (23.39)		
Education Level				
No Education	2,860 (60.28)	1,885 (39.72)	15.24	<0.001
Primary	4,570 (67.83)	2,190 (32.17)		
Secondary	6,015 (77.52)	1,744 (22.48)		
Higher	3,907 (88.17)	528 (11.83)		
Enabling Factors				
Wealth Index				
Poorest	3,169 (61.81)	1,958 (38.19)	2.12	<0.001
Poor	3,520 (70.19)	1,487 (29.81)		
Middle	5,592 (75.53)	1,812 (24.47)		
Rich	7,012 (80.23)	1,730 (19.77)		
Richest	7,682 (85.57)	1,298 (14.43)		
Place of Residence				
Urban	7,322 (80.07)	1,831 (19.93)	12.65	<0.001
Rural	6,348 (70.09)	3,588 (29.91)		
Media Exposure				
Yes (Access to Radio/TV/Newspapers)	9,542 (83.34)	1,910 (16.66)	0.98	0.322
No	4,128 (69.90)	2,509 (30.10)		
Need/System Factors				
Region				
North	8,754 (79.01)	2,335 (20.99)	4.21	0.04
South	8,181 (85.03)	1,448 (14.97)		
East	5,024 (72.38)	1,877 (27.62)		
West	5,355 (81.89)	1,064 (18.11)		
Time to Water Source				
≤30 minutes	9,400 (80.67)	2,262 (19.33)	6.34	0.012
>30 minutes	4,270 (68.87)	3,157 (31.13)		

Table 2: Multivariable Logistic Regression Analysis of Factors Associated with ANC Utilization

Variable	Unadjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Age (ref: 15-24)						
25-34	0.67	0.61-0.74	<0.001	0.91	0.83-1.01	0.082
35+	0.86	0.77-0.96	0.006	1.05	0.94-1.17	0.376
Education (ref: No education)						
Primary	0.70	0.65-0.76	<0.001	0.88	0.78-0.99	0.037
Secondary	0.42	0.39-0.46	<0.001	0.69	0.58-0.81	<0.001
Higher	0.21	0.18-0.24	<0.001	0.61	0.44-0.86	0.004
Wealth Index (ref: Poorest)						
Poor	0.67	0.62-0.73	<0.001	0.94	0.84-1.05	0.263
Middle	0.49	0.45-0.53	<0.001	0.89	0.78-1.02	0.091
Rich	0.39	0.36-0.42	<0.001	0.84	0.71-1.00	0.051
Richest	0.25	0.23-0.27	<0.001	0.76	0.61-0.94	0.012
Place of Residence (ref: Rural)						
Urban	0.58	0.54-0.63	<0.001	0.81	0.71-0.92	0.001
Media Exposure (ref: No)						
Yes	0.47	0.44-0.51	<0.001	0.94	0.84-1.06	0.310
Region (ref: North)						
South	0.65	0.60-0.71	<0.001	0.79	0.66-0.95	0.012
East	1.38	1.27-1.50	<0.001	1.07	0.91-1.26	0.387
West	0.83	0.76-0.91	<0.001	0.94	0.78-1.13	0.498
Time to Water Source (ref: ≤30 min)						
>30 min	1.89	1.76-2.04	<0.001	1.14	1.01-1.30	0.036

OR – Odds Ratio

Table 3: Stratified Bivariate Analysis of Inadequate ANC by Urban-Rural Residence

Variable	Urban			Rural		
	Inadequate ANC (%)	Chi-Square	p-value	Inadequate ANC (%)	Chi-Square	p-value
Education Level						
No Education	410 (28.5)	8.52	0.004	1,475 (42.1)	21.43	<0.001
Primary	540 (22.7)			1,650 (35.6)		
Secondary	620 (16.3)			1,520 (28.4)		
Higher	200 (10.4)			390 (16.8)		
Wealth Index						
Poorest	580 (35.2)	6.02	0.014	1,378 (45.5)	18.37	<0.001
Poor	510 (28.9)			1,295 (38.2)		
Middle	430 (19.5)			1,160 (31.1)		
Rich	360 (15.1)			970 (25.6)		
Richest	250 (11.2)			760 (18.4)		

Note: Chi-square values are shown only for index categories; others were not calculated.

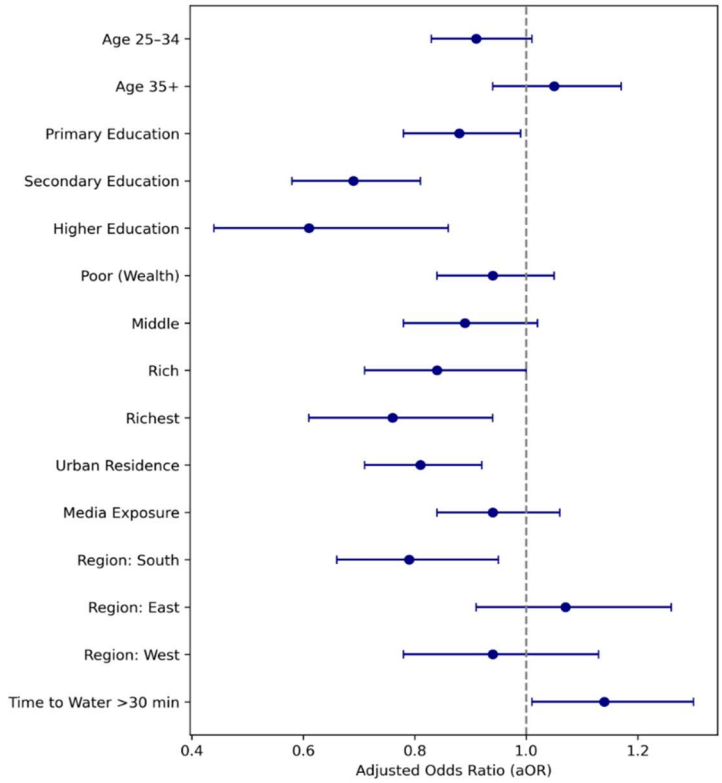

Fig 1: Adjusted odds ratios (aOR) with 95% confidence intervals for determinants of inadequate ANC utilization (forest plot)

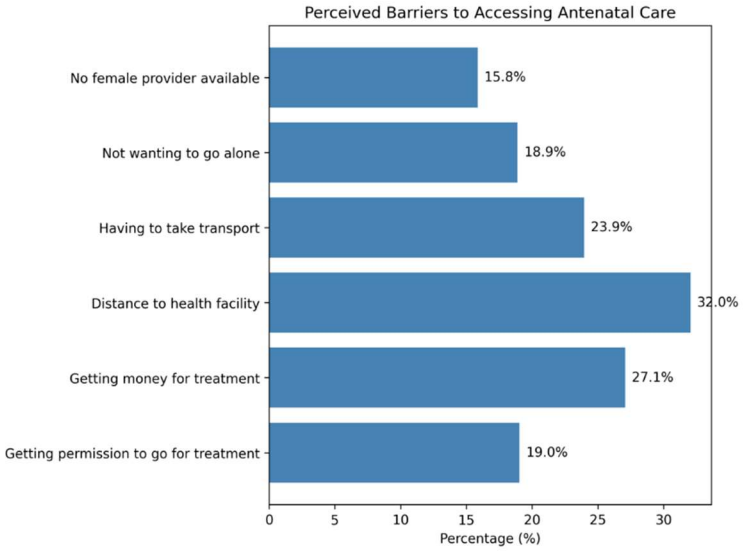

Fig 2: Reported Barriers to Antenatal Care Utilization Among Women with Inadequate ANC (n = 5,419)

Examining inadequate ANC across educational backgrounds revealed notable differences. The proportion of women with inadequate care decreased progressively as education level increased, from 39.7% for women with no formal education to 32.2% with primary education, 22.5% with secondary education, and 11.8% with higher education (p<0.001).

There were clear differences in ANC Care use across economic strata. The rate of inadequate ANC was 38.2% in the poorest quintile and 14.4% in the richest quintile (p<0.001). Inadequate care rates were higher in rural areas (29.9%) than in urban areas (19.9%) (p<0.001).

Regional analysis showed significant regional variation, with the East performing worst (27.6%) and the South best (15.0% inadequate care) (p=0.040). Accessibility was also significant: women who walked more than 30 minutes to a water source had 31.1% inadequate ANC, whereas respondents with closer access had 19.3% (p=0.012).

Women of the younger age group presented a lower rate of inadequate care (19.5%), followed by those who were aged <25 years (26.5%), by those who were 35 years or older (26.5%), and by those who were 35 years or older (23.4%), although the differences according to age group were not statistically significant (p=0.062). There were differences in inequity by level of media exposure while 16.7% of exposed women had received insufficient care, this was the case for 30.1% of women with no media exposure the association was not statistically significant(p=0.322).

Multivariate Regression Findings: After adjusting for confounding variables, Table 2 presents the findings of multivariate logistic regression that identify independent risk factors for insufficient ANC.

The best indicator of adequate care was found to be educational attainment. Compared to not attending school, primary education decreased the risk of inadequate ANC (aOR: 0.88; 95% CI: 0.78-0.99; p=0.037). Higher education offered the greatest benefit (aOR: 0.61; 95% CI: 0.44-0.86; p=0.004), while secondary education offered the most protection (aOR: 0.69; 95% CI: 0.58-0.81; p<0.001).

Only the top quintile had significantly lower odds of inadequate care than the bottom quintile, according to wealth analysis (aOR: 0.76; 95% CI: 0.61-0.94; p=0.012). After adjustment, middle-income groups did not exhibit any significant differences, but the second-highest quintile approached significance (aOR: 0.84; 95% CI: 0.71-1.00; p=0.051).

Compared to rural living, urban living provided protection against insufficient ANC (aOR: 0.81; 95% CI: 0.71-0.92; p=0.001). Other regional comparisons were not significant after adjustment, but living in a southern region gave a significant advantage over northern areas (aOR: 0.79; 95% CI: 0.66-0.95; p=0.012).

When compared to convenient access, an extended water collection time (>30 minutes) increased the risk of inadequate ANC (aOR: 1.14; 95% CI: 1.01-1.30; p=0.036). There were no significant adjusted associations found for age, media exposure, or eastern/western regional residence. (Fig. 1)

Urban-Rural Comparative Analysis: Results of a stratified analysis comparing inadequate ANC by residential type, with an emphasis on wealth and education variables, are shown in Table 3. Although effect sizes varied by location, both settings showed significant relationships between education and wealth and care utilization.

Urban educational gradients ranged from 10.4% among university graduates to 28.5% among unschooled women (p=0.004). Rural gradients were more pronounced, ranging from 16.8% among women with tertiary education to 42.1% among participants with no formal education (p<0.001).

Economic trends held true in all contexts. Inadequate care in urban areas varied from 11.2% (richest) to 35.2% (poorest) (p=0.014). The percentages in rural areas were 45.5% and 18.4%, respectively (p<0.001). These results imply that socioeconomic factors are more potent in rural settings where the prevalence of baseline substandard care is higher than in urban areas.

Healthcare Access Obstacles: Obstacles to healthcare access reported by women with insufficient ANC (n=5,419) are listed in Figure 2. The biggest barrier was facility distance (32.03%), which was followed by budgetary constraints (27.07%) and transportation issues (23.95%). Significant social barriers were found: 19.04% mentioned the need for permission, 18.89% said it was uncomfortable to travel alone, and 15.85% said there weren't enough female providers.

We performed sensitivity analyses using different definitions of inadequate ANC in order to evaluate the robustness of our findings. Initially, we used the revised WHO threshold of <8 contacts rather than <4 visits. The prevalence of inadequate ANC rose from 28.4% to 63.7% under this definition. The direction and significance of the main predictors, however, stayed consistent: wealth status remained protective (aOR for richest quintile: 0.72; 95% CI: 0.60-0.87), and women with higher education continued to have significantly lower odds of inadequate ANC (aOR for higher education: 0.59; 95% CI: 0.46-0.77). Living in a rural area was still linked to increased risk (aOR: 1.21; 95% CI: 1.08-1.35).

Second, we re-estimated the regression models without media exposure, which in the original analysis did not reveal any significant association (aOR: 0.94; 95% CI: 0.84-1.06). The results were not significantly altered by the removal of this variable; for instance, the aOR for secondary education stayed at 0.70 (95% CI: 0.59-0.82) as opposed to 0.69 (95% CI: 0.58-0.81) in the main model. These findings indicate

that the main results are robust to different ANC cut-offs and model specifications.

DISCUSSION

Based on the NFHS-5, this nationally representative data were used along with Andersen's Behavioral Model as a theoretical framework to analyse what contributes to poor utilization of prenatal care among Indian women. Despite national initiatives to increase coverage, the results show that 28.4% of Indian women received fewer than the WHO-recommended minimum of four ANC visits during their most recent pregnancy, pointing to significant gaps in maternal healthcare utilization.

Our analysis found that predisposing, enabling, and need factors significantly influenced ANC utilization, which is consistent with Andersen's model. With a somewhat clear gradient in odds of reporting inadequate ANC over rising education levels, maternal education emerged as one of the relatively strongest predictors of adequate ANC use among predisposing factor variables. This finding is in line with studies done in low and middle-income countries, including India that indicate that women's education has a protective effect on maternal healthcare utilisation.[11,12] Education enhances the health literacy of women, and their autonomy and knowledge of the services available, all of which contribute to their healthcare seeking.[13] The odds of inadequate ANC were 31% lower for women with secondary education in our study than for those without (aOR: 0.69; 95% CI: 0.58-0.81). Using NFHS-4 data, Kumar G et al.[14] discovered a nearly identical effect (aOR: 0.71), confirming education's ongoing protective effect across survey periods.

Residence and economic status were the significant predictors of ANC utilization in enabling factors. Women in the richest quintile were 24% less likely than women in the poorest quintile to have inadequate ANC, revealing the protective effect of wealth. This economic gradient, reported in previous Indian studies[15,16] and reflects the various ways in which socioeconomic status influences access to health care, not only through financial means but also social capital. Consistent with the findings of the NFHS-4 analysis, which indicated that women in the richest wealth group were 1.49 times as likely to receive full ANC as women in the poorest wealth group (aOR: 1.49; 95% CI: 1.34±1.66), we also observed that women in the richest wealth group had 24% reduced odds of inadequate ANC (aOR: 0.76). Although the alignment of Indian government with free access to public services such as maternal health through Janani Suraksha Yojana (JSY)[12] have been established as successful measure to reduce economic barrier for maternal healthcare[17] our results have indicated continuing socio-economic inequity in utilization of ANC.

Urban women, however, had 19% lower odds (aOR 0.81, 95% CI: 0.74, 0.90) of not receive enough ANC compared to rural women after adjusting for other variables, suggesting that place of residence was associated with better ANC utilization. This urban advantage has been well researched in studies conducted in India as well as other developing countries.[18,19] The discrepancies between rural and urban areas could be attributed to differences in transportation networks or healthcare infrastructure, availability of providers, and social norms with regard to prenatal care.[20] We found that residing in urban; 19% less odds of inadequate ANC (aOR: 0.81; 95% CI: 0.71-0.92). This is in line with Singh SK et al.[21] NFHS-4 analysis, which found an urban advantage with an aOR of 0.79.

There were regional differences in the use of ANC, and women from the South fared considerably better than those from the North. This trend is consistent with Southern states' historically superior performance on health and development metrics, which have been linked to improved governance, stronger health systems, and higher female literacy.[22] Time to the water point was strongly correlated with ANC attendance (as a rough indicator of remoteness and infrastructural development). The likelihood of not having received an adequate ANC was also 14% higher in women who had to walk more than 30 minutes to drinking water, therefore, lack of physical access continues to be a barrier to care.

While wealth and education were significant in both the urban and rural contexts, as evidence by our stratified analysis, their effect was greater in rural areas, owing to a higher baseline of inadequacy. According to this study, among rural women in poor social - economic conditions, the multiple level of marginalization occurs due to the fact that their socioeconomic vulnerabilities add up to geographical exclusion.[23] In rural areas, prioritised interventions on the demand-side barriers (awareness, financial protection) and supply-side constraints (health infrastructure, quality) may be particularly important.

A deeper probe into different reported barriers to receiving low ANC among women has provided information about the challenges that this disadvantaged group may face. The primary obstacles were access to medical centers (32.03%) economic (27.07%), and transportation constraints (23.95%). Similar barriers to physical access have been recorded in other qualitative studies conducted in rural India[24,25] and highlight the need for interventions such as community-based care, mobile health units and transport vouchers that improve access to health services.

The importance of addressing sociocultural determinants of healthcare utilization is highlighted by the persistence of social and gender-related barriers, such as needing family permission (19.04%), feeling uncomfortable traveling alone (18.89%), and lacking female providers (15.85%). These results are consistent with research by Srivastava A et al.[26], who found that family dynamics and gender norms have a

significant impact on how women in North India seek healthcare. These barriers might be lessened by interventions that involve family members, especially husbands and mothers-in-law, and expand the pool of female providers.[27]

Strengths and Limitations

The use of nationally representative data, the application of a theoretical framework, the thorough analysis of numerous determinants, and the investigation of both statistical associations and perceived barriers are some of the study's strong points. But there are some restrictions that should be taken into account. First, causal inference is not possible due to the cross-sectional nature of the data. Second, quality factors and visit timing are not taken into account when defining inadequate ANC based only on visit volume. Recall bias is another limitation because the number of ANC visits was self-reported and could be over- or under-reported, particularly by women recalling pregnancies from a number of years ago. This might have caused adequate ANC use to be mistakenly classified as inadequate. By using prospective data collection, shorter recall periods, or verifying self-reported ANC visits against maternal health cards and medical facility records, future research could reduce recall bias. Fourth, although we incorporated a number of important Andersen's model determinants, data constraints prevented us from analyzing some of them, including pregnancy intentions, health beliefs, and the caliber of prior medical experiences. Due to inconsistent ANC visit data, women who had stillbirths or pregnancy terminations were not included in this study. However, given that women who experience unfavorable pregnancy outcomes frequently exhibit unique patterns of care utilization, this exclusion may have understated the prevalence of inadequate ANC. Where possible, such high-risk groups should be incorporated into studies since these healthcare-seeking patterns might provide vital information on shortcomings of the quality and coverage of ANC. In spite of the evaluation of barriers to ANC use, the data did not afford an opportunity for a separate analysis according to the social class or rural/urban category sub-group. Such stratification should be investigated in future research to better capture contextual variations in barriers.

Conclusion

In the context of overall improvements in coverage of ANC, this study shows continued disparities in the usage of ANC among Indian women by poverty, location, and demographic characteristics. Attaining universal maternal healthcare: A socio-economic approach by direct cash incentive policy in South Asian and Indian Maternal healthcare settings is commendable, but accessibility should be further improved using demand-side incentives to reduce financial barriers, investment in women's education and upgrading rural health facilities such as mobile health units with enhanced transport facilities.

Comprehensive strategy addressing both supply and demand-side factors is necessary. This will involve facility investments, quality enhancements, community participation and targeted system support for geographical and socially-excluded groups with numerous barriers to accessing care.

Further research is needed to explore quality of antenatal care other than number of visits and family dynamics including male participation in maternal health care decision making and effectiveness of the intervention. Prospective research into the evolution of determinants as policy changes would be interesting.

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References

1. World Health Organization, UNICEF, UNFPA, World Bank Group, United Nations Population Division. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva (CH): World Health Organization; 2023. Available from: https://www.who.int/publications/i/item/97892400

68759 [Accessed on 05 Sep, 2025]

2. Meh C, Sharma A, Ram U, Fadel S, Correa N, Snelgrove JW, et al. Trends in maternal mortality in India over two decades in nationally representative surveys. BJOG. 2022;129(4):550-561. DOI: https://doi.org/10.1111/1471-0528.16888

3. Afulani PA, Altman M, Musana J, Sudhinaraset M. Conceptualizing pathways linking women's empowerment and prematurity in developing countries. BMC Pregnancy Childbirth. 2017;17(Suppl 2):338. DOI: https://doi.org/10.1186/s12884-017-1502-6 PMid:29143627 PMCid:PMC5688445

4. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva (CH): World Health Organization; 2016. Available from: https://www.who.int/publications/i/item/9789241549912 [Accessed on 05 Sep, 2025]

5. Meitei WB, Singh A. The nexus between maternal antenatal care attendance, newborn postnatal care and neonatal mortality in India: a matched case-control study. BMC Pregnancy Childbirth. 2024;24(1):691. DOI: https://doi.org/10.1186/s12884-024-06881-6 PMid:39438848 PMCid:PMC11520158

6. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019-21: India. Mumbai (IN): IIPS; 2022.

7. Singh PK, Kumar C, Rai RK, Singh L. Factors associated with maternal healthcare services utilization in nine high focus states in India: a multilevel analysis based on 14,385 communities in 292 districts. Health Policy Plan. 2014;29(5):542-559. DOI: https://doi.org/10.1093/heapol/czt039 PMid:23783832

8. Sanneving L, Trygg N, Saxena D, Mavalankar D, Thomsen S. Inequity in India: the case of maternal and reproductive health. Glob Health Action. 2013;6:19145. DOI: https://doi.org/10.3402/gha.v6i0.19145 PMid:23561028 PMCid:PMC3617912

9. Roy MP, Mohan U, Singh SK, Singh VK, Srivastava AK. Determinants of utilization of antenatal care services in rural Lucknow, India. J Family Med Prim Care. 2013;2(1):55-59. DOI: https://doi.org/10.4103/2249-4863.109946 PMid:24479045 PMCid:PMC3894022

10. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? J Health Soc Behav. 1995; 36(1): 1-10. DOI: https://doi.org/10.2307/2137284 PMid:7738325

11. Fagbamigbe AF, Idemudia ES. Barriers to antenatal care use in Nigeria: evidences from non-users and implications for maternal health programming. BMC Pregnancy Childbirth. 2015; 15:95. DOI: https://doi.org/10.1186/s12884-015-0527-y

12. Lim SS, Dandona L, Hoisington JA, James SL, Hogan MC, Gakidou E. India's Janani Suraksha Yojana, a conditional cash transfer programme to increase births in health facilities: an impact evaluation. Lancet. 2010;375(9730):2009-2023. DOI: https://doi.org/10.1016/S0140-6736(10)60744-1

13. Bhowmik J, Biswas R, Ananna N. Women's education and coverage of skilled birth attendance: an assessment of Sustainable Development Goal 3.1 in the South and Southeast Asian region. PLoS One. 2020;15(4):e0231489. DOI: https://doi.org/10.1371/journal.pone.0231489 PMid:32315328

14. 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 Childbirth. 2019;19(1):327. DOI: https://doi.org/10.1186/s12884-019-2473-6 PMid:31488080 PMCid:PMC6727513

15. Joe W, Perkins JM, Kumar S, Rajpal S, Subramanian SV. Institutional delivery in India, 2004-14: unravelling the equity-enhancing contributions of the public sector. Health Policy Plan. 2018 Jun 1;33(5):645-653. DOI: https://doi.org/10.1093/heapol/czy029. PMID: 29659831.

16. Ali B, Chauhan S. Inequalities in the utilisation of maternal health care in rural India: evidences from National Family Health Survey III and IV. BMC Public Health. 2020;20:369. DOI: https://doi.org/10.1186/s12889-020-08480-4

17. Singh A, Palaniyandi S, Palaniyandi A, Gupta V, Panika RK, et al. A cross-sectional study to assess the utilization pattern of maternal health services and associated factors in aspirational district of Haryana, India. J Family Med Prim Care. 2021;10(8): 2879-2885. DOI: https://doi.org/10.4103/jfmpc.jfmpc_1762_20 PMid:34660420 PMCid:PMC8483117

18. Yaya S, Bishwajit G, Ekholuenetale M. Factors associated with the utilization of institutional delivery services in Bangladesh. PLoS One. 2017;12(2):e0171573. DOI: https://doi.org/10.1371/journal.pone.0171573 PMid:28192478

19. Kumar S, Dansereau E, Murray CJ. Does distance matter for institutional delivery in rural India? Appl Econ. 2014; 46(33): 4091-4103. DOI: https://doi.org/10.1080/00036846.2014.916391

20. Agarwal S, Curtis SL, Angeles G, Speizer IS, Singh K, Thomas JC. The impact of India's accredited social health activist (ASHA) program on the utilization of maternity services: a nationally representative longitudinal modelling study. Hum Resour Health. 2019;17(1):68. DOI: https://doi.org/10.1186/s12960-019-0402-4 PMid:31277652 PMCid:PMC6612177

21. Singh SK, Kaur R, Gupta M, Kumar R. Impact of National Rural Health Mission on perinatal mortality in rural India. Indian Pediatr. 2012;49(2):136-138. DOI: https://doi.org/10.1007/s13312-012-0022-8 PMid:21992866

22. Navaneetham K, Dharmalingam A. Utilization of maternal health care services in Southern India. Soc Sci Med. 2002;55 (10):1849-1869. DOI: https://doi.org/10.1016/S0277-9536(01)00313-6 PMid:12383469

23. Kesterton AJ, Cleland J, Sloggett A, Ronsmans C. Institutional delivery in rural India: the relative importance of accessibility and economic status. BMC Pregnancy Childbirth. 2010;10:30. DOI: https://doi.org/10.1186/1471-2393-10-30

24. Joshi C, Torvaldsen S, Hodgson R, Hayen A. Factors associated with the use and quality of antenatal care in Nepal: a population-based study using the demographic and health survey data. BMC Pregnancy Childbirth. 2014;14:94. DOI: https://doi.org/10.1186/1471-2393-14-94 PMid:24589139

25. Vidler M, Ramadurg U, Charantimath U, Katageri G, Karadiguddi C, et al. Utilization of maternal health care services and their determinants in Karnataka State, India. Reprod Health. 2016;13(Suppl 1):37. DOI: https://doi.org/10.1186/s12978-016-0138-8 PMid:27356502 PMCid:PMC4943501

26. Srivastava A, Mahmood S, Mishra P, Shrotriya V. Correlates of maternal health care utilization in rohilkhand region, India. Ann Med Health Sci Res. 2014 May;4(3):417-25. DOI: https://doi.org/10.4103/2141-9248.133471. PMID: 24971219;

27. Bhattacharyya S, Srivastava A, Avan BI. Delivery should happen soon and my pain will be reduced: understanding women's perception of good delivery care in India. Glob Health Action. 2013;6(1):22635. DOI: https://doi.org/10.3402/gha.v6i0.22635 PMid:24267316 PMCid:PMC3838967