BMC Public Health

RESEARCH

Open Access

Inequalities in antenatal care service utilization in Nepal: evidence from nationally representative Nepal multiple indictor cluster surveys 2014 and 2019

Suman Sapkota[1,2], Amrita Gyawali[3*], Bipin Thapa[1] and Yifei Hu[1]

Abstract

Introduction Antenatal care (ANC) is essential for improving maternal and neonatal health outcomes, and its utilization is influenced by socioeconomic factors. This study aims to assess disparities in ANC service utilization by wealth, caste/ethnicity, and province among Nepalese women, using data from the nationally representative Nepal Multiple Indicator Cluster Surveys (MICS) 2014 and 2019.

Methods We assessed the association of ANC service utilization with the household wealth index quintiles, caste/ethnicity and province using multivariable logistic and negative binomial regression models. We also measured wealth-related inequality using concentration curves and concentration indices.

Results The proportion of women who received four or more ANC visits increased from 60.6% in 2014 to 77.8% in 2019. However, in both 2014 and 2019, women in the highest wealth quintile were over five times more likely to receive recommended ANC visits than those in the lowest quintiles. Similarly, the expected number of ANC visits was 70% higher in 2014 and 35% higher in 2019 for women in the highest wealth quintile compared to the lowest quintile. Concentration curves showed a decrease in pro-rich inequality in ANC utilization by 2019 relative to 2014, though notable inequality remained. Geographic disparities were evident: Karnali and Madhesh provinces had significantly lower utilization of recommended ANC visits and fewer ANC visits than Koshi Province. Ethnic disparities were also prominent, with women from Dalit, Disadvantaged Janajati, and Other Madheshi caste groups being significantly less likely to complete recommended ANC visits.

Conclusion Our findings reveal persistent wealth-related inequality in ANC service utilization in Nepal, with women from wealthier households, advantaged caste/ethnic groups and better-off provinces having higher odds of receiving recommended ANC visits and a higher number of ANC visits. Concerted efforts are needed to address these equity gaps in ANC service utilization, particularly for women from low-income households, disadvantaged caste/ethnic groups, and underserved provinces.

Keywords Antenatal care, Equity, Household wealth, Nepal, Concentration curve

*Correspondence:
Amrita Gyawali
gyawaliamrita63@gmail.com
Full list of author information is available at the end of the article

Introduction

The importance of ensuring equitable access to high-quality maternal and neonatal health services in achieving universal health coverage (UHC) and meeting sustainable development goals (SDGs) by 2030 cannot be overstated [1]. Despite global progress in maternal and child health outcomes, maternal health indicators remain poor in many low- and middle-income countries (LMICs), including Nepal [2]. Nepal's maternal mortality ratio of 174 per 100,000 live births is one of the highest in the world [2], making it imperative to enhance the quality and coverage of maternal healthcare services to meet the SDG targets [3–5].

Antenatal care (ANC) is an integral component of safe motherhood, providing pregnant women with health-promoting, preventive, and curative interventions while serving as a gateway to a continuum of care for mothers and newborns [3–6]. Early detection and treatment of potential obstetric complications during ANC can reduce maternal mortality and morbidity [3, 4, 7]. Moreover, ANC directly reduces stillbirths and newborn deaths by ensuring optimal fetal growth and development [8].

In Nepal, ANC services are widely available free of cost at all levels of government health institutions, and cash incentives are provided to encourage the completion of four or more ANC visits [9–11]. Nepal has implemented demand-side financing schemes since 2005, including the Aama Program, which was introduced in 2009. The Aama Program eliminated fees for institutional delivery and ANC services and provided cash incentives for women who completed the recommended ANC visits and delivered in a health facility [11]. These policies align with the National Health Policy 2014, the recent National Health Policy 2019, and the Nepal Health Sector Strategy 2015–2020, which aim to improve maternal and newborn health by enhancing the effectiveness, sustainability, and equity of public health activities [9, 12]. Moreover, Nepal updated its ANC guidelines in 2022, aligning with the World Health Organization (WHO) recommendations, by changing the standard schedule from four focused ANC visits to eight ANC contacts to promote better service coverage [4, 13, 14].

Despite these efforts, studies have shown that disparities in access to and utilization of ANC services persist between different socioeconomic groups and geographic regions in Nepal [15–19]. Geographic inequities, ethnic disparities and wealth-related inequalities have been identified as major markers of inequity, not only in Nepal but also in other LMICs [20, 21]. Notably, between 2014 and 2019, Nepal experienced notable socioeconomic development, exemplified by a reduction in multidimensional poverty index from 30.1% to 17.4% [22]. Additionally, Nepal adopted a new constitution in 2015, establishing a federal structure and designating the provision of basic health services as the responsibility of local governments. To understand if these socioeconomic developments and health sector decentralization are translated into improved utilization of ANC services and a reduced inequalities across wealth, geographic, and ethnic groups, it is necessary to study the relationship between the socioeconomic status (SES) of women and their ANC service utilization in Nepal during this period.

Although previous studies have assessed the general socioeconomic predictors of ANC visits and their quality in Nepal [15, 23], none have comprehensively analyzed wealth-related inequality alongside geographic and ethnic dimensions using consecutive Nepal Multiple Indicator Cluster Surveys (MICS) data. By addressing these gaps, this study contributes insights into the intersection of socioeconomic development and ANC service utilization. Specifically, this study aims to assess the relationship between wealth, geography, and caste/ethnicity with ANC service utilization among Nepalese women of reproductive age using data from the 2014 and 2019 Nepal MICS. In addition, this study descriptively assessed the coverage and quality of ANC services received. By shedding light on these relationships and observing changes in ANC service utilization alongside changes in the inequality, this study provides insights into addressing disparities in ANC service utilization, thereby promoting equitable access to and utilization of ANC services in Nepal.

Methods

Data source

We conducted a secondary data analysis using data from two consecutive nationally representative surveys, the MICS 2014 and MICS 2019, carried out by the Central Bureau of Statistics (CBS) in collaboration with the United Nations Children's Fund (UNICEF) as a part of the Global MICS program. Both surveys used a two-stage cluster sampling design to select a nationally representative sample of women of reproductive age (15–49 years). In the MICS 2014, 28 strata were used based on geographic region and urban–rural classification, whereas MICS 2019 used 15 strata based on provincial and urban–rural classifications. Enumeration areas (EAs) or primary sampling units (PSUs) were identified in each stratum and data were collected from randomly selected PSUs. In MICS 2014, 500 PSUs were sampled, whereas in MICS 2019, 504 PSUs were sampled. In both surveys, systematic random sampling was used to select households within the sampled PSUs. Questionnaire-based interviews were conducted with women who had given birth in the two years preceding the survey.

A total of 2,086 women and 2,519 women who gave birth to a child two years preceding the survey participated in the MICS 2014 and MICS 2019, respectively. After excluding observations with missing values on ANC visits, the final analysis included 2,045 (weighted sample size = 2,009) women from the MICS 2014 and 2,518 (weighted sample size = 1,949) women from the MICS 2019 (Fig. 1). Details about the survey methodology are available in the full survey reports of Nepal MICS 2014 [24] and Nepal MICS 2019 [25].

Variables

Outcome variables and their measurement

To assess the utilization of ANC services, we used two primary outcome variables as described below.

I) Receipt of recommended ANC visits

The first outcome, receipt of recommended ANC visits, was defined as a binary variable indicating whether a woman received at least four antenatal care visits during her last pregnancy (Yes = 1 vs No = 0).

II) The number of ANC visits

The second outcome variable, number of ANC visits, was a discrete count outcome variable defined as the total number of ANC visits that a woman received during her last pregnancy.

Independent variables and their measurement

In this study, we selected the household wealth index, caste/ethnicity and province of residence as the key independent variables. We utilized the household wealth index as a measure of long-term living standards because data on more preferred methods such as direct measures of income, expenditure, or consumption were not available in the surveys [26]. The household wealth index was constructed by the MICS team using a principal component analysis of information on access to electricity, type of fuel used for cooking, ownership of consumer goods and durables, dwelling characteristics, and the status of water, sanitation, and hygiene. The wealth index was used to rank households from the poorest to the richest and reflects long-term household SES, although it does not capture absolute income or current consumption. In the descriptive and regression analysis, we grouped the household wealth index into quintiles; for the concentration curves and concentration indices, we used raw household wealth index. Further details on the construction of the wealth index can be found in the Nepal MICS 2014 [24] and Nepal MICS 2019 survey reports [25].

Caste/ethnicity was another key independent variable, reflecting the social stratification prevalent in Nepal. These categories were aligned with Nepal's social structure, grouping populations into broad groups such as Brahmin (Hill Brahmin and Madheshi Brahmin), Chhetri (including Sanyasi and Dasnami), Dalit (Hill Dalit,

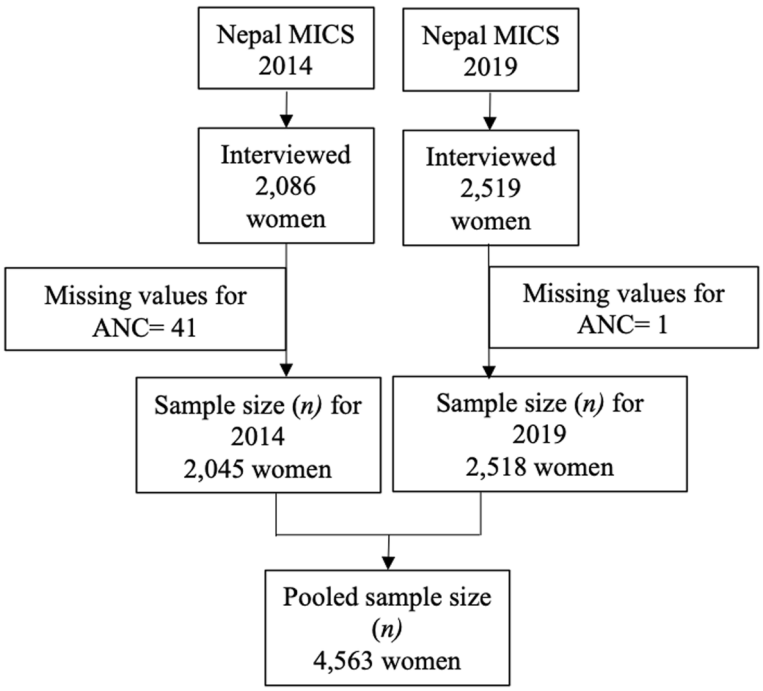

Fig. 1 Flowchart of selection of study participants for analysis

Madheshi Dalit, and Other Dalit), relatively advantaged Janajati (Newar, Gurung and Thakali) and relatively disadvantaged Janajati (Hill Janajati, Madheshi Janajati, and Other Janajati), Other Madheshi caste, and Muslim/unspecified groups [27]. This categorization was intended to capture the socio-cultural and historical disparities among groups and their potential associations with health and socioeconomic outcomes.

Province of residence was included as an independent variable only for the 2019 survey, as Nepal adopted a federal structure in 2015 with the promulgation of the new constitution. Due to the lack of GIS data in the 2014 survey, it was not feasible to retrospectively assign 2014 survey participants to provinces.

Covariates and their measurement

We selected covariates based on their theoretical relevance and the availability of data in the MICS datasets. The major covariates included women's sociodemographic characteristics, household characteristics, and type of residence.

Women's sociodemographic characteristics included age, education, child's birth order, and media exposure. Age was measured in completed years and grouped into four categories: 15–19, 20–24, 25–29, and 30 + years. Education was classified into three categories according to the categorization by the Ministry of Education: none, basic (grade 1–8), and secondary or higher (grade 9 or higher) [28]. The birth order of the child was classified into two categories: first child or not. Mass media exposure was measured by whether a woman reported listening to radio, reading newspapers, or watching television at least once a week; women were classified as exposed to media or not.

Household characteristics included household size and the sex of the household head. Household size was the number of individuals in the household, classified into two categories: ≤ 4 and ≥ 5. The sex of the household head was recorded as male or female.

Settlement of residence was classified into two categories: urban or rural, based on the administrative classification.

We included the survey year as a covariate in the pooled data analysis. The survey year indicated the year of the survey (2014 or 2019).

Statistical analyses

Data preparation and descriptive analysis

We merged the household dataset with the women's dataset using R software for statistical computing and prepared the dataset for the final analysis. For descriptive analysis, we calculated the mean (and standard deviation) and median, [with 25 th percentile (P_{25}) and 75 th percentile (P_{75})] for continuous variables, and the number and percentage for categorical variables. Differences in proportions between 2014 and 2019 were tested using two-sample z-tests. Differences in the median number of ANC visits between survey years (within categories of the independent variables and covariates) were assessed using survey-weighted Wilcoxon rank-sum tests.

Regression analysis

We conducted separate cross-sectional regression analyses using the MICS 2014 and MICS 2019 datasets, in addition to the regression analyses using the data pooled (appended) from both surveys. We used multivariable logistic regression analysis with the survey package in R to explore the association between receipt of recommended ANC visits and wealth index quintiles, caste/ethnic group, and provinces [29]. For the count outcome, the number of ANC visits, we used multivariable negative binomial regression analysis in Stata version 14.1. Negative binomial regression is appropriate for count data, particularly when overdispersion occurs, where variance exceeds the mean because this model includes an additional dispersion parameter, ensuring robust standard errors and valid inference [30]. We exponentiated the regression coefficients and interpreted those as odds ratios and incidence rate ratios for logistic regression and negative binomial regression, respectively. We also presented their corresponding 95% confidence intervals (CIs) along with *p-values*. A two-sided *p-value* of less than 0.05 was considered statistically significant in all the analyses. All analyses accounted for survey design elements including survey weights, stratification, and clustering. For the pooled analysis, we adjusted survey weights by de-normalizing them to reflect the actual population distribution of women of reproductive age (15–49 years) during the corresponding survey years, using data from the United Nations Population Division [31, 32].

Concentration curves and concentration indices

We examined wealth-related inequality in ANC service utilization in Nepal using concentration curves and concentration indices. Concentration curves were used to illustrate the extent to which ANC service utilization was unequally distributed across household wealth in 2014 and 2019. The concentration curve plots the cumulative percentage of the health variable (y-axis) against the cumulative percentage of the population, ranked by living standards, beginning with the poorest and ending with the richest (x-axis) [26]. We plotted separate concentration curves to visualize the distribution of the receipt of recommended ANC visits and the number of ANC visits by wealth index. A concentration curve below the diagonal line, also called the line of perfect equality, indicates

that ANC visits are concentrated among the rich, also called pro-rich inequality, whereas a curve above the diagonal line indicates that they are concentrated among the poor, also called pro-poor inequality [26].

Furthermore, we calculated the concentration indices as summary measures of of wealth-related inequality. The concentration index ranges from −1 to 1, with 0 indicating perfect equality, negative values indicating that ANC service utilization is concentrated among the poor, and positive values indicating that it is concentrated among the rich [26]. To calculate the concentration index for receipt of recommended ANC visits, which is a binary outcome, we used the Erreygers-corrected method [33]. Similarly, for the number of ANC visits, we used the generalized concentration index proposed by Wagstaff et al. [34]. The concentration indices were calculated using the *conindex* command in Stata version 14.1 [35] for both outcomes. The concentration indices were computed for the receipt of recommended ANC visits and the number of ANC visits in 2014 and 2019.

Ethical considerations

Ethical review and approval were waived for this study because the survey protocols for MICS 2014 and MICS 2019 were approved according to the Statistical Act of Nepal, 1958. The Statistical Act enables the CBS to conduct surveys according to the government's ethics protocol without involving an institutional review board. The datasets obtained from the MICS did not include any personal identifiers.

Patients and public involvement

As this study is based on the analysis of secondary data provided by MICS, it was not possible to directly involve patients or the public in the design, conduct, or reporting of our research.

Results

Comparison of recommended ANC visits between 2014 and 2019

Between 2014 and 2019, the percentage of women receiving the recommended ANC visits increased across all sociodemographic groups. Younger women (15–19 years) showed the largest improvement, rising from 50.4% in 2014 to 78.9% in 2019 ($p < 0.001$). Similar upward trends were observed across all age groups. Women with higher educational attainment were more likely to receive recommended ANC, with the percentage increasing from 79.4% to 89.3% among those with secondary or higher education ($p < 0.001$). Recommended ANC visits also increased significantly among women who gave birth to their first child with coverage rising from 68.2% to 84.1% ($p = 0.014$). A similar significant increase was observed in women with and without exposure to mass media (Table 1).

Caste/ethnic disparities persisted, though improvements were evident across groups. The highest coverage was observed among Brahmin women, increasing from 76.0% to 93.7% ($p < 0.001$), while Dalit women also experienced a significant increase from 52.8% to 72.2% ($p < 0.001$). Moreover, wealthier women had consistently higher ANC coverage, with the highest quintile reaching 94.5% in 2019 ($p = 0.094$), whereas the lowest quintile showed the greatest improvement, from 41.8% to 69.6% ($p < 0.001$) (Table 1, Fig. 2).

Women in smaller households (≤ 4 members) had higher ANC coverage compared to those in larger households in 2019, though both groups experienced significant increases over time. Women in male-headed households also showed improvement (60.2% to 76.6%, $p < 0.001$). Rural–urban disparities persisted, with rural women showing a notable increase from 57.0% to 72.4% ($p = 0.019$), while urban coverage remained high but slightly declined from 85.0% in 2014 to 80.7% in 2019 ($p = 0.015$) (Table 1).

Overall, the percentage of women receiving the recommended ANC visits significantly increased from 60.6% (95% CI: 56.9, 64.3) in 2014 to 77.8% (95% CI: 75.5, 80.1) in 2019 ($p < 0.001$), indicating substantial progress in ANC utilization over time (Table 1).

The proportion of women attending at least one ANC visit was universally high across provinces in 2019, exceeding 90% in all regions. Madhesh and Karnali provinces had the lowest coverage for at least one ANC visit with 90.8% and 91.5% of women attending at least one ANC. Gandaki reported the highest coverage, with 98.4% of women receiving at least one ANC visit, closely followed by Sudoorpashchim (98.3%) and Bagmati (97.3%). However, stark disparities emerged in the proportion of women achieving the recommended ANC visits. Gandaki had the highest coverage for recommended ANC visits with 91.2%, while Madhesh and Karnali lagged significantly at 56.8% and 72.3%, respectively (Fig. 3).

The mean number of ANC visits increased across all wealth quintiles and caste/ethnic groups between 2014 and 2019. Women from the highest wealth quintile had the highest mean ANC visits in both years (5.67 in 2014 and 5.74 in 2019), while those in the lowest wealth quintile had the lowest (2.6 in 2014, increasing to 3.59 in 2019). Among caste/ethnic groups, Brahmin and Advantaged Janajati women had the highest mean ANC visits (4.6 and 5.42 in 2014, increasing to 5.25 and 5.55 in 2019, respectively), while Dalit women had the lowest, increasing from 3.39 in 2014 to 3.81 in 2019. In 2019, Bagmati had the highest mean ANC visits (5.51), whereas Karnali had the lowest (3.61). Nationally, the mean ANC visits increased from 3.8 in 2014 to 4.33 in 2019 (Table 2).

Table 1 Percentage distribution of women of reproductive age who had recommended ANC visits during the pregnancy of the most recent live birth in Nepal in 2014 and 2019

Characteristic	2014 N	2019 N	2014 Recommended ANC visits, % (95% CI)	2019 Recommended ANC visits, % (95% CI)	*P*-value for difference (2014 vs 2019)
Age group					
15–19 years	213	200	50.4 (41.9, 58.9)	78.9 (72.4, 84.2)	< 0.001
20–24 years	705	730	64.0 (58.4, 69.2)	76.5 (72.6, 80.0)	< 0.001
25–29 years	665	588	63.6 (58.3, 68.7)	81.6 (78.1, 84.7)	< 0.001
30 + years	425	431	55.5 (49.1, 61.6)	74.4 (70.1, 78.3)	< 0.001
Educational attainment of woman					
None	736	405	41.8 (36.6, 47.3)	53.4 (47.7, 59.1)	0.004
Basic	637	599	63.5 (57.8, 68.9)	76.2 (72.6, 79.5)	< 0.001
Secondary or higher	636	946	79.4 (75.0, 83.2)	89.3 (87.3, 91.0)	< 0.001
Birth order					
First child	1250	1099	68.2 (63.3, 72.7)	84.1 (81.2, 86.7)	0.014
Not the first child	758	850	56.0 (51.5, 60.4)	73.0 (69.8, 75.9)	0.016
Exposure to mass media					
Not exposed	736	742	44.2 (38.2, 50.2)	68.0 (63.5, 72.1)	0.022
Exposed	1272	1207	70.1 (66.6, 73.5)	83.9 (81.5, 86.0)	0.011
Caste/ethnic group					
Brahmin	205	211	76.0 (67.4, 82.9)	93.7 (90.4, 95.9)	< 0.001
Chhetri	368	326	68.0 (61.5, 73.8)	83.7 (79.4, 87.2)	< 0.001
Dalit	298	323	52.8 (44.2, 61.2)	72.2 (66.2, 77.5)	< 0.001
Janajati (Advantaged)	103	101	85.8 (74.5, 92.5)	92.6 (85.2, 96.5)	0.190
Janajati (Disadvantaged)	576	579	57.6 (51.0, 63.9)	82.1 (78.0, 85.6)	< 0.001
Muslim and Others	114	139	55.7 (38.9, 71.3)	67.6 (59.4, 74.8)	0.209
Other Madheshi caste	344	271	49.5 (42.5, 56.5)	55.7 (47.9, 63.2)	0.245
Wealth index quintile					
Lowest	439	442	41.8 (35.2, 48.8)	69.6 (64.8, 74.0)	< 0.001
Second	431	413	53.3 (46.7, 59.8)	73.5 (68.0, 78.3)	< 0.001
Middle	437	384	57.1 (49.3, 64.6)	75.4 (70.0, 80.1)	< 0.001
Fourth	390	384	70.5 (63.3, 76.9)	80.2 (74.3, 85.0)	0.028
Highest	311	327	89.7 (84.1, 93.4)	94.5 (90.1, 97.0)	0.094
Household size					
4 or fewer	564	571	64.6 (59.5, 69.4)	82.0 (78.2, 85.3)	0.253
5 or more	1444	1379	59.1 (54.8, 63.1)	76.1 (73.2, 78.7)	0.021
Sex of household head					
Female	478	421	61.8 (55.3, 67.9)	82.4 (78.5, 85.6)	< 0.001
Male	1531	1529	60.2 (56.3, 64.1)	76.6 (73.8, 79.1)	< 0.001
Settlement of residence					
Rural	1749	672	57.0 (52.9, 61.0)	72.4 (68.6, 76.0)	0.019
Urban	259	1277	85.0 (79.0, 89.5)	80.7 (77.5, 83.5)	0.015
Total	2009	1949	60.6 (56.9, 64.3)	77.8 (75.5, 80.1)	< 0.001

Number is weighted number of participants, % represents row percentage, *p-values* from z-test test statistic for the difference in proportions

Components of ANC services

A substantial increase in access to ANC tests was observed across wealth quintiles from 2014 to 2019, with the highest improvements noted in the lowest wealth quintile for all three tests (blood pressure, urine test, and blood test). For example, in the lowest wealth quintile, the proportion of women receiving blood pressure checks increased from 87.3% (95% CI: 83.1, 90.6) in 2014

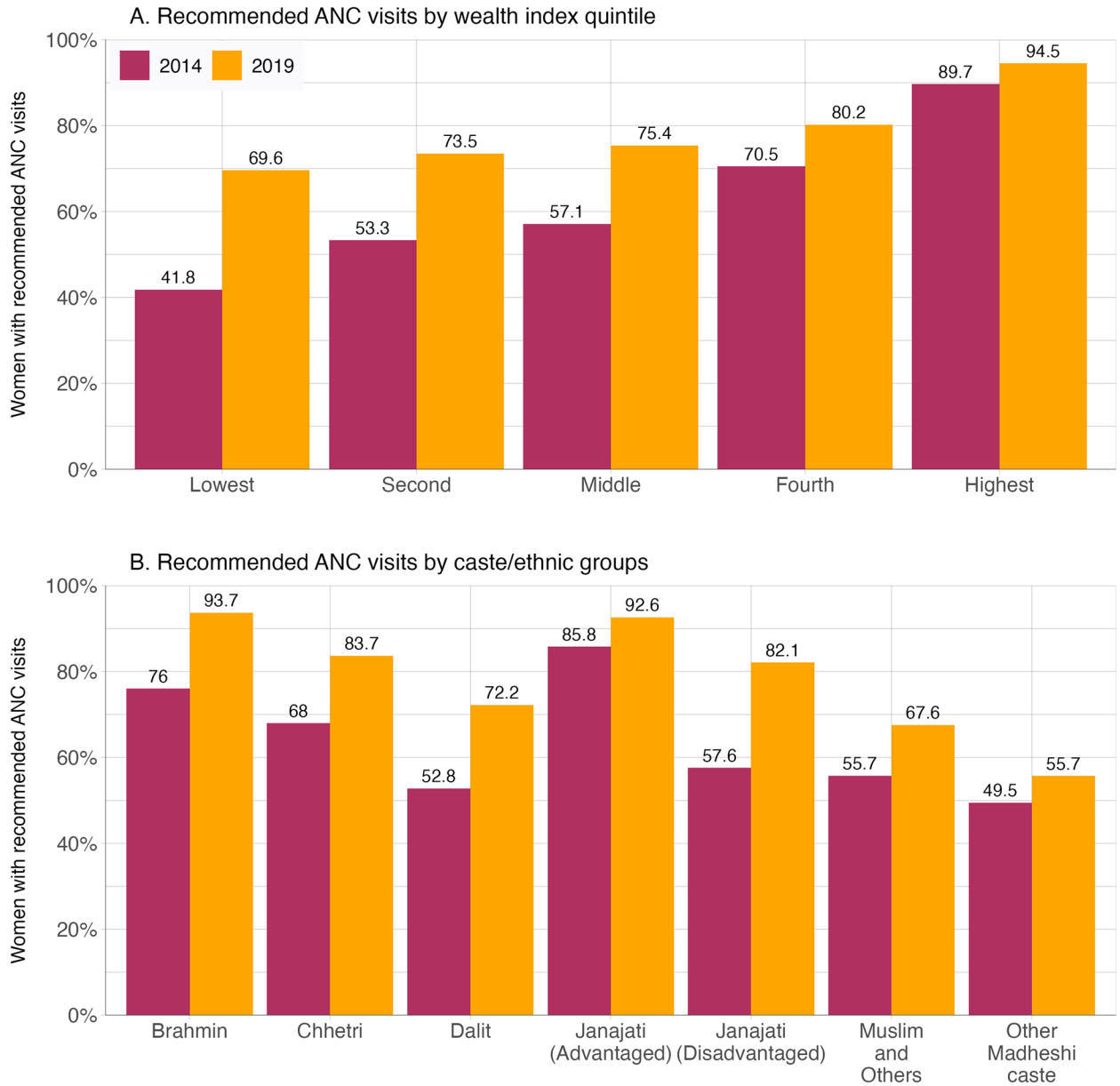

Fig. 2 Distribution of recommended ANC visits and number of ANC visits by wealth index quintile and caste/ethnic group in Nepal, 2014 and 2019

to 90.4% (95% CI: 86.6, 93.2) in 2019, while blood test coverage rose from 50.5% (95% CI: 44.3, 56.8) to 79.8% (95% CI: 75.5, 83.6). The most pronounced improvement was seen in the proportion receiving all three recommended ANC tests, where coverage increased from 46.5% (95% CI: 40.5–52.5) in 2014 to 76.2% (95% CI: 71.6–80.3) in 2019.

Brahmin women had near-universal coverage for all ANC tests in 2019 (blood pressure: 99.4%, urine test: 98.1%, blood test: 98.3%, and all three: 97.2%). In contrast, Dalit women had significant improvements, particularly in receiving a blood test (62.8% in 2014 to 83.7% in 2019), although they still lagged behind other groups. Janajati (Advantaged) women had the highest coverage for all tests in 2019, with 98.8% (95% CI: 96.2–99.6) receiving blood pressure checks and 96.8% (95% CI: 93.3–98.5) receiving all three recommended tests.

Similarly, Gandaki showed the highest overall ANC test coverage in 2019 among provinces, with blood pressure checks at 97.1% (95% CI: 90.6–99.2) and all three tests at 95.1% (95% CI: 89.7–97.8). Conversely, Karnali had the lowest coverage, with only 83.6% (95% CI: 76.6–88.8) of

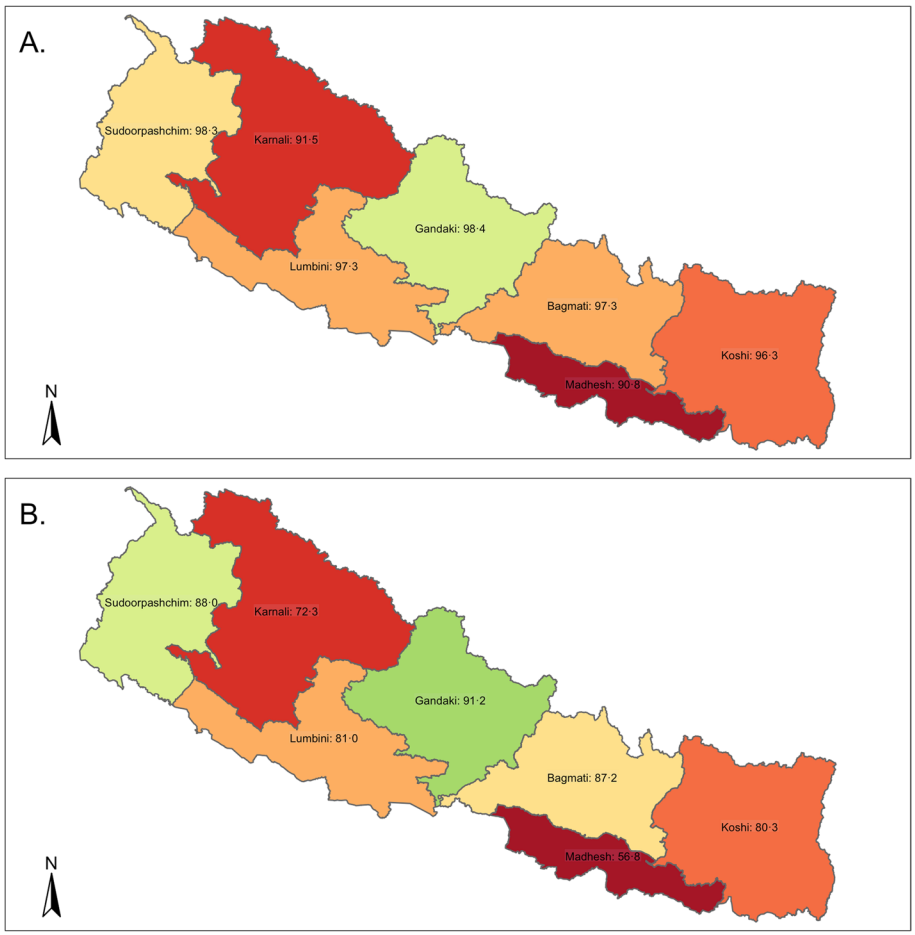

Fig. 3 Distribution of at least one ANC visit and recommended ANC visits by province in Nepal in 2019; **A** Percentage of women with at least one ANC visits; **B** Percentage of women with recommended ANC visits

women receiving blood pressure checks, and just 68.8% (95% CI: 61.3–75.5) completing all three tests (Supplementary table S1).

Multivariable regression analysis of the receipt of recommended ANC visits

The logistic regression models showed that the odds of receiving recommended antenatal care visits increased progressively across wealth quintiles in both survey years and in the pooled analysis. In 2014, compared to women in the lowest wealth quintile, the adjusted odds ratio (aOR) for receiving recommended ANC visits was 1.71 (95% CI: 1.15, 2.52) in the second quintile, 2.37 (95% CI: 1.47, 3.83) in the middle quintile, 3.10 (95% CI: 1.87, 5.14) in the fourth quintile, and 5.80 (95% CI: 3.08, 10.9) in the highest quintile. Similar patterns were observed in 2019, with the aORs ranging from 1.89 (95% CI: 1.27, 2.82) in the second quintile to 5.58 (95% CI: 2.69, 11.6) in the highest quintile. Pooled analysis revealed consistent associations, with the odds increasing from 1.48 (95% CI: 1.14, 1.92) in the second quintile to 5.23 (95% CI: 3.25, 8.42) in the highest quintile.

Disparities in ANC utilization were evident across ethnic groups, as Dalit women, women from the Disadvantaged Janajati group, Other Madheshi caste group and Muslim and other group showed consistently lower odds of receiving recommended ANC visits. In 2014, women from the Disadvantaged Janajati group (aOR: 0.70; 95% CI: 0.42, 1.16) and women from Other Madheshi caste group (aOR: 0.48; 95% CI: 0.25, 0.89) had reduced odds compared to Brahmin women. In 2019, Dalit women (aOR: 0.51; 95% CI: 0.27, 0.94), Muslim and others (aOR: 0.43, 95% CI: 0.22, 0.85) and Other Madheshi caste groups (aOR: 0.36, 95% CI: 0.19, 0.66) had significantly lower odds of receiving recommend ANC visits. Pooled analysis revealed similar trends, with Dalit women, Disadvantaged Janajati women, women from Muslim and other and Other Madheshi caste groups persistently underutilizing recommended ANC services.

Table 2 Mean and Median number of ANC visits by pregnant women of reproductive age in 2014 and 2019 in Nepal

Characteristics	Mean (SD)		Median (IQR)		*P*-value
	2014	2019	2014	2019	
Wealth index quintile					
Lowest	2.6 (2.12)	3.59 (1.61)	3 (0, 4)	4 (3, 4)	0.033
Second	3.34 (2.03)	3.88 (1.71)	4 (2, 4)	4 (3, 5)	0.009
Middle	3.74 (1.96)	4.22 (1.8)	4 (3, 5)	4 (4, 5)	< 0.001
Fourth	4.21 (1.89)	4.55 (1.93)	4 (3, 5)	4 (4, 5)	0.014
Highest	5.67 (2.42)	5.74 (2.32)	5 (4, 7)	5 (4, 7)	0.834
Caste/ethnic group					
Brahmin	4.6 (2.18)	5.25 (2.19)	4 (4, 6)	4 (4, 6)	0.396
Chhetri	4.01 (2.28)	4.41 (1.82)	4 (3, 5)	4 (4, 5)	0.556
Dalit	3.39 (2.2)	3.81 (1.58)	4 (2, 4)	4 (3, 4)	< 0.001
Janajati (Advantaged)	5.42 (2.13)	5.55 (2.33)	5 (4, 6)	5 (4, 7)	< 0.001
Janajati (Disadvantaged)	3.55 (2.16)	4.47 (1.93)	4 (3, 4)	4 (4, 5)	0.004
Muslim and Others	3.72 (2.71)	3.83 (1.95)	4 (2, 5)	4 (3, 5)	0.108
Other Madheshi caste	3.4 (2.21)	3.61 (1.97)	3 (2, 5)	4 (3, 5)	0.962
Province					
Koshi		4.37 (1.76)		4 (4, 5)	
Madhesh		3.72 (2.2)		4 (3, 5)	
Bagmati		5.51 (2.6)		5 (4, 7)	
Gandaki		4.66 (1.54)		4 (4, 5)	
Lumbini		4.04 (1.28)		4 (4, 4)	
Karnali		3.61 (1.46)		4 (3, 4)	
Sudoorpaschim		3.97 (0.92)		4 (4, 4)	
Nepal	3.8 (2.29)	4.33 (2)		4 (4, 5)	

SD Standard deviation, *IQR* Interquartile range

P-values were derived using the survey-weighted Wilcoxon rank-sum test

Substantial provincial differences were also observed in ANC utilization in 2019. Compared to Koshi Province, women in Madhesh Province were significantly less likely to receive recommended ANC visits (aOR: 0.43; 95% CI: 0.28, 0.66). In contrast, women in Sudoorpaschim Province exhibited the highest odds (aOR: 3.08; 95% CI: 1.82–5.22), followed by Gandaki Province (aOR: 1.65; 95% CI: 0.96–2.84), though the latter association was not statistically significant (Table 3).

Multivariable regression analysis of the number of ANC visits

The incidence rate ratios (IRR) from negative binomial regression models for the number of ANC visits revealed substantial disparities across wealth quintiles, caste/ethnic groups, and provinces.

Women in higher wealth quintiles exhibited progressively higher adjusted incidence rate ratios (aIRR) for receiving ANC visits. In 2014, compared to women in the lowest quintile, the aIRR was 1.26 (95% CI: 1.11, 1.43) in the second quintile, 1.46 (95% CI: 1.28, 1.67) in the middle quintile, 1.49 (95% CI: 1.31, 1.69) in the fourth quintile, and 1.70 (95% CI: 1.48, 1.96) in the highest quintile. Similar trends were observed in 2019, with the aIRR increasing from 1.08 (95% CI: 1.01, 1.16) in the second quintile to 1.35 (95% CI: 1.22, 1.49) in the highest quintile. The pooled analysis demonstrated consistent patterns, with the highest quintile achieving an aIRR of 1.55 (95% CI: 1.42, 1.69).

Marked disparities were evident among caste/ethnic groups. In 2014, Disadvantaged Janajati women (aIRR: 0.92; 95% CI: 0.83, 1.02) and women from Other Madheshi caste groups (aIRR: 0.88; 95% CI: 0.76, 1.00) were less likely to receive recommended ANC visits compared to Brahmin women. By 2019, Dalit women (aIRR: 0.91; 95% CI: 0.84, 0.99) and women from Muslim and other ethnic groups (aIRR: 0.88; 95% CI: 0.79, 0.98) continued to demonstrate reduced number of ANC visits. Pooled analysis reinforced these findings, with other Madheshi caste groups exhibiting an aIRR of 0.86 (95% CI: 0.79, 0.93), highlighting persistent inequities. Advantaged Janajati group had the higher aIRR compared to Brahmin group in all the regression models.

Provincial disparities in the number of ANC visits were pronounced in 2019. Compared to women in Koshi Province, those in Madhesh Province had a reduced aIRR of 0.93 (95% CI: 0.84, 1.01), while women in Bagmati Province exhibited higher IRR (aIRR: 1.11; 95% CI: 1.02, 1.20) (Table 4).

Wealth-related inequality in the receipt of recommended ANC visits

The concentration curves shown in the left panel of Fig. 4 illustrate the distribution of the receipt of recommended ANC visits for 2014 and 2019. In both years, the concentration curve was below the line of equality. This indicates that the distribution of receiving recommended ANC visits was unevenly skewed toward wealthier population groups. However, a noticeable shift toward the line of equality was observed in 2019 compared to 2014. This finding suggests a reduction in the equity gap for receiving recommended ANC visits between the two years.

To quantify this trend, we utilized the Erreygers normalized concentration index (CIx), which provides a measure of the extent of pro-rich or pro-poor inequality. The results indicate that for 2014 and 2019, the CIx values were 0.352 (standard error:0.031; $p < 0.001$) and 0.175 (standard error:0.234; $p < 0.001$), respectively. This suggests that there is a pro-rich inequality in receiving recommended ANC visits, indicating that women with higher SES are more likely to receive recommended ANC

Table 3 Association of household wealth index quintile, province of residence and caste/ethnicity with receipt of recommended ANC visits among women aged 15–49 years in Nepal

Characteristics	2014		2019		Pooled	
	cOR (95% CI)[1,a]	aOR (95% CI)[1,a]	cOR (95% CI)[1,a]	aOR (95% CI)[1,a]	cOR (95% CI)[1,a]	aOR (95% CI)[1,a]
Wealth index quintile						
Lowest	Ref	Ref	Ref	Ref	Ref	Ref
Second	1.59 (1.10, 2.30)*	1.71 (1.15, 2.52)**	1.21 (0.87, 1.68)	1.89 (1.27, 2.82)**	1.36 (1.06, 1.74)*	1.48 (1.14, 1.92)**
Middle	1.85 (1.22, 2.82)**	2.37 (1.47, 3.83)**	1.34 (0.95, 1.87)	2.36 (1.55, 3.61)***	1.51 (1.14, 2.00)**	2.07 (1.50, 2.85)***
Fourth	3.33 (2.16, 5.13)***	3.10 (1.87, 5.14)***	1.77 (1.18, 2.64)**	2.14 (1.25, 3.66)**	2.41 (1.80, 3.24)***	2.34 (1.61, 3.39)***
Highest	12.1 (6.82, 21.3)***	5.80 (3.08, 10.9)***	7.50 (3.81, 14.8)***	5.58 (2.69, 11.6)***	9.27 (6.06, 14.2)***	5.23 (3.25, 8.42)***
Caste/ethnic group						
Brahmin	Ref	Ref	Ref	Ref	Ref	Ref
Chhetri	0.67 (0.40, 1.12)	1.49 (0.88, 2.54)	0.34 (0.20, 0.59)***	0.54 (0.29, 0.98)*	0.54 (0.36, 0.81)**	1.16 (0.78, 1.74)
Dalit	0.35 (0.21, 0.59)***	0.94 (0.51, 1.71)	0.17 (0.10, 0.30)***	0.51 (0.27, 0.94)*	0.30 (0.20, 0.44)***	0.74 (0.49, 1.14)
Janajati (Advantaged)	1.90 (0.85, 4.26)	1.73 (0.84, 3.57)	0.84 (0.36, 1.99)	1.00 (0.40, 2.51)	1.45 (0.78, 2.69)	1.41 (0.79, 2.49)
Janajati (Disadvantaged)	0.43 (0.26, 0.70)***	0.70 (0.42, 1.16)	0.31 (0.18, 0.51)***	0.65 (0.37, 1.12)	0.41 (0.28, 0.61)***	0.70 (0.48, 1.02)
Muslim and Others	0.40 (0.18, 0.89)*	0.89 (0.38, 2.10)	0.14 (0.08, 0.25)***	0.43 (0.22, 0.85)*	0.29 (0.17, 0.49)***	0.55 (0.31, 0.95)*
Other Madheshi caste	0.31 (0.18, 0.53)***	0.48 (0.25, 0.89)*	0.08 (0.05, 0.15)***	0.36 (0.19, 0.66)**	0.19 (0.13, 0.29)***	0.35 (0.22, 0.54)***
Province						
Koshi			Ref	Ref		
Madhesh			0.32 (0.21, 0.50)***	0.43 (0.28, 0.66)***		
Bagmati			1.67 (0.99, 2.81)	0.93 (0.53, 1.63)		
Gandaki			2.55 (1.53, 4.23)***	1.65 (0.96, 2.84)		
Lumbini			1.04 (0.66, 1.65)	1.17 (0.74, 1.85)		
Karnali			0.64 (0.38, 1.06)	1.36 (0.80, 2.33)		
Sudoorpaschim			1.80 (1.11, 2.90)*	3.08 (1.82, 5.22)***		

All models were adjusted for age of woman, education of woman, birth order of child, media exposure of woman, caste/ethnic group, household size, sex of household head, settlement; 2019 model was additionally adjusted for Province; Pooled model was additionally adjusted for survey year

[a] *CI* Confidence Interval, *cOR* Crude Odds Ratio, *aOR* Adjusted Odds Ratio

[1] *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

visits. Nevertheless, the observed reduction in the CIx for 2019 indicates a reduction in the magnitude of the pro-rich inequality and an improvement in equity in the distribution of receiving recommended ANC visits.

Wealth-related inequality in the number of ANC visits

The concentration curves shown in the right panel of Fig. 4 illustrate the distribution of the number of ANC visits for 2014 and 2019. It is clear that in both years, the concentration curve lies below the line of equality. This indicates that the distribution of the number of ANC visits is unevenly skewed towards the wealthier population groups. However, a shift toward the line of equality was observed in 2019 compared to 2014. This suggests a reduction in the equity gap for the number of ANC visits between the two years.

The CIx for the number of ANC visits in 2014 and 2019 were 0.145 (standard error:0.011; $p < 0.001$) and 0.091 (standard error:0.009; $p < 0.001$), respectively. This suggests that there is a pro-rich inequality in the number of ANC visits, which implies that women with higher SES are more likely to receive a higher number of ANC visits. Nevertheless, the observed reduction in the CIx in 2019 compared to 2014 indicates a reduction in the magnitude of the pro-rich inequality in the number of ANC visits.

Discussion

We measured the wealth-related, caste/ethnic and provincial inequalities in ANC service utilization among women of reproductive age in Nepal using two outcome variables: receipt of recommended ANC visits and the number of ANC visits. The findings of this study reveal that service coverage rates and quality of ANC service increased between 2014 and 2019, although marked wealth-, caste/ethnic-, and region-based disparities were observed in the utilization of ANC services in both years. We found that women from poorer households, disadvantaged caste/ethnic groups and historically underserved provinces (Madhesh and Karnali) were less likely

Table 4 Association of household wealth index quintile, province of residence and caste/ethnicity with the number of ANC visits among women aged 15–49 years in Nepal

Characteristics	2014		2019		Pooled	
	cIRR (95% CI)[1,a]	aIRR (95% CI)[1,a]	cIRR (95% CI)[1,a]	aIRR (95% CI)[1,a]	cIRR (95% CI)[1,a]	aIRR (95% CI)[1,a]
Wealth index quintile						
Lowest	Ref	Ref	Ref	Ref	Ref	Ref
Second	1.28 (1.12, 1.46)***	1.26 (1.11, 1.43)***	1.08 (1.01, 1.15) *	1.08 (1.01, 1.16)*	1·16 (1·08, 1·25)***	1.15 (1.07, 1.23)***
Middle	1.44 (1.26, 1.65)***	1.46 (1.28, 1.67)***	1.18 (1.11, 1.25) ***	1.17 (1.09, 1.26)***	1·28 (1·19, 1·38)***	1.29 (1.2, 1.39)***
Fourth	1.62 (1.43, 1.84)***	1.49 (1.31, 1.69)***	1.27 (1.18, 1.36)***	1.19 (1.1, 1.29) ***	1·41 (1·32, 1·51)***	1.32 (1.23, 1.42)***
Highest	2.18 (1.92, 2.47)***	1.70 (1.48, 1.96)***	1.60 (1.46, 1.75)***	1.35 (1.22, 1.49) ***	1·84 (1·71, 1·98)***	1.55 (1.42, 1.69)***
Caste/ethnic group						
Brahmin	Ref	Ref	Ref	Ref	Ref	Ref
Chhetri	0.87 (0.77, 1.98)*	1.01 (0.99, 1.20)	0.84 (0.78, 0.91)***	0.98 (0.91, 1.06)	0.85 (0.79, 0.91)***	1.03 (0.97, 1.1)
Dalit	0.73 (0.65, 0.84)***	1.03 (0.9, 1.19)	0.73 (0.67, 0.79)***	0.91 (0.84, 0.99)	0.73 (0.68, 0.79)***	0.96 (0.89, 1.03)
Janajati (Advantaged)	1.18 (1.02, 1.36)*	1.13 (1.00, 1.27)*	1.06 (0.94, 1.20)	0.99 (0.88, 1.12)	1.11 (1.01, 1.22)*	1.09 (1, 1.19)*
Janajati (Disadvantaged)	0.77 (0.68, 0.87)***	0.92 (0.83, 1.02)	0.85 (0.79, 0.91)***	0.96 (0.9, 1.02)	0.81 (0.76, 0.87)***	0.95 (0.9, 1.01)
Muslim and Others	0.80 (0.62, 1.05)	1.05 (0.81, 1.35)	0.73 (0.66, 0.81)***	0.88 (0.79, 0.98)*	0.77 (0.67, 0.88)***	0.92 (0.81, 1.05)
Other Madheshi caste	0.73 (0.65, 0.85)***	0.88 (0.76, 1.00)	0.68 (0.61, 0.77)***	0.88 (0.8, 0.97)**	0.71 (0.65, 0.77)***	0.86 (0.79, 0.93)***
Province						
Koshi			Ref	Ref		
Madhesh			0.85 (0.77, 0.95)**	0.93 (0.84, 1.01)		
Bagmati			1.26 (1.15, 1.38)***	1.11 (1.02, 1.2)*		
Gandaki			1.07 (1.00, 1.13)*	0.99 (0.93, 1.05)		
Lumbini			0.92 (0.87, 0.98)*	0.94 (0.89, 0.99)*		
Karnali			0.83 (0.76, 0.9)***	0.95 (0.87, 1.03)		
Sudoorpaschim			0.91 (0.86, 0.96)**	0.96 (0.9, 1.02)		

All models were adjusted for age of woman, education of woman, birth order of child, media exposure of woman, caste/ethnic group, household size, sex of household head, settlement; 2019 model was additionally adjusted for Province; Pooled model was additionally adjusted for survey year

[a] *CI* Confidence Interval, *cIRR* Crude Incidence Rate Ratio, *aIRR* Adjusted Incidence Rate Ratio

[1] $*p < 0.05$; $**p < 0.01$; $***p < 0.001$

to receive recommended ANC services, and have a lower number of ANC visits. Encouragingly, the equity gap narrowed over time: the concentration index became less pro-rich in 2019 compared to 2014, indicating that ANC utilization has become more equitable. Nevertheless, an appreciable pro-rich pattern persists, meaning wealthier women still enjoy higher ANC coverage than poor. These results are consistent with previous studies showing a positive association between household wealth and ANC service utilization in LMICs [36–38].

Several interrelated factors help explain why wealthier and higher-caste women have better ANC uptake. Women from wealthier households are more likely to have financial resources, higher education, exposure to mass media, and autonomy in healthcare decisions, all of which facilitate the use of maternal health services. They also tend to live in areas with better health infrastructure and transportation. In contrast, poorer and marginalized women often face geographical barriers (remote terrain, lack of roads), indirect costs (transport, lost wages), and social obstacles (lower decision-making power, potentially even exposure to intimate partner violence) that hinder access to care [19, 23, 39–41]. Moreover, wealthier women are more likely to benefit from government efforts, such as the Aama program [10].

Nepal is a lower-middle-income country and its health system has been characterized as weak and under resourced [42, 43]. Access to healthcare is particularly challenging for individuals residing in remote areas, and the quality of healthcare services varies widely across different geographical locations [42]. Despite these challenges, Nepal has made remarkable progress in improving maternal and child health status in recent decades. The Nepal Demographic and Health Survey (NDHS) 2011 showed that the proportion of women who received ≥ 4 ANC visits during the five years prior to the survey was 50.1% [44]. Our study shows that receipt of recommended ANC visits increased to 60.6% in 2014, which

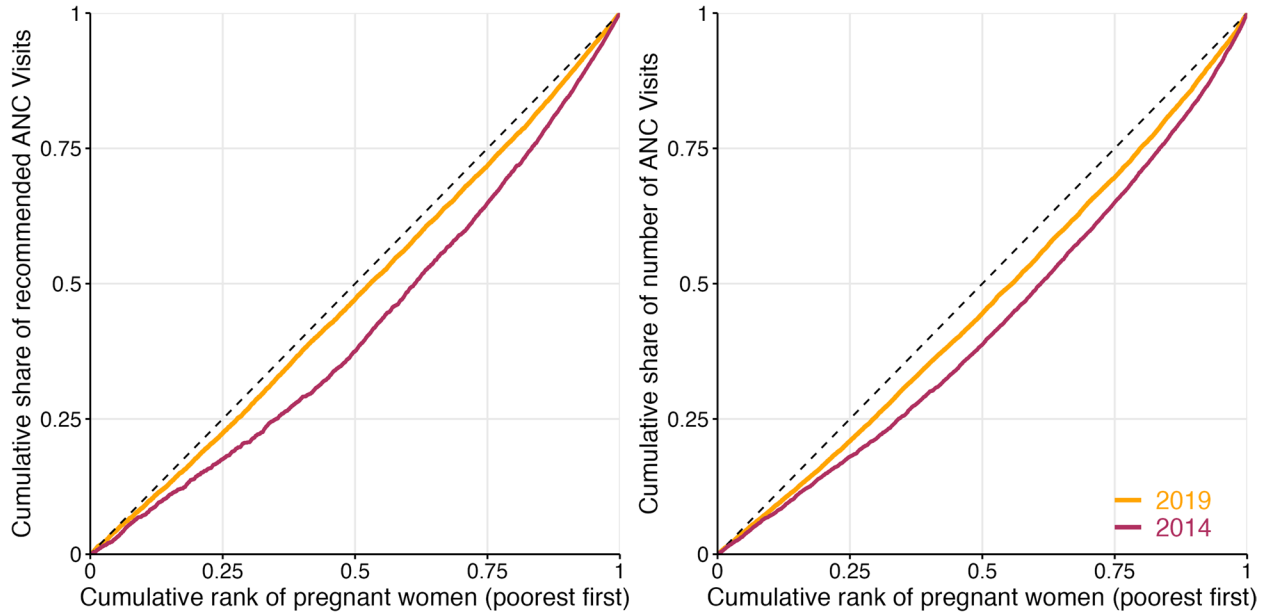

Fig. 4 Concentration curves for recommended ANC visits and number of ANC visits

indicates an increase in ≥4 ANC visits between 2011 and 2014. Similarly, in our study, the percentage of women who received recommended ANC visits increased to 77.8% in 2019, an increase from 69.4% of women who had ≥4 ANC visits in 2016, according to NDHS 2016 [45]. Moreover, the proportion of women who had no ANC visits in 2011 was 15.2% [44], which decreased to 12.3% in 2014 based on our analysis (results not shown in the text). This proportion continued to decrease to 4.5% in 2016 [45] and 2.3% in 2019, according to our analysis, reflecting a sustained decreasing trend.

The observed improvement in the utilization of ANC services from 2014 to 2019 can be attributed partly to several concerted efforts by government and development partners, alongside broad improvements in living standards. During 2014–2019, Nepal experienced rapid socioeconomic progress, with the multidimensional poverty rate falling from about 30% to 17% [22]. These findings are consistent with previous studies conducted in other LMICs, which have also demonstrated an association between improved SES and increased utilization of maternal health services [21].

Our findings on the positive association between household wealth, relatively advantaged ethnicity, and better-off provinces with the receipt of recommended antenatal visits and the frequency of ANC visits in Nepal are consistent with several previous studies. For instance, a study using the 2016 NDHS data revealed that women in the upper 60% of the wealth group had significantly higher rates of maternal care visits, including ANC, institutional delivery, and postnatal visits than women in the lower 40% group [46]. Likewise, a separate study analyzing the 2016 NDHS data showed that women from the middle and richest tertiles were 1.3 and 1.5 times more likely to complete ≥4 antenatal visits than women from the poorest wealth tertile [47]. A similar pattern emerged in the analysis of a nationally representative survey in India, where women from the richest wealth tertile were 2.99 times more likely to receive ≥4 antenatal visits than their counterparts in the poorest wealth tertile [48]. An analysis of the 2016 NDHS data established the household wealth index as a significant predictor of ANC visit numbers in Nepal, with the highest wealth tertile exhibiting an adjusted prevalence ratio of 1.27 in comparison to the lowest wealth tertile [23]. Likewise, a comprehensive study across 36 Sub-Saharan countries corroborated this trend, revealing that women in the middle and richest wealth tertiles were 1.32 and 1.38 times more likely, respectively, to have ≥8 ANC visits than their counterparts in the poorest wealth tertile [37]. Consistent with our findings, previous studies have consistently shown that women from Brahmin, Chhetri and advantaged Janajati ethnic groups have significantly better health outcomes, including ANC coverage, compared to Dalit, disadvantaged Janajati groups and other caste groups in Madhesh region of Nepal [16, 40]. Madhesh and Karnali Provinces of Nepal have the lowest Human Development Indices (HDIs), at 0.51 and 0.538, respectively, while Bagmati and Gandaki Provinces boast the highest HDIs at 0.661 and 0.618, surpassing the national average [49]. Madhesh and Karnali provinces face

persistent challenges in education, particularly among women, and in ensuring equitable access to health services [49]. Moreover, these provinces also have lower availability of health service providers, lower adherence to standard/protocols for antenatal services, and lower availability of basic client services in general, potentially contributing to lower utilization of ANC services [50]. Karnali Province is additionally severely affected by rugged geographical terrain, which hinders geographical access to health facilities.

Our study suggests a pro-rich inequality in ANC service utilization, as indicated by the concentration curves and concentration indices. It is concerning that women from poorer households have lower utilization of ANC visits despite having a greater need for services. However, we note that the concentration curves are progressively approaching the line of equality, which offers some encouragement. Our findings are consistent with the results from several previous studies. A study that used concentration curves to analyze the wealth-related disparities in maternal health service utilization from 2001 to 2016 in Nepal found that the coverage of ≥4 ANC visits is disproportionately higher among women in richer households [15]. The same study also reported a consistent decrease in the concentration index from 2001 to 2016 in ≥4 ANC visits, with the most substantial gains occurring between 2011 (CIx: 0.22) and 2016 (CIx: 0.08) [15]. Furthermore, a study encompassing 12 countries in the Southern African Development Community region, which utilized the concentration index, revealed that 11 out of 12 countries had wealth-related inequality in the number of ANC visits, including ≥4 ANC visits [51].

Strengths and limitations

A strength of this study is the use of recent, nationally representative survey data from two time points with sufficiently large sample size, which enhances the generalizability of the findings. Additionally, we used appropriate statistical tools including concentration curves and concentration indices to quantify the wealth-related inequality in ANC service utilization. However, our study has some limitations. The self-reported data on ANC service use used in this study may have been subject to recall bias or social desirability bias. Moreover, the associations of independent variables with ANC service utilization may not be interpreted as causal. Finally, our focus was on quantitative service coverage; aspects of care quality were not assessed in depth, though they are undoubtedly an important component of effective ANC.

Policy implications

Our findings have important policy implications for Nepal's national health goals and international commitments. The persistent inequalities in ANC uptake identified by this study indicate that Nepal's National Health Policy 2019 goal of "universal and equitable access to health services", particularly for underserved populations, is not yet fully realized [12]. To bridge these gaps, government must strengthen financial support programs like the Aama initiative and enhance their effectiveness among poorer and marginalized women through targeted awareness campaigns and active community engagement. Furthermore, with the recent shift to the World Health Organization's recommendation of eight ANC contacts per pregnancy under the Antenatal service and postnatal service continuum guidelines (2022) [4], Nepal must urgently address barriers that disadvantaged communities face in accessing these increased service contacts. Without additional support, disparities may worsen, given the greater ease with which wealthier urban women can access frequent visits compared to poorer rural counterparts.

These equity considerations are directly tied to Nepal's broader commitment to achieving UHC and the SDGs by 2030. While recent statistics—94% of women receiving at least one ANC visit and 80% achieving four or more visits—indicate progress toward these targets [52], intensified efforts are needed to prevent the exclusion of the most vulnerable groups. Equity-oriented interventions, including targeted resource allocation to low-performing provinces such as Madhesh and Karnali, increased outreach ANC clinics, improved transportation infrastructure, telehealth options, and strengthened health system capacities in rural areas, are essential. Policymakers should also foster multisectoral collaboration, encompassing education and women's empowerment initiatives, to effectively address underlying socioeconomic barriers to ANC utilization. By embedding these targeted interventions within the existing policy frameworks of the National Health Policy 2019 and SDG-driven national plans, Nepal can significantly reduce maternal and neonatal health inequities, fulfilling its national and international health commitments.

Conclusion

The study reveals an increase in antenatal care (ANC) service utilization and a reduction in wealth-related inequality among women of reproductive age in Nepal between 2014 and 2019. However, significant disparities persist across caste, ethnic groups, and provinces. Women from wealthier households, Brahmin/Chhetri, and Advantaged Janajati groups, as well as those in Bagmati and Gandaki provinces were more likely to receive the recommended ANC visits and had higher overall utilization rates compared to women from disadvantaged households and provinces. These findings underscore the disproportionate concentration of ANC services among women from higher socioeconomic strata, emphasizing the urgent need for targeted interventions to enhance

access to and utilization of ANC services among women from disadvantaged households in Nepal.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22897-9.

Supplementary Material 1.

Acknowledgements
We are grateful to the Central Bureau of Statistics and UNICEF for allowing us to use the MICS datasets. We are grateful to the peer reviewers for their invaluable feedback to improve the quality of this paper.

Institutional review board
Ethical review and approval were waived for this study because the survey protocols for MICS 2014 and MICS 2019 were approved according to the Statistical Act of Nepal, 1958. The Statistical Act enables the CBS to conduct surveys according to the government's ethics protocol without involving an institutional review board. The datasets obtained from the MICS did not include any personal identifiers.

Authors' contributions
Conceptualization, S.S. and Y.H; methodology, S.S.; software, S.S.; writing—original draft preparation, S.S., B.T., A.G.; writing—review and editing, S.S., B.T., A.G., and Y.H.; visualization, S.S.; supervision, Y.H. All authors have read and agreed to the published version of the manuscript.

Funding
YH is funded by the Beijing Municipal Natural Science Foundation (grant No.7202009), and the National Natural Science Foundation of China (grant No.82073574). Funders have no role in the design and execution of the study, analysis, and interpretation of data, or writing of this study.

Data availability
The datasets used for analyses in this study are open-access and publicly available freely upon request from the MICS website: https://mics.unicef.org/surveys.

Declarations

Consent for publication
The questionnaires were administered after thorough introduction and verbal consent by respondents. All respondents were informed of the voluntary nature of participation in the survey and of their right to refuse to answer all or particular questions, as well as to stop the interview at any time. They were also informed of the confidentiality and anonymity of their information.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Child and Adolescent Health and Maternal Care, School of Public Health, Capital Medical University, Beijing 100069, China. [2]Nepal Health Economics Association, Maharajgunj, Kathmandu 44600, Nepal. [3]Ministry of Health and Population, Ramshahpath, Kathmandu, Nepal.

Received: 15 September 2023 Accepted: 23 April 2025
Published online: 09 May 2025

References

1. Boerma T, Eozenou P, Evans D, et al. Monitoring progress towards universal health coverage at country and global levels. PLoS Med. 2014;11:e1001731.
2. World Health Organization. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. 2023.
3. Bhutta ZA, Das JK, Bahl R, et al. Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? Lancet. 2014;384:347–70.
4. Ministry of Health and Population Nepal. Antenatal service and postnatal service continuum Reference Material (Nepali version). Kathmandu: Family Welfare Division, Department of Health Services, Ministry of Health and Population, Nepal; 2022.
5. Huber-Krum S, Khadka A, Pradhan E, et al. The effect of antenatal counseling and intrauterine device insertion services on postpartum contraceptive use in Nepal: results from a stepped-wedge randomized controlled trial. Contraception. 2020;101:384–92. https://doi.org/10.1016/j.contraception.2019.12.014.
6. Khanal V, Zhao Y, Sauer K. Role of antenatal care and iron supplementation during pregnancy in preventing low birth weight in Nepal: comparison of national surveys 2006 and 2011. Arch Public Health. 2014;72. https://doi.org/10.1186/2049-3258-72-4.
7. Carroli G, Rooney C, Villar J. How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. Paediatr Perinat Epidemiol. 2001;15:1–42. https://doi.org/10.1046/j.1365-3016.2001.0150s1001.x.
8. Bhutta ZA, Das JK, Rizvi A, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013;382:452–77. https://doi.org/10.1016/S0140-6736(13)60996-4.
9. Ministry of Health and Population Nepal. Nepal Health Sector Strategy 2015–2020. Kathmandu: Ministry of Health and Population, Nepal; 2015.
10. Bhatt H, Tiwari S, Ensor T, et al. Contribution of Nepal's free delivery care policies in improving utilisation of maternal health services. Int J Health Policy Manag. 2018;7:645–55. https://doi.org/10.15171/ijhpm.2018.01.
11. Ministry of Health and Population Nepal. Aama Programme Implementation Guidelines 2022 (Nepali). 2022.
12. Ministry of Health and Population Nepal. National Health Policy 2076. 2019.
13. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. 2016.
14. Ministry of Health and Population Nepal. Nepal Safe Motherhood and Newborn Health Road Map 2030. 2019.
15. Sapkota VP, Bhusal UP, Acharya K. Trends in national and subnational wealth related inequalities in use of maternal health care services in Nepal: an analysis using demographic and health surveys (2001–2016). BMC Public Health. 2021;21. https://doi.org/10.1186/s12889-020-10066-z.
16. Ghimire U, Manandhar J, Gautam A, et al. DHS Further Analysis Reports No. 117 Inequalities in Health Outcomes and Access to Services by Caste/Ethnicity, Province, and Wealth Quintile in Nepal. 2019.
17. Khatri RB, Alemu Y, Protani MM, et al. Intersectional (in) equities in contact coverage of maternal and newborn health services in Nepal: insights from a nationwide cross-sectional household survey. BMC Public Health. 2021;21:1098. https://doi.org/10.1186/S12889-021-11142-8.
18. Ali S, Thind A, Stranges S, et al. Investigating Health Inequality Using Trend, Decomposition and Spatial Analyses: A Study of Maternal Health Service Use in Nepal. Int J Public Health. 2023;68. https://doi.org/10.3389/IJPH.2023.1605457.
19. Tohan MM, Islam MA, Rahman MA. Exploring the factors behind socio-economic inequalities in Antenatal Care (ANC) utilization across five South Asian natiaons: a decomposition approach. PLoS One. 2024;19. https://doi.org/10.1371/JOURNAL.PONE.0304648.
20. Arsenault C, Jordan K, Lee D, et al. Equity in antenatal care quality: an analysis of 91 national household surveys. Lancet Glob Health. 2018;6:e1186–95. https://doi.org/10.1016/S2214-109X(18)30389-9.
21. Anindya K, Marthias T, Vellakkal S, et al. Socioeconomic inequalities in effective service coverage for reproductive, maternal, newborn, and child health: a comparative analysis of 39 low-income and middle-income countries. EClinicalMedicine. 2021;40. https://doi.org/10.1016/j.eclinm.2021.101103.
22. National Planning Commission Government of Nepal. Multidimensional Poverty Index. Kathmandu, Nepal: National Planning Commission, Government of Nepal; 2021.

23. Adhikari M, Chalise B, Bista B, et al. Sociodemographic correlates of antenatal care visits in Nepal: results from Nepal Demographic and Health Survey 2016. BMC Pregnancy Childbirth. 2020;20:513.
24. Central Bureau of Statistics. Nepal Multiple Indicator Cluster Survey 2014, Final Report. Kathmandu, Nepal: Central Bureau of Statistics and UNICEF Nepal; 2015.
25. Central Bureau of Statistics (CBS). Nepal Multiple Indicator Cluster Survey 2019, Survey Findings Report. Kathmandu: Central Bureau of Statistics and UNICEF Nepal; 2020.
26. O'Donnell O, van Doorslaer E, Wagstaff A, et al. Analyzing Health Equity Using Household Survey Data. Washington: The World Bank; 2007.
27. Bennet L, Dahal DR, Govindasamy P. Caste, ethnic, and regional identity in Nepal: Further analysis of the 2006 Nepal Demographic and Health Survey. 2008.
28. Pal KB, Basnet BB, Pant RR, et al. Education system of Nepal: impacts and future perspectives of COVID-19 pandemic. Heliyon. 2021;7:e08014. https://doi.org/10.1016/j.heliyon.2021.e08014.
29. Lumley T. Complex Surveys: A Guide to Analysis Using R. Hoboken: Wiley; 2010.
30. Ver Hoef JM, Boveng PL. Quasi-Poisson vs. negative binomial regression: how should we model overdispersed count data? Ecology. 2007;88:2766–72. https://doi.org/10.1890/07-0043.1.
31. United Nations Department of Economic and Social Affairs Population Division. Female population of reproductive age (15-49 years). World Population Prospects: The 2024 Revision. 2024. https://population.un.org/dataportal/data/indicators/41/locations/524/start/2012/end/2020/table/pivotbylocation?df=6e3f2dec-432e-40bc-b343-bb887038f187. Accessed 7 Feb 2025.
32. Ren R. Note on DHS standard weight de-normalization. https://userforum.dhsprogram.com/index.php?t=getfile&id=535&S=bdd681b8de26f1e00bd0586fc8f9e3a2.
33. Erreygers G. Correcting the concentration index. J Health Econ. 2009;28:504–15. https://doi.org/10.1016/j.jhealeco.2008.02.003.
34. Wagstaff A, Paci P, van Doorslaer E. On the measurement of inequalities in health. Soc Sci Med. 1991;33:545–57. https://doi.org/10.1016/0277-9536(91)90212-U.
35. O'Donnell O, O'Neill S, Van Ourti T, et al. Conindex: estimation of concentration indices. Stata J. 2016;16:112–38. https://doi.org/10.1177/1536867X1601600112.
36. Rahman M, Hossain F, Islam R, et al. Equity in antenatal care visits among adolescent mothers: an analysis of 54 country levels trend and projection of coverage from 2000 to 2030. J Glob Health. 2022;12https://doi.org/10.7189/jogh.12.04016.
37. Tessema ZT, Tesema GA, Yazachew L. Individual-level and community-level factors associated with eight or more antenatal care contacts in sub-Saharan Africa: evidence from 36 sub-Saharan African countries. BMJ Open. 2022;12. https://doi.org/10.1136/bmjopen-2021-049379.
38. Neal S, Channon AA, Carter S, et al. Universal health care and equity: Evidence of maternal health based on an analysis of demographic and household survey data. Int J Equity Health. 2015;14. https://doi.org/10.1186/s12939-015-0184-9.
39. Khatri RB, Karkee R. Social determinants of health affecting utilisation of routine maternity services in Nepal: a narrative review of the evidence. Reprod Health Matters. 2018;26:32–46. https://doi.org/10.1080/09688080.2018.1535686.
40. Umesh G, Jyoti M, Arun G, et al. Inequalities in health outcomes and access to services by caste/ethnicity, province, and wealth quintile in Nepal. DHS Further Analysis Report. 2019;xvi-pp.
41. Gautam S, Jeong HS. The role of women's autonomy and experience of intimate partner violence as a predictor of maternal healthcare service utilization in Nepal. Int J Environ Res Public Health. 2019;16. https://doi.org/10.3390/ijerph16050895.
42. Cao WR, Shakya P, Karmacharya B, et al. Equity of geographical access to public health facilities in Nepal. BMJ Glob Health. 2021;6. https://doi.org/10.1136/bmjgh-2021-006786.
43. Sharma J, Aryal A, Thapa GK. Envisioning a high-quality health system in Nepal: if not now, when? Lancet Glob Health. 2018;6:e1146–8.
44. Ministry of Health and Population Nepal, New Era Nepal, ICF International. Nepal Demographic and Health Survey 2011. Kathmandu, Nepal: MOHP/Nepal, New ERA, and ICF International 2012.
45. Ministry of Health Nepal, New Era, ICF. Nepal Demographic and Health Survey 2016. 2017.
46. Khatri RB, Karkee R, Durham J, et al. Universal coverage of the first antenatal care visit but poor continuity of care across the maternal and newborn health continuum among Nepalese women: analysis of levels and correlates. Glob Health. 2021;17. https://doi.org/10.1186/s12992-021-00791-4.
47. Neupane B, Rijal S, G.c. S, et al. Andersen's model on determining the factors associated with antenatal care services in Nepal: An evidence-based analysis of Nepal demographic and health survey 2016. BMC Pregnancy Childbirth. 2020;20. https://doi.org/10.1186/s12884-020-02976-y.
48. Ogbo FA, Dhami MV, Ude EM, et al. Enablers and barriers to the utilization of antenatal care services in India. Int J Environ Res Public Health. 2019;16. https://doi.org/10.3390/ijerph16173152.
49. National Planning Commission. Nepal Human Development Report 2020. 2020.
50. Aryal KK, Dangol R, Gartoulla P, et al. Health services availability and readiness in seven provinces of Nepal. 2018.
51. Selebano KM, Ataguba JE. Decomposing socio-economic inequalities in antenatal care utilisation in 12 Southern African Development Community countries. SSM Popul Health. 2022;17. https://doi.org/10.1016/j.ssmph.2021.101004.
52. Ministry of Health and Population. Nepal Demographic and Health Survey 2022. Kathmandu: Ministry of Health and Population [Nepal]; 2023.

Publisher's Note