

Prevalence and Determinants of Delayed Antenatal Care Initiation Among Pregnant Women in Bangladesh: A Nationally Representative Cross-Sectional Study

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Abstract

Background

Delayed initiation of antenatal care (ANC) remains a major public health concern in Bangladesh, contributing to adverse maternal and neonatal outcomes. This study aimed to estimate the national prevalence of late ANC initiation and identify its sociodemographic, economic, and obstetric determinants among reproductive-age women in Bangladesh.

Methods

We analyzed data from the Bangladesh Demographic and Health Survey (BDHS) 2022, including 5,103 women aged 15–49 years who had at least one birth in the five years preceding the survey. Late ANC initiation was defined as a first ANC visit occurring after the first trimester of pregnancy (i.e., beyond 12 completed gestational weeks). Descriptive statistics, design-based chi-square tests, and complex-survey-weighted binary logistic regression (unadjusted and adjusted) were performed using Stata 17. Socioeconomic inequality in ANC timing was quantified using the concentration index.

Results

The overall prevalence of late ANC initiation was 62.0% (95% CI: 60.0%–63.9%). In the adjusted logistic regression, women with no formal education (AOR: 2.11; 95% CI: 1.34–3.32), women belonging to the poorest wealth quintile (AOR: 2.58; 95% CI: 1.91–3.49), those without media exposure (AOR: 1.25; 95% CI: 1.07–1.45), and those who perceived distance to a health facility as a barrier (AOR: 1.21; 95% CI: 1.05–1.39) had significantly higher odds of delayed ANC initiation. Women with a history of caesarean section (AOR: 0.68; 95% CI: 0.58–0.80) and prior abortion (AOR: 0.69; 95% CI: 0.54–0.89) were significantly less likely to delay ANC initiation. Substantial regional variation was observed across administrative divisions. The concentration index of -0.143 indicated a pro-rich inequality in timely ANC uptake.

Conclusions

Late ANC initiation remains highly prevalent in Bangladesh, with pronounced socioeconomic and geographic disparities. Targeted interventions addressing educational inequity, poverty, media access, and healthcare proximity are urgently needed to improve timely maternal care engagement, particularly among rural, low-income, and less-educated women.

Introduction

Antenatal care (ANC) is a cornerstone of safe motherhood, providing a structured platform for the early detection and management of pregnancy-related complications, health education, nutritional support, immunization, and referral to higher-level care. The World Health Organization (WHO) recommends that all pregnant women initiate ANC within the first trimester and complete at least eight contacts over the course of their pregnancy (1). Timely initiation of ANC in the first trimester is particularly critical, as it allows for early screening of gestational conditions such as anemia, hypertensive disorders, gestational diabetes, and infections, and provides the opportunity for folic acid supplementation and HIV counselling (2, 3).

Maternal mortality remains a pressing global concern. Each year, approximately 300,000 women die from pregnancy and childbirth-related complications, with the vast majority of deaths occurring in low- and middle-income countries (LMICs) (4). The global maternal mortality ratio (MMR) was estimated at 211 per 100,000 live births in 2017, with LMICs bearing a disproportionate burden (2). Reducing preventable maternal deaths is a central target of the Sustainable Development Goals (SDG 3.1), and strengthening ANC coverage and quality has been demonstrated to reduce neonatal mortality by up to 71%, stillbirths by 33%, and maternal mortality by 54% in LMICs (5, 6). Despite this evidence, many women in LMICs do not initiate ANC at all or delay their first visit well into the second or third trimester (7, 8).

Globally, early ANC attendance (within the first trimester) occurs in approximately 43% of pregnant women, with substantially lower rates in sub-Saharan Africa (38%) and some regions of South and Southeast Asia (9, 10). A study in Papua New Guinea found that only 23% of pregnant women initiated ANC in the first trimester (11). In 2013, timely ANC initiation was reported in 81.9% of women in high-income countries compared to only 24% in low-income settings (12). These disparities underscore the role of structural and socioeconomic factors in shaping women's engagement with maternal health services.

Bangladesh has made notable progress in maternal health indicators over recent decades, reducing its MMR from 574 per 100,000 live births in 1990 to 163 per 100,000 live births in 2017. Despite this progress, the proportion of women initiating ANC within the first trimester remains suboptimal, and overall ANC coverage continues to fall short of WHO recommendations (9, 13). Evidence from prior national surveys and community-based studies in Bangladesh indicates that a range of sociodemographic, geographic, and obstetric factors influence ANC utilization, including maternal education, household wealth, place of residence, parity, and media exposure (9, 14–16). However, healthcare facility-level factors, particularly geographic accessibility remain relatively understudied in the national context (14).

Furthermore, most existing studies on ANC timing in Bangladesh have been limited in geographic scope or have relied on older survey data, limiting their policy relevance. Updated, nationally representative evidence is essential for policymakers, programme managers, and researchers to design targeted interventions that can accelerate progress toward equitable and timely ANC uptake.

The present study addresses these gaps by estimating the national prevalence of delayed ANC initiation and identifying its individual-level, household-level, community-level, and healthcare access determinants using the most recent BDHS 2022 data. It additionally employs a concentration index to quantify socioeconomic inequality in ANC timing. The findings are intended to inform evidence-based policies to improve maternal healthcare engagement in Bangladesh and comparable LMIC settings.

Methods

Study Design and Data Source

This study used a cross-sectional analytical design, drawing on data from the Bangladesh Demographic and Health Survey (BDHS) 2022 a nationally representative household survey conducted by the National Institute of Population Research and Training (NIPORT), with technical support from ICF International through the DHS Program and implementation by Mitra and Associates. The survey was financially supported by the Government of Bangladesh and the United States Agency for International Development (USAID). The BDHS 2022 collected detailed information on fertility, family planning, maternal and child health, nutrition, and other demographic indicators from households across all eight administrative divisions of Bangladesh.

Sampling Design and Study Population

The BDHS 2022 employed a stratified, two-stage cluster sampling design. In the first stage, 675 enumeration areas (EAs) – 237 urban and 438 rural were selected from the Integrated Multi-Purpose Sampling Master Sample with probability proportional to EA size. In the second stage, a systematic random sample of 45 households per EA was drawn, yielding a total sample of 30,330 residential households. A total of 30,358 ever-married women aged 15–49 years were identified as eligible for individual interview.

The analytical sample for this study comprised all women of reproductive age (15–49 years) who had at least one birth in the five years preceding the survey and had documented ANC records. For women who had multiple births in this period, the most recent birth was included. Women who had a birth history but no ANC record were excluded. After applying these criteria, the final analytic sample comprised 5,103 women.

Outcome Variable

The outcome variable was late ANC initiation, operationalized as a binary indicator. Consistent with WHO recommendations, early ANC initiation was defined as a first ANC visit occurring within the first trimester of pregnancy (i.e., within 12 completed gestational weeks or before 13 weeks of gestation). Late ANC

initiation was defined as initiation after 12 completed gestational weeks (i.e., after the first trimester). Accordingly, women who initiated ANC late were coded 1, and those who initiated early were coded 0.

Exposure Variables

Independent variables were selected based on a literature review of determinants of ANC utilization in LMICs and the availability of relevant items in the BDHS 2022 questionnaire. Variables were operationalized across four conceptual levels: (1) individual-level factors, (2) household-level factors, (3) community-level factors, and (4) obstetric and healthcare access factors.

Individual-level variables included maternal age group (15–24, 25–34, and 35–49 years), marital status (married vs. widowed/divorced/separated), maternal education (no formal education, primary, secondary, higher), and maternal occupation (working vs. not working). Household-level variables included husband's education (no formal education, primary, secondary, higher), household wealth index (quintiles: poorest, poorer, middle, richer, richest, as constructed by the BDHS using principal component analysis of household assets), media exposure (yes/no, based on reported radio or television access at least once per week), health insurance coverage (yes/no), sex of household head (male/female), household size (1–4 vs. 5 + members), and religion (Islam vs. others). Community-level variables included place of residence (urban/rural) and administrative division (Barishal, Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, Sylhet). Obstetric and healthcare access variables included parity (1, 2, 3, 4+), history of stillbirth (yes/no), history of abortion (yes/no), planned pregnancy status (yes/no), history of caesarean section (yes/no), and perceived distance to a health facility as a barrier (big problem vs. not a big problem).

Statistical Analysis

All analyses were performed using Stata version 17 (StataCorp LLC, College Station, TX, USA), accounting for the complex survey design using the svy command suite with sampling weights, primary sampling units, and strata as specified in the BDHS 2022 documentation. All estimates are weighted to be representative of the national population of reproductive-age women with recent births.

Descriptive statistics were used to characterize the study population. Bivariate analyses were conducted using design-adjusted Pearson chi-square tests to examine associations between each independent variable and the outcome. Row percentages of late ANC initiation with 95% confidence intervals (CIs) were reported for each category of independent variables.

Binary logistic regression was employed in two stages. First, unadjusted (univariate) logistic regression models were fitted for each independent variable separately to compute unadjusted odds ratios (UORs) with 95% CIs. Variables with a p-value ≤ 0.25 in the unadjusted models were eligible for inclusion in the adjusted model. Second, a multivariable logistic regression model incorporating all eligible variables was fitted simultaneously to compute adjusted odds ratios (AORs) and 95% CIs, controlling for potential

confounders. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test (with results grouped into deciles of predicted probabilities), and multicollinearity was evaluated via variance inflation factors (VIF) on an unweighted equivalent model. Statistical significance was set at $p < 0.05$.

Socioeconomic inequality in late ANC initiation was quantified using the concentration index (CI), calculated using the household wealth index as the ranking variable. The CI ranges from -1 to $+1$; a negative value indicates a pro-poor concentration of the outcome (i.e., late ANC is more prevalent among poorer women), and a positive value indicates a pro-rich concentration.

Results

Sample Characteristics

Table 1 presents the background characteristics of the 5,103 women included in the analysis. Nearly half (47.1%) were aged 15-24 years and 44.4% were aged 25-34 years, with women aged 35-49 years comprising only 8.6% of the sample. The vast majority (99.0%) were married. The sample was predominantly rural (73.2%). In terms of educational attainment, 54.0% of women had completed secondary education and 17.8% had higher education, while 5.4% had no formal education. For husbands, secondary education was the most common category (35.2%). Most women were not engaged in paid employment (73.4%). Regarding economic status, the sample was approximately evenly distributed across wealth quintiles, with slightly fewer women in the richest quintile (18.3%). Health insurance coverage was negligible (0.3%). Media exposure was reported by 56.8% of participants, and 45.1% perceived distance to the nearest health facility as a major barrier to access. Nearly one-third (33.5%) were in their first pregnancy, and 44.6% had a prior caesarean section (among women with available data).

Table 1. Background characteristics of reproductive-age women who gave birth in the five years preceding the BDHS 2022 survey (N = 5,103).

Background Characteristics	n (%)
<i>Mother's current age group</i>	
15-24 years	2,402 (47.1)
25-34 years	2,264 (44.4)
35-49 years	437 (8.6)
<i>Marital status</i>	
Married	5,052 (99.0)
Widowed/Divorced/Separated	51 (1.0)
<i>Place of residence</i>	
Urban	1,365 (26.8)
Rural	3,738 (73.2)
<i>Administrative division</i>	
Barishal	318 (6.2)
Chattogram	1,122 (22.0)
Dhaka	1,242 (24.3)
Khulna	527 (10.3)
Mymensingh	450 (8.8)
Rajshahi	542 (10.6)
Rangpur	572 (11.2)
Sylhet	330 (6.5)
<i>Mother's education level</i>	
No formal education	277 (5.4)
Primary	1,164 (22.8)
Secondary	2,756 (54.0)
Higher	906 (17.8)
<i>Husband's education level</i>	
No formal education	776 (15.2)
Primary	1,493 (29.2)
Secondary	1,796 (35.2)

Higher	987 (19.3)
<i>Mother's occupation</i>	
Working	1,357 (26.6)
Not working	3,746 (73.4)
<i>Religion</i>	
Islam	4,720 (92.5)
Others	383 (7.5)
<i>Household wealth index</i>	
Poorest	1,034 (20.3)
Poorer	1,069 (20.9)
Middle	1,052 (20.6)
Richer	1,016 (19.9)
Richest	932 (18.3)
<i>Media exposure</i>	
Yes	2,900 (56.8)
No	2,203 (43.2)
<i>Health insurance coverage</i>	
Yes	15 (0.3)
No	5,088 (99.7)
<i>Sex of household head</i>	
Male	4,495 (88.1)
Female	608 (11.9)
<i>Household size</i>	
1-4 members	1,682 (33.0)
5+ members	3,421 (67.0)
<i>Distance to health facility</i>	
Big problem	2,303 (45.1)
Not a big problem	2,800 (54.9)
<i>Parity (birth order)</i>	

1	1,710 (33.5)
2	1,610 (31.6)
3	996 (19.5)
4+	787 (15.4)
<i>History of stillbirth</i>	
Yes	406 (8.0)
No	4,697 (92.0)
<i>History of abortion</i>	
Yes	493 (9.7)
No	4,610 (90.3)
<i>Planned pregnancy</i>	
Yes	4,131 (81.0)
No	972 (19.0)
<i>History of caesarean section</i>	
Yes	2,272 (44.5)
No	2,817 (55.2)

Abbreviations: HH, household; BDHS, Bangladesh Demographic and Health Survey. Missing values were identified for husband's education (n=51) and history of caesarean section (n=14); percentages for these variables are calculated among the total analytic sample (N=5,103).

Prevalence of Late ANC Initiation

The overall prevalence of late ANC initiation was 62.0% (95% CI: 60.0%-63.9%). Figure 1 illustrates the distribution of early versus late ANC uptake in the study population. This high prevalence indicates that approximately three in five women with recent births in Bangladesh did not initiate ANC within the first trimester.

Bivariate Analysis

Table 2 presents the prevalence of late ANC initiation stratified by background characteristics, along with 95% CIs and p-values from design-adjusted chi-square tests.

Maternal age was significantly associated with late ANC initiation ($p=0.0065$). The youngest age group (15-24 years) had the highest prevalence of late ANC (64.5%; 95% CI: 62.0-66.9), compared to 59.3% (95% CI: 56.6-62.1) among women aged 25-34 years and 62.1% (95% CI: 56.8-67.0) among those aged 35-49 years. A significantly higher proportion of rural women (66.7%; 95% CI: 64.6-68.7) experienced late ANC initiation compared to urban women (49.2%; 95% CI: 44.9-53.6) ($p<0.001$). Marked geographic variation was also observed across administrative divisions ($p<0.001$), with the highest prevalence in Rangpur (71.5%; 95% CI: 67.5-75.2) and the lowest in Dhaka (51.1%; 95% CI: 45.8-56.4) (Figure 2).

Both maternal and paternal education were strongly and inversely associated with late ANC initiation ($p<0.001$ for both). Among women with no formal education, 80.0% (95% CI: 73.2-85.5) initiated ANC late, compared to only 39.1% (95% CI: 35.2-43.1) among women with higher education. A parallel gradient was observed for husband's education: 77.7% (95% CI: 74.1-80.9) in the no formal education category versus 39.2% (95% CI: 35.5-43.1) in the higher education category.

Household wealth was strongly and inversely associated with late ANC initiation ($p<0.001$). Women in the poorest quintile had the highest prevalence (77.8%; 95% CI: 74.7-80.7), while those in the richest quintile had the lowest (34.2%; 95% CI: 30.1-38.7) (Figure 4). Women without media exposure were significantly more likely to have late ANC initiation (71.1%; 95% CI: 68.7-73.4) compared to those with exposure (55.1%; 95% CI: 52.7-57.5) ($p<0.001$). Perception of distance to a health facility as a major problem was also associated with higher prevalence of late ANC (66.5%; 95% CI: 64.0-69.0 vs. 58.3%; 95% CI: 55.8-60.8; $p<0.001$).

Regarding obstetric factors, parity was significantly associated with late ANC initiation ($p=0.010$), with the proportion rising from 59.6% among primigravid women to 67.4% among those with four or more prior births. History of abortion was associated with lower late ANC prevalence (56.5% among women with prior abortion vs. 62.6% without; $p=0.018$). Women with a history of caesarean section had substantially lower prevalence of late ANC initiation (51.3%; 95% CI: 48.5-54.1) compared to those without (70.7%; 95% CI: 68.5-72.8) ($p<0.001$). Planned pregnancy was also significantly associated with ANC timing ($p=0.009$), with unplanned pregnancy associated with higher late ANC prevalence (66.2% vs. 61.0%).

Table 2. Prevalence of late ANC initiation by background characteristics with 95% confidence intervals and p-values, BDHS 2022 (N = 5,103).

Background Characteristics	Late ANC % [95% CI]	P-value
Mother's current age group		
15-24 years	64.5 [62.0, 66.9]	0.0065
25-34 years	59.3 [56.6, 62.1]	
35-49 years	62.1 [56.8, 67.0]	
Marital status		
Married	61.9 [59.9, 63.8]	0.087
Widowed/Divorced/Separated	73.6 [59.8, 83.9]	
Place of residence		
Urban	49.2 [44.9, 53.6]	<0.001
Rural	66.7 [64.6, 68.7]	
Administrative division		
Barishal	67.9 [63.7, 71.9]	<0.001
Chattogram	66.4 [62.1, 70.5]	
Dhaka	51.1 [45.8, 56.4]	
Khulna	61.5 [57.2, 65.6]	
Mymensingh	65.3 [60.1, 70.1]	
Rajshahi	63.0 [57.6, 68.1]	
Rangpur	71.5 [67.5, 75.2]	
Sylhet	60.4 [54.5, 65.9]	
Mother's education level		
No formal education	80.0 [73.2, 85.5]	<0.001
Primary	74.1 [71.0, 76.9]	
Secondary	62.6 [60.5, 64.8]	
Higher	39.1 [35.2, 43.1]	
Husband's education level		
No formal education	77.7 [74.1, 80.9]	<0.001
Primary	71.6 [68.8, 74.3]	
Secondary	59.4 [56.6, 62.2]	

Higher	39.2 [35.5, 43.1]	
<i>Mother's occupation</i>		
Working	62.9 [59.5, 66.2]	0.510
Not working	61.7 [59.5, 63.8]	
<i>Religion</i>		
Islam	62.3 [60.2, 64.3]	0.217
Others	58.6 [53.1, 63.9]	
<i>Household wealth index</i>		
Poorest	77.8 [74.7, 80.7]	<0.001
Poorer	73.3 [70.0, 76.3]	
Middle	66.2 [62.7, 69.5]	
Richer	55.2 [51.3, 59.0]	
Richest	34.2 [30.1, 38.7]	
<i>Media exposure</i>		
Yes	55.1 [52.7, 57.5]	<0.001
No	71.1 [68.7, 73.4]	
<i>Health insurance coverage</i>		
Yes	62.2 [33.6, 84.3]	0.987
No	62.0 [60.0, 63.9]	
<i>Sex of household head</i>		
Male	62.5 [60.5, 64.5]	0.063
Female	58.3 [53.8, 62.6]	
<i>Household size</i>		
1-4 members	59.9 [56.7, 63.1]	0.099
5+ members	63.0 [60.7, 65.3]	
<i>Distance to health facility</i>		
Big problem	66.5 [64.0, 69.0]	<0.001
Not a big problem	58.3 [55.8, 60.8]	
<i>Parity (birth order)</i>		

1	59.6 [56.4, 62.8]	0.010
2	60.6 [57.4, 63.8]	
3	64.0 [60.7, 67.3]	
4+	67.4 [63.2, 71.3]	
<i>History of stillbirth</i>		
Yes	58.8 [53.5, 64.0]	0.196
No	62.3 [60.3, 64.2]	
<i>History of abortion</i>		
Yes	56.5 [51.6, 61.2]	0.018
No	62.6 [60.5, 64.6]	
<i>Planned pregnancy</i>		
Yes	61.0 [58.8, 63.2]	0.009
No	66.2 [62.8, 69.5]	
<i>History of caesarean section</i>		
Yes	51.3 [48.5, 54.1]	<0.001
No	70.7 [68.5, 72.8]	

P-values derived from design-adjusted Pearson chi-square tests. CI, confidence interval; ANC, antenatal care. Boldface p-values indicate statistical significance (p<0.05).

Logistic Regression Analysis

Table 3 presents the unadjusted and adjusted odds ratios from the logistic regression analyses. The multivariable model included all variables that met the $p \leq 0.25$ threshold in unadjusted analyses. Model fit was satisfactory (Hosmer-Lemeshow $\chi^2=7.20$, $df=8$, $p=0.516$), and no problematic multicollinearity was detected (all VIFs <5).

Maternal age was a significant predictor in the adjusted model: women aged 15-24 years had 39% higher odds of late ANC initiation compared to those aged 35-49 years (AOR: 1.39; 95% CI: 1.02-1.90; $p=0.040$). After adjustment, rural residence was no longer statistically significant (AOR: 1.17; 95% CI: 0.99-1.39; $p=0.068$), although the point estimate remained elevated. Significant geographic variation persisted across administrative divisions (Figure 3), with women in Rangpur (AOR: 1.67; 95% CI: 1.27-2.18), Khulna (AOR: 1.59; 95% CI: 1.23-2.06), Barishal (AOR: 1.40; 95% CI: 1.07-1.84), Chattogram (AOR: 1.28; 95% CI:

1.01-1.63), and Rajshahi (AOR: 1.36; 95% CI: 1.03-1.80) all having significantly higher odds of late ANC initiation compared to women in Dhaka.

Maternal education was a strong and independent predictor of late ANC initiation. Women with no formal education had more than twice the odds of delayed initiation compared to those with higher education (AOR: 2.11; 95% CI: 1.34-3.32; $p=0.001$), while primary (AOR: 1.72; 95% CI: 1.32-2.25; $p<0.001$) and secondary (AOR: 1.34; 95% CI: 1.09-1.63; $p=0.004$) education were also associated with significantly higher odds relative to higher education. A similar education gradient was observed for husband's education: no formal education (AOR: 2.17; 95% CI: 1.60-2.94), primary (AOR: 1.80; 95% CI: 1.40-2.30), and secondary (AOR: 1.47; 95% CI: 1.19-1.81), all compared to higher education ($p<0.001$ for each).

Household wealth remained a highly significant predictor across all quintiles after full adjustment. Women in the poorest quintile had 2.58 times the odds of late ANC initiation compared to those in the richest quintile (AOR: 2.58; 95% CI: 1.91-3.49; $p<0.001$), with a clear dose-response gradient across wealth categories (Figure 4). Women without media exposure had 25% higher odds of late ANC initiation compared to those with exposure (AOR: 1.25; 95% CI: 1.07-1.45; $p=0.004$). Perceiving distance to a health facility as a major problem was associated with 21% higher odds of late ANC initiation (AOR: 1.21; 95% CI: 1.05-1.39; $p=0.009$).

Among obstetric factors, women with a prior caesarean section had 32% lower odds of late ANC initiation (AOR: 0.68; 95% CI: 0.58-0.80; $p<0.001$), and women with a history of abortion had 31% lower odds (AOR: 0.69; 95% CI: 0.54-0.89; $p=0.004$) relative to their respective reference groups. Other obstetric variables (parity, stillbirth history, planned pregnancy) were not statistically significant in the adjusted model. The concentration index was -0.143 (SE: 0.007), confirming a significant pro-rich inequality in timely ANC uptake.

Table 3. Unadjusted and adjusted odds ratios from binary logistic regression for late ANC initiation, BDHS 2022.

Background Characteristics	UOR (95% CI)	P- value	AOR (95% CI)	P- value
<i>Mother's current age group [Ref: 35-49 years]</i>				
15-24 years	1.11 (0.88, 1.41)	0.375	1.39 (1.02, 1.90)	0.040
25-34 years	0.89 (0.71, 1.12)	0.331	1.10 (0.85, 1.44)	0.460
35-49 years (Ref)	—	—	—	—
<i>Place of residence [Ref: Urban]</i>				
Rural	2.06 (1.69, 2.51)	<0.001	1.17 (0.99, 1.39)	0.068
Urban (Ref)	—	—	—	—
<i>Administrative division [Ref: Dhaka]</i>				
Barishal	2.03 (1.53, 2.69)	<0.001	1.40 (1.07, 1.84)	0.013
Chattogram	1.89 (1.43, 2.51)	<0.001	1.28 (1.01, 1.63)	0.043
Khulna	1.53 (1.16, 2.02)	0.003	1.59 (1.23, 2.06)	0.001
Mymensingh	1.80 (1.32, 2.44)	<0.001	1.11 (0.84, 1.47)	0.460
Rajshahi	1.63 (1.20, 2.22)	0.002	1.36 (1.03, 1.80)	0.032
Rangpur	2.40 (1.80, 3.19)	<0.001	1.67 (1.27, 2.18)	<0.001
Sylhet	1.46 (1.06, 2.00)	0.021	0.87 (0.65, 1.15)	0.323
Dhaka (Ref)	—	—	—	—
<i>Mother's education level [Ref: Higher]</i>				
No formal education	6.25 (4.13,	<0.001	2.11 (1.34,	0.001

	9.45)		3.32)	
Primary	4.45 (3.57, 5.53)	<0.001	1.72 (1.32, 2.25)	<0.001
Secondary	2.61 (2.21, 3.09)	<0.001	1.34 (1.09, 1.63)	0.004
<i>Higher (Ref)</i>	—	—	—	—
<i>Husband's education level [Ref: Higher]</i>				
No formal education	5.39 (4.18, 6.95)	<0.001	2.17 (1.60, 2.94)	<0.001
Primary	3.90 (3.18, 4.79)	<0.001	1.80 (1.40, 2.30)	<0.001
Secondary	2.27 (1.89, 2.72)	<0.001	1.47 (1.19, 1.81)	<0.001
<i>Higher (Ref)</i>	—	—	—	—
<i>Household wealth index [Ref: Richest]</i>				
Poorest	6.74 (5.23, 8.69)	<0.001	2.58 (1.91, 3.49)	<0.001
Poorer	5.26 (4.07, 6.79)	<0.001	2.52 (1.92, 3.32)	<0.001
Middle	3.76 (2.92, 4.85)	<0.001	2.24 (1.73, 2.91)	<0.001
Richer	2.36 (1.87, 2.99)	<0.001	1.69 (1.34, 2.13)	<0.001
<i>Richest (Ref)</i>	—	—	—	—
<i>Media exposure [Ref: Yes]</i>				
No	2.00 (1.74, 2.30)	<0.001	1.25 (1.07, 1.45)	0.004
<i>Yes (Ref)</i>	—	—	—	—
<i>Distance to health facility [Ref: Not a big problem]</i>				

Big problem	1.42 (1.24, 1.63)	<0.001	1.21 (1.05, 1.39)	0.009
<i>Not a big problem (Ref)</i>	—	—	—	—
<i>History of abortion [Ref: No]</i>				
Yes	0.77 (0.63, 0.96)	0.018	0.69 (0.54, 0.89)	0.004
<i>No (Ref)</i>	—	—	—	—
<i>History of caesarean section [Ref: No]</i>				
Yes	0.44 (0.38, 0.51)	<0.001	0.68 (0.58, 0.80)	<0.001
<i>No (Ref)</i>	—	—	—	—
<i>Mother's age [Other variables retained in model but not significant]</i>				
<i>Religion, Mother's occupation, Health insurance, Sex of HH head, HH size, Parity, Stillbirth, Planned pregnancy — included in adjusted model; p>0.05</i>				

UOR, unadjusted odds ratio; AOR, adjusted odds ratio; CI, confidence interval; Ref, reference category; HH, household. All analyses used complex survey weights. P-values <0.05 are considered statistically significant. Model fit: Hosmer-Lemeshow $\chi^2=7.20$, df=8, p=0.516.

Discussion

This study provides nationally representative estimates of the prevalence and determinants of delayed ANC initiation in Bangladesh using the most recent BDHS 2022 data. We found that 62.0% of women with recent births initiated their first ANC visit after the first trimester, representing a serious public health challenge with important implications for maternal and neonatal outcomes. Our findings reveal multidimensional inequalities driven by socioeconomic, educational, geographic, and obstetric factors, and add nuance to the growing global evidence base on barriers to timely maternal care.

The prevalence of late ANC initiation identified in this study (62.0%) substantially exceeds rates reported from other LMICs. For comparison, Nigatu and Birhan reported a late ANC initiation rate of 67.7% in the Gambia (17); Mare et al. documented rates ranging from 48% to 71% across multiple sub-Saharan African countries (18); and Gbene et al. reported 56.1% in a Ghanaian multicenter study (19). While Bangladesh's rate is comparable to some African settings, it is notably higher than estimates from several Southeast Asian countries and underscores the need for urgent policy attention. An earlier national analysis from Bangladesh by Hossain et al. reported similarly high rates of delayed initiation,

suggesting limited progress in this indicator over time despite improvements in overall ANC coverage (9).

Rural residence was associated with higher odds of late ANC initiation in the unadjusted analysis (UOR: 2.06), although this association was attenuated and no longer statistically significant after adjustment for wealth, education, media exposure, and distance to health facilities (AOR: 1.17; $p=0.068$). This pattern suggests that the rural disadvantage in ANC timing is substantially mediated through these socioeconomic and access pathways rather than reflecting a purely geographic effect. This is consistent with studies from sub-Saharan Africa and Ethiopia demonstrating that socioeconomic deprivation, limited media access, and poor healthcare infrastructure account for much of the urban-rural gap in maternal healthcare utilization (17,18,20). Complementarily, women in urban settings benefit from greater access to ANC-related information through peer networks, healthcare workers, and digital media, which collectively promote earlier help-seeking behavior (21).

Significant geographic heterogeneity in late ANC initiation was observed across Bangladesh's eight administrative divisions, with Rangpur (71.5%) and Barishal (67.9%) exhibiting the highest burden and Dhaka (51.1%) the lowest. After adjustment, women in Rangpur, Khulna, Barishal, Chattogram, and Rajshahi all had significantly higher odds of late ANC initiation compared to Dhaka. These findings likely reflect differential distributions of healthcare infrastructure, healthcare worker density, community health programme intensity, and socioeconomic development across divisions. Rangpur, in particular, is known for its high rates of poverty and food insecurity, factors that intersect with reduced healthcare engagement. These findings reinforce the importance of division-specific strategies and resource allocation in maternal health programming.

Both maternal and paternal education exerted strong, independent, and dose-dependent effects on the probability of late ANC initiation (22). Women with no formal education had twice the adjusted odds of late initiation compared to those with higher education (AOR: 2.11), with a monotonically increasing gradient from higher to no formal education. The association for husband's education followed the same pattern (AOR for no formal education: 2.17), corroborating evidence from Ethiopia, Nigeria, Myanmar, Zambia, and other LMIC settings (20,21,23–26). Education enhances awareness of pregnancy risks, improves comprehension of ANC recommendations, and increases autonomous decision-making capacity. Husband's education is particularly influential in the Bangladesh context, where patriarchal household dynamics often mean that women require male partner support or permission to access healthcare (27). These findings support the case for continued investment in girls' education as a foundational long-term strategy for improving maternal health outcomes, as well as targeted male engagement programmes in the near term.

Household wealth was among the most powerful predictors of late ANC initiation, with a strong and consistent gradient across all five wealth quintiles. Women in the poorest quintile had 2.58 times the adjusted odds of late initiation compared to the richest. This is corroborated by studies in Bangladesh, East Africa, and other LMICs, and is largely attributable to the direct and indirect costs of ANC utilization

including transportation, consultation fees, and opportunity costs, which are prohibitive for low-income households (15,28). The concentration index of -0.143 further quantifies this inequality, indicating that the burden of late ANC initiation falls disproportionately on economically disadvantaged women. Targeted conditional cash transfer programmes, maternal health voucher schemes, and community-based health financing mechanisms have demonstrated potential to reduce these economic barriers and merit policy attention.

Women without exposure to mass media had 25% higher adjusted odds of late ANC initiation, consistent with evidence from Ethiopia and from Bangladesh-specific ANC studies (16,26,28). Mass media, particularly radio and television serve as critical channels for disseminating information about maternal health, the recommended timing of ANC, and the benefits of early care-seeking. In Bangladesh, where community health workers (such as BRAC Shashthya Shebikas) and government health messages are often transmitted through these channels, the absence of media exposure likely reflects informational poverty that compounds the effects of low education and economic deprivation. Expanding community radio programming, utilizing mobile phone health messaging platforms, and investing in digital health literacy may help bridge this information gap.

Distance to a health facility was an independent predictor of late ANC initiation after full adjustment (AOR: 1.21; $p=0.009$). This finding aligns with evidence from tribal and rural communities in Bangladesh and from other LMICs, where geographic inaccessibility constitutes a formidable structural barrier to maternal care, particularly for women who must rely on informal or costly transport (15). Community-based models of ANC delivery, mobile health clinics, and strengthening of rural healthcare infrastructure represent potential strategies to address this constraint.

Women with a prior caesarean section had significantly lower odds of late ANC initiation (AOR: 0.68). This is consistent with findings from Malawi and plausibly reflects heightened awareness of pregnancy risk and increased familiarity with the healthcare system among women who have previously undergone surgical delivery (29). These women may be more likely to be counselled about early ANC by healthcare providers following their prior delivery, leading to earlier care-seeking in subsequent pregnancies. Similarly, women with a history of prior abortion were 31% less likely to initiate ANC late (AOR: 0.69), possibly because the experience of a prior adverse obstetric event sensitizes women to pregnancy risks and motivates earlier engagement with maternal care services.

In contrast to the unadjusted analysis, parity, planned pregnancy, and history of stillbirth were not statistically significant in the adjusted model. The attenuation of the parity effect after adjustment suggests that its apparent association in unadjusted analysis may be confounded by socioeconomic and educational factors that co-vary with parity. The non-significance of planned pregnancy status after adjustment contrasts with findings from several other studies and may reflect the specific social and demographic profile of the Bangladesh sample, where the relationship between pregnancy intention and care-seeking behavior may be mediated by other variables already included in the model (30,31).

Strengths and Limitations

This study has several notable strengths. It uses a nationally representative, methodologically rigorous dataset with a large sample size, enabling generalization to the population of reproductive-age women in Bangladesh. The use of complex survey-weighted analyses ensures appropriate estimation accounting for the multistage cluster design. The multivariable logistic regression model comprehensively accounts for a wide range of potential confounders across multiple conceptual levels, and the concentration index provides a formal quantification of socioeconomic inequality in ANC timing.

Several limitations should be acknowledged. The cross-sectional design precludes causal inference; associations observed should be interpreted as correlational. Gestational age at ANC initiation was based on maternal recall, which may be subject to recall bias, particularly for births occurring several years before the survey. The BDHS does not capture quality of ANC or provider type, which are important dimensions of ANC utilization not addressed in this study. Health insurance coverage was extremely low in the sample (0.3%), precluding meaningful analysis of its effect. Finally, the DHS does not collect information on healthcare supply-side factors such as facility quality, provider competence, or waiting times, which are known to influence ANC-seeking behavior.

Conclusions

This nationally representative study demonstrates that delayed ANC initiation remains highly prevalent in Bangladesh, with approximately 62% of women with recent births failing to initiate ANC within the first trimester. Socioeconomic inequality in ANC timing is substantial, with the burden falling disproportionately on women who are less educated, economically disadvantaged, without media access, and living in geographically underserved areas. Administrative division-level disparities underscore the importance of geographically targeted maternal health programming.

Key independent determinants of late ANC initiation included lower maternal and paternal educational attainment, membership in lower wealth quintiles, absence of media exposure, perceived distance to health facilities, and younger maternal age. Conversely, prior caesarean section and prior abortion history were associated with earlier ANC initiation, reflecting increased health system engagement among women with adverse obstetric histories.

To achieve timely ANC initiation for all women in Bangladesh, a comprehensive, multi-sectoral response is needed. This should include sustained investment in girls' education; targeted social protection and conditional cash transfer programs for economically marginalized households; community-based mass media campaigns promoting early ANC registration; expansion of community-level maternal health services, including satellite clinics and mobile health units; and active engagement of male partners in reproductive health education. Future research should employ longitudinal and qualitative designs to elucidate the causal mechanisms underlying delayed ANC initiation and evaluate the effectiveness of specific interventions in the Bangladesh context.

Abbreviations

ANC: Antenatal care; AOR: Adjusted odds ratio; BDHS: Bangladesh Demographic and Health Survey; CI: Confidence interval; DHS: Demographic and Health Survey; EA: Enumeration area; ICF: International Classification of Functioning; LMIC: Low- and middle-income country; MMR: Maternal mortality ratio; NIPOORT: National Institute of Population Research and Training; SDG: Sustainable Development Goal; UOR: Unadjusted odds ratio; USAID: United States Agency for International Development; VIF: Variance inflation factor; WHO: World Health Organization.

Declarations

Ethics approval and consent to participate

This study is a secondary analysis of publicly available, de-identified data from the BDHS 2022. The original survey received ethical approval from the ICF Institutional Review Board and the Bangladesh Medical Research Council. All participants provided informed consent prior to data collection. No additional ethical approval was required for the present analysis.

Consent for publication

Not applicable.

Availability of data and material

The BDHS 2022 data used in this study are publicly available and can be accessed from the DHS Program website (<https://dhsprogram.com>) upon registration and request.

Competing interests

The authors declare no competing interests.

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Authors' contributions

SJT conceived and designed the study, conducted the literature review, and acquired the data. SJT and ARR performed the statistical analyses, interpreted the findings, and drafted the manuscript. AH, ASA, and KSAN contributed to the critical revision of the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

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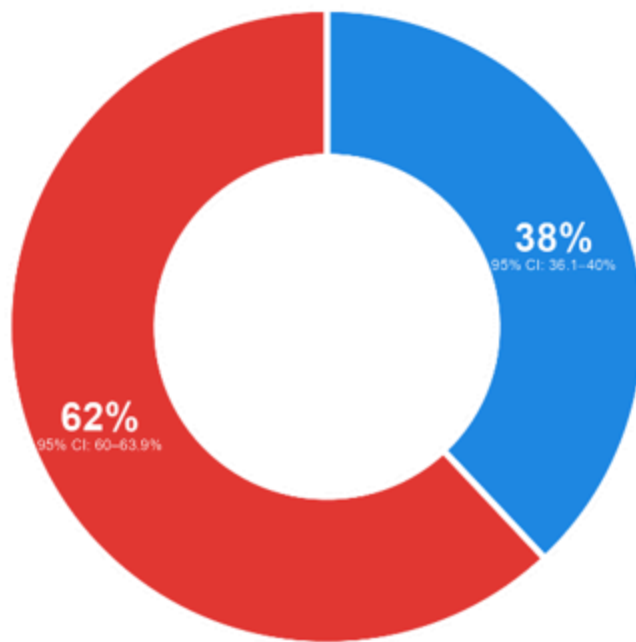
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Figures



label ■ Early ANC (≤ first trimester) ■ Late ANC (> first trimester)

N = 5,054 (unweighted). Weighted analysis accounting for BDHS 2022 complex survey design.
Late ANC = first visit initiated after the first trimester (>3 months gestation).

Figure 1

Overall percentage of early versus late antenatal care (ANC) initiation among women with recent births in Bangladesh, BDHS 2022.

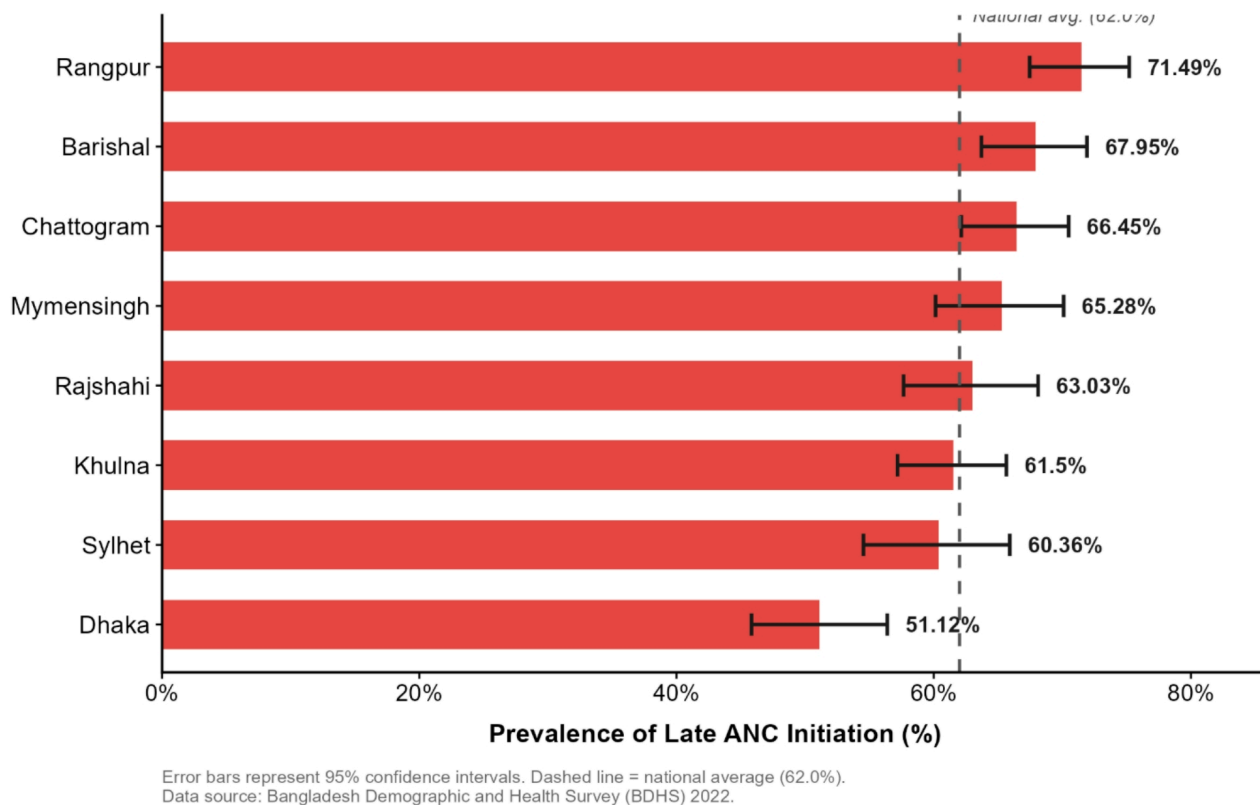


Figure 2

Prevalence of late antenatal care (ANC) initiation by administrative division, Bangladesh Demographic and Health Survey 2022.

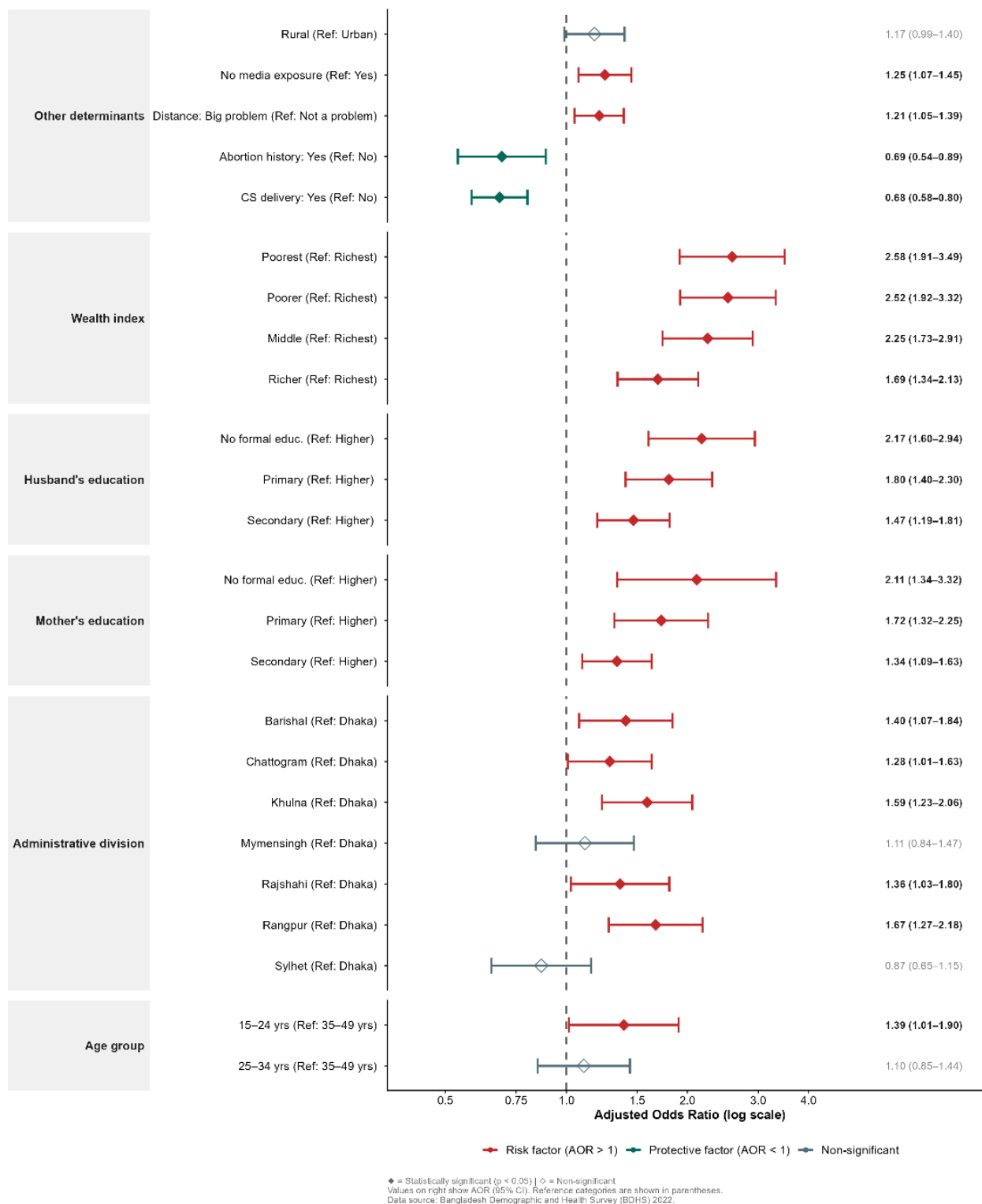


Figure 3

Forest plot of adjusted odds ratios (AOR) and 95% confidence intervals for determinants of late antenatal care (ANC) initiation, BDHS 2022. AOR >1 indicates higher odds of late ANC initiation; AOR <1 indicates lower odds (protective effect).

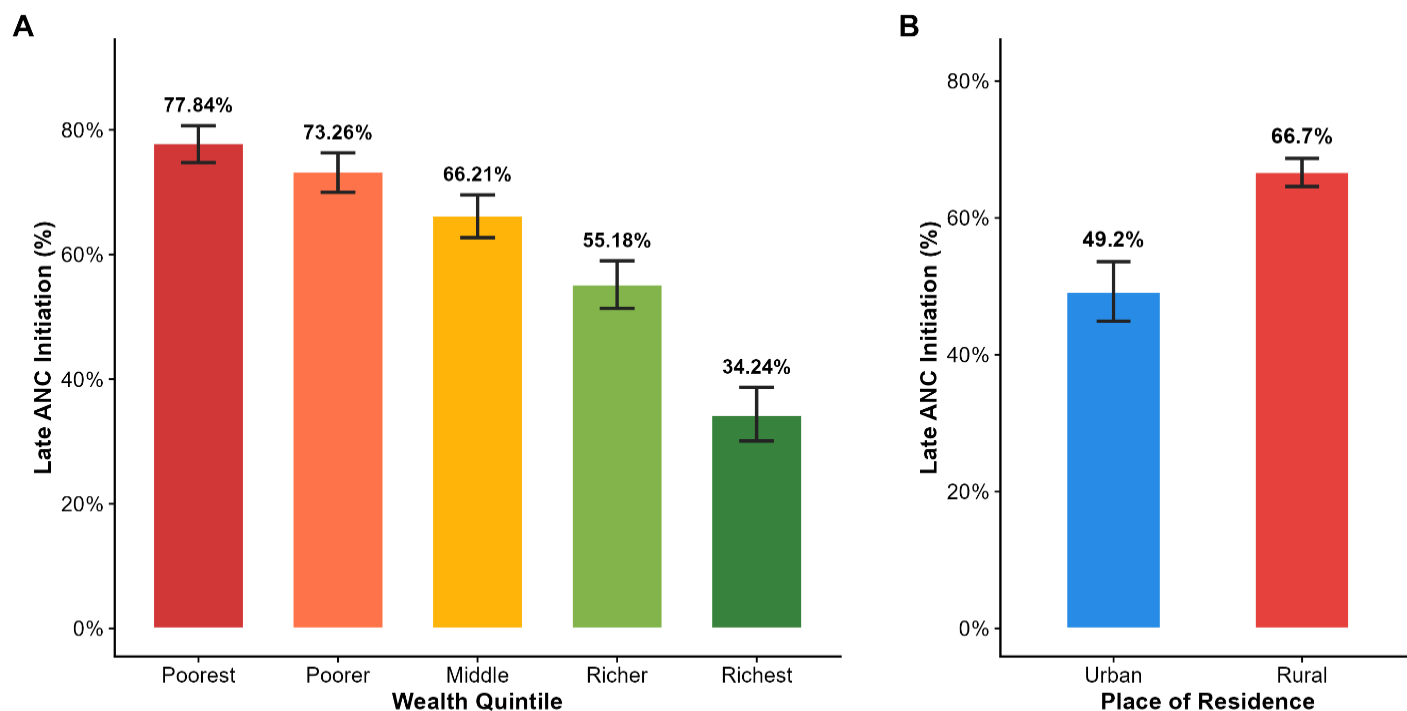


Figure 4

Prevalence of late antenatal care (ANC) initiation stratified by household wealth index and place of residence, BDHS 2022.