Progressive Status of Antenatal Care Visits in Bangladesh: A Comparison Study

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Abstract

Antenatal care (ANC) visits is a proven way to reduce the maternal as well as infant mortality and WHO recommended four or more ANC visits during pregnancy. This study aimed to observe the progressive status of antenatal care visits (ANC) by exploring the trend of 1^+ANC, WHO recommended 4^+ANC visits and determine the factors of ANC visits frequency over the periods 2004 to 2018. Data on ANC were taken from Bangladesh Demographic and Health Surveys. This research used descriptive statistics (mean, median and prevalence) to observe the changes (%) of ANC visits. ANOVA, Kruskal-Walis, chi-square (bivariate analysis) test and mixed hurdle negative binomial regression were performed to identify the determinants of ANC visits frequency. The mean and prevalence (%) were increased for ANC over the periods however, 4^+ANC visits was much lower than 1^+ANC visits across the factors. Poorest rural women who living in Chittagong, Sylhet division had significant negative impacts on increasing the 1^+ANC visits frequency and are less likely to receive 4^+ANC. On the other hand, wealthiest educated women with educated husband in Khulna, Rangpur region having more chances to get 4^+ANC visits and positively effects on 1^+ANC visits frequency for 2004 to 2018. Pregnancy wanted, Birth order number, and Last birth a C-Section are also the significant variable for 1^+ and 4^+ ANS. Although 1+ ANC visits have gradually increased in Bangladesh, the progress in achieving 4+ ANC visits has been much slower than expected. Therefore, the government and policymakers should focus their attention and prioritize interventions targeting the specific groups of women identified in this study.

Keywords: Antenatal care visits, Progressive Status, Hurdle Negative Binomial, BDHS data, Determinants, Trends.

AMS Classification: 62P10, 62E99.

1. Introduction

Child and maternal health are essential to measuring fundamental changes in a country's socioeconomic development. Although Bangladesh is a developing country, it has made noticeable success in the sector of Public Health[1-3]. Bangladesh is trying to achieve the Sustainable Development Goal (SDG) of reducing the maternal mortality ratio to 70 per 100,000 live births, neonatal mortality to at least as low as 12 live births per 1,000 live births, and under-five child mortality to at least as low as 25 live births[4]. However, the ratios mentioned above are currently noticeably high that is, 245 per 100,000, 30 per 1,000, and 45 per 1,000 live births, respectively[5]. Antenatal care (ANC) visit (which provides medical checkups and helps maintain a healthy lifestyle during pregnancy) is one of the best processes to diminish this mortality[5-8]. It has been found that mothers who do not receive ANC have a three times higher infant mortality rate than those who do during pregnancy[9] in Bangladesh. Through ANC services, women at risk of anemia, pregnancy-related hypertension, and preterm labor[10-13] are easily identified and can take immediate action to solve these problems. The presence of the midwife, doctor, nurse during delivery and postnatal care is also increased through ANC visits[14]. So, proper ANC during pregnancy reduces child and maternal mortality and increases their survival probability. According to World Health Organization (WHO), without any known pre-existing health condition, any pregnant woman should visit trained professionals at least four times[15].

A report from the Bangladesh Demographic and Health survey shows that the percentage of one or more ANC visit (1^{+}ANC) has significantly increased[5,16-18] from 64% in 2014 to 82% in 2017. Despite the accelerated progress in the minimum visits frequency, the percentage of women making four or more ANC visits (4^{+}ANC) is still far behind the targeted one, which will be 98% by 2030[18]. It is to be noted that in Bangladesh, the current prevalence of women receiving at 4^{+}ANC visits is 47%[5]. If we consider the whole world, it is 55%[19], and this picture for the low-income countries is comparatively worse (37%), which is not satisfactory. Several types of research have been done to identify factors associated with the antenatal care visits frequency in general[20-22]. Unfortunately, very few of them have emphasized on receiving 4^{+}ANC visits frequency, and most studies have focused on quantitative reporting of 1^{+}ANC visits frequency. The frequency of 4^{+}ANC visits utilization is proven to be a significant way to improve the health condition of mother and baby and reduce child and maternal mortality[7,21]. A comprehensive strategy is needed to observe the prevalence status of 1^{+}ANC and 4^{+}ANC visits and find factors responsible for the ANC (1^{+}ANC and 4^{+}ANC) visits frequency and its trends for the last consecutive years. According to the author's knowledge, at the national level in Bangladesh, no studies have been conducted previously to explore the trend of the frequency of 1^{+}ANC and 4^{+}ANC visits across the periods (2004 - 2018). In this study, our main objective is to use available Bangladesh Demographic and Health Survey (BDHS) data to observe the progressive status by exploring the factors and trend of 1^{+}ANC and 4^{+}ANC visits frequency in Bangladesh with different socioeconomic demographic variables using a well fitted count regression model. This trend might be informative for the country's policymakers at the national level to improve maternal health during pregnancy by accelerating the coverage of 4^{+}ANC visits.

2. Methodology
Data and Sample

This study has used BDHS secondary data for 2004, 2011 and 2017-2018 survey years which are electronically available from: (https://dhsprogram.com/data/available-datasets.cfm). This research

involved the ever-married women aged 15-49 years as participants who utilized the antenatal care visits in their last birth preceding 3 years within the surveys. The information was gathered from 5364, 7319 and 5012 women for 2004, 2011 and 2017-2018 survey years, respectively[5,17,23].

Outcome Variable

1^+ANC visits frequency: 0,1,2,3, ..., in the last pregnancy of women was considered as primary response variable. We recoded the 1+ANC visits frequency as 4^+ANC visits frequency: $< 4 = 0, 4 = 1, 5 = 2, 6 = 3$ ... ...,. We also created two categorical variables: 1^+ANC (>=1(Yes), 0(No)) and 4^+ANC (>=4(Yes), <4(No)) for prevalence and bivariate analysis.

Independent Variables

A set of socioeconomic and demographic variables were taken in this study these significantly associated with the ANC visits frequency from the existing literature. These variables included division, place of residence, woman's age at first birth, mothers and husbands education level, last birth a caesarean section, husbands occupation (AGRWF: Agriculture and Related Workers, Fisherman, LDSOW: Labour, Domestic Servent and other worker, PB: Professionals and Businessman, UO: Unemployed and Others), respondent occupation (Not work, AGRWF and LDSOW, PB), Watching TV, women pregnancy wanted, birth order and decision making power on health care (HCDM). In this study, wealth index was calculated using asset variables such as household has TV/radio, refrigerator, sanitation and water facilities, materials of house construction, farming land etc. by widely used principal component analysis (PCA) techniques. Using asset score, rank the household into the five socioeconomic groups from poorest (lowest 20%) to richest (top 20%). There were small percentages of missing values in variables husband education, husband occupation, HCDM for 2017 and women age, husband age, HCDM for 2011 BDHS data. We imputed these missing values using random forest method for categorical data under "mice" R package.

Statistical Analysis

Mean and median of 1^+ANC visits frequency were computed by the survey years according to the women background characteristics. Trends of 1^+ANC visits frequency were calculated on the basis of observed mean (%) change over the survey years (2004 to 2011 and 2011 to 2018). To find the significant difference in 1^+ANC visits frequency among groups of women characteristics one way analysis of variance (ANOVA) were used. Kruskal-Walis (KW) test were performed to identify the significant factors of 1^+ANC visits frequency in terms of median differences. In this study, we also compute the prevalence of 1^+ANC and 4^+ANC by the survey years and prevalence (%) change were demonstrated to show the trends over time 2004 to 2018. We were performed the chi-square test to check the association between 1^+ANC, 4^+ANC with explanatory variables.

In the literature, Bhowmik KR et al.[20] Fitting the model for antenatal care visits frequency using 2014 BDHS data. They were taken the number of one part and two part count model with the consideration of extra zeros, cluster specific variance and intra-cluster correlation. Initially, Poisson regression (PR) and Negative binomial regression (NBR) were occupied. After that mixed PR, NBR, zero inflated PR (ZIPR), NBR (ZINBR), mixed ZIPR and ZINBR, hurdle PR and NBR, mixed HPR, HNBR with and without extra random effects were considered. Through the evaluation process using different fitting criteria MHNBR with extra random effects model was selected as a best model. We used this model for 1^+ANC and 4^+ANC visits frequency. All the analysis was conducted using R 4.1.1 and SPSS 25 software.

3. Results

In this research, we have calculated the mean (%) changes over the periods, 2004 to 2011 and 2011 to 2018 across all the determinants and also performed ANOVA and Kruskal-Walis test to identify the significant factors for 1^+ANC visits frequency (Table 1). It is observed that the mean number of 1^+ANC visits are significantly increasing trend for almost all the variables. This increase is more accelerated during the year 2011 to 2017-2018 than in the period 2004 to 2011. However, the percentage of women who receive 4^+ANC visits is much lower than that of women who attain 1^+ANC visits in general for the years 2004, 2011, and 2018. Women living in Khulna and Rangpur had a higher mean number of 1^+ANC visits and also a higher percentage of having 4^+ANC visits.

Table 1: Change of 1^+ANC visits frequency across significant factors.

| Variables | 1^+ANC visits frequency | | | | | | Mean (%) Change | |
| | 2004 | | 2011 | | 2017-2018 | | | |
	Mean	Median	Mean	Median	Mean	Median	2004-2011	2011-2018
Division***								
Barisal	1.51	1	2.39	2	3.52	3	58.3	47.3
Chittagong	1.81	1	2.10	1	3.42	3	16.0	62.9
Dhaka	2.08	1	2.42	1	4.37	4	16.3	80.6
Khulna	2.19	1	2.81	2	4.62	4	28.3	64.4
Mymensingh					3.85	3		
Rajshahi	1.98	1	2.36	2	4.14	4	19.2	75.4
Rangpur			2.94	3	4.54	4		54.4
Sylhet	1.54	1	1.92	1	3.22	3	24.7	67.7
Place of Residence***								
Urban	3.11	2	3.51	3	4.69	4	12.9	33.6
Rural	1.33	0	1.87	1	3.52	3	40.6	88.2
Women's Education***								
No Education	0.92	0	1.08	0	2.19	2	17.4	102.8
Primary	1.48	1	1.71	1	3.08	2	15.5	80.1
Secondary	2.72	2	2.84	2	4.08	4	4.4	43.7
Higher	5.53	5	5.29	5	5.39	5	-4.3	1.9
Age at First Birth***								
Less than 18	1.47	1	1.99	1	3.56	3	35.4	78.9
Between 18 and 25	2.39	1	2.65	2	4.07	4	10.9	53.6
Greater than 25	3.51	3	4.56	4	5.40	6	29.9	18.4
Last Birth a C-Section***								
No	1.68		1.99	1	3.27	3	18.5	64.3
Yes	5.81		4.50	4	5.22	5	-22.5	16.0
Partner's Education Level***								
No Education	1.05	0	1.31	0	2.81	2	24.8	114.5
Primary	1.43	1	1.96	1	3.29	3	37.1	67.9
Secondary	2.45	2	2.77	2	4.15	4	13.1	49.8
Higher	4.49	4	4.52	4	5.43	5	0.7	20.1
Partner's Occupation***								
AGRWF	1.07	0	1.49	1	3.16	3	39.3	112.1
LDSOW	1.87	1	2.35	2	3.81	3	25.7	62.1
PB	2.71	2	3.29	3	4.66	4	21.4	41.6
UO	1.99	1	2.16	1	4.45	4	8.5	106.0

Wealth Status*								
Poorest	0.71	0	1.24	0	2.79	2	74.6	125.0
Poorer	1.07	0	1.55	1	3.29	3	44.9	112.3
Middle	1.47	1	2.03	1	3.89	3	38.1	91.6
Richer	2.03	1	2.63	2	4.23	4	29.6	60.8
Richest	3.95	3	4.43	4	5.45	5	12.2	23.0
Watching TV*								
Not at all	1.03	0	1.47	1	2.98	3	42.7	102.7
Less than once a week	1.59	1	1.99	1	3.71	3	25.2	86.4
At least once a week	1.67	1	3.23	3	4.63	4	93.4	43.3
Almost Every Day	3.64	3						
Birth Order Number*								
First	2.37	2	2.82	2	4.19	4	19.0	48.6
Second	1.59	1	1.88	1	3.46	3	18.2	84.0
Third	0.88	0	0.95	0	2.15	2	8.0	126.3
Pregnancy Wanted*								
Then	2.00	1	2.52	2	4.06	4	26.0	61.1
Later	1.99	1	2.53	2	3.73	3	27.1	47.4
No more	1.28	0	1.54	1	2.89	2	20.3	87.7
Decision on Health Care*								
Respondent alone	2.04	1	2.53	2	4.03	3	24.0	59.3
Respondent & Husband	2.08	1	2.52	2	3.97	3	21.2	57.5
Husband alone	1.73	1	2.09	1	3.76	3	20.8	79.9
Other	2.04	1	2.48	2	3.80	3	21.6	53.2
National	**1.89**	**1**	**2.39**	**2**	**3.92**	**3**	**26.5**	**64.0**
Sample Size	5364		7319		5012			

***p-values <0.001, **p-values<0.01 and *p-values<0.05.

In contrast, the Sylhet division has the smallest percentage for 1^+ANC visits and 4^+ANC visits. As expected, urban women had a higher mean of 1^+ANC visits than their rural counterparts. The percentage of 1^+ANC visits in the rural area gradually increased highly compared with the urban percentage, but this dramatically falls when we compare 4^+ANC visits percentage (Table 1 and Table 2). For instance, from Table 2, the prevalence percentage of rural people with 1^+ANC (Yes/No) visits are 49.6%, 59.9%, and 90.3%, and the prevalence percentage of 4^+ANC(Yes/No) visits are 10.7%, 18.7%, and 42.5% in the year 2004, 2011 and 2017-2018 respectively, and these figures for urban people are 75.6%, 80.9% and 94.9% for 1^+ANC visits change to 34.6%, 43.0% and 59% for 4+ANC visits respectively. Women's and their partner's education have the mean number of 1^+ANC visits increasing with time and are significantly positively associated with attaining 4^+ANC visits during pregnancy (Table 1 and Table 2). But the percentage of the 4+ANC visits is not expected compared to 1^+ANC visits for no education groups, while it is expected in the highly educated groups.

Generally, mid-aged women (age >25) are concerned about ANC visits, so the percentage of 1^+ANC visits and 4^+ANC visits are more significant in the mid-aged group than the other age groups. Unfortunately, it is alarming for women under 18 years, and the prevalence of 4^+ANC visits percentages are unsatisfactory at 12.7%, 20.8%, and 42.2% (Table 2). In the percentage of women whose last childbirth through cesarean sections, the prevalence percentage of 1^+ANC visits is satisfactory at 97.4%, 91.8%, and 98.8%; however, when the standard 4^+ANC visits are taken into

account, the picture becomes alarming since the changing percentage is only 24.2% from the year 2011 to the year 2018 (Table 2). It is always expected and exhibited that the wealthiest women have more facilities to attend skilled birth attendants (SBA) and ANC visits. Watching TV (media exposure) has played an important role in increasing ANC visits; that's why the prevalence percentage of 1^+ANC visits for those who watch TV is higher than for those who do not.

Table 2: Prevalence of 1^+ANC (Yes/No), 4^+ANC (Yes/No) and its changes across associated factors

	1^+ANC Visits Prevalence			ΔPrevalence (%)		4^+ANC Visits Prevalence			ΔPrevalence (%)	
	2004	2011	2018	2004-2011-2018		2004	2011	2018	2004-2011-2018	
Division***										
Barisal	50.1	66.1	86.3	31.9	30.6	14.9	27.5	40.1	84.6	45.8
Chittagong	56.7	62.5	91.4	10.2	46.2	17.6	21.3	40.5	21.0	90.1
Dhaka	58.8	64.8	93.4	10.2	44.1	20.4	26.7	53.3	30.9	99.6
Khulna	64.4	74.9	96.2	16.3	28.4	21.7	32.7	59.6	50.7	82.3
Mymensingh			90.7					48.3		
Rajshahi	61.8	72.1	95.3	16.7	32.2	18.7	24.9	50.5	33.2	102.8
Rangpur		75.8	95.5		26.0		36.3	61.5		69.4
Sylhet	50.4	54.3	87.3	7.7	60.8	13.6	19.1	36.8	40.4	92.7
Place of Residence***										
Urban	75.6	80.9	94.9	7.0	17.3	34.6	43.0	59.0	24.3	37.2
Rural	49.6	59.9	90.3	20.8	50.8	10.7	18.7	42.5	74.8	127.3
Women's Education***										
No Education	38.5	39.9	72.4	3.6	81.5	6.5	8.9	20.2	36.9	127.0
Primary	55.2	57.7	86.9	4.5	50.6	11.2	16.7	34.5	49.1	106.6
Secondary	75.4	78.0	94.6	3.4	21.3	29.2	32.3	51.5	10.6	59.4
Higher	97.3	96.3	99.0	-1.0	2.8	68.1	67.6	70.5	-0.7	4.3
Age at First Birth***										
Less than 18	52.8	61.9	89.7	17.2	44.9	12.7	20.8	42.2	63.8	102.9
Between 18 and 25	64.1	70.3	93.2	9.7	32.6	25.0	30.1	50.7	20.4	68.4
Greater than 25	71.4	81.7	96.2	14.4	17.7	39.7	57.0	71.8	43.6	26.0
Last Birth a C-Section***										
No	55.6	61.8	88.4	11.2	43.0	15.6	20.9	37.9	34.0	81.3
Yes	97.4	91.8	98.8	-5.7	7.6	68.3	55.4	68.8	-18.9	24.2
Partner's Education Level***										
No Education	43.4	47.5	82.5	9.4	73.7	7.2	11.9	30.1	65.3	152.9
Primary	53.3	62.4	88.5	17.1	41.8	12.1	19.8	38.4	63.6	93.9
Secondary	70.2	76.4	95.1	8.8	24.5	25.4	31.8	51.8	25.2	62.9
Higher	88.0	90.6	98.9	3.0	9.2	53.2	56.3	71.9	5.8	27.7
Partner's Occupation***										
AGRWF	44.7	52.6	86.8	17.7	65.0	7.1	14.1	36.5	98.6	158.9
LDSOW	59.2	68.1	91.9	15.0	34.9	17.5	25.2	46.6	44.0	84.9
PB	67.9	77.3	95.6	13.8	23.7	29.8	39.7	59.2	33.2	49.1
UO	60.6	65.0	77.8	7.3	19.7	22.5	22.2	55.6	-1.3	150.5

Wealth Status***										
Poorest	33.0	45.5	81.9	37.9	80.0	3.9	10.7	30.9	174.4	188.8
Poorer	45.5	53.7	89.3	18.0	66.3	7.3	14.7	38.1	101.4	159.2
Middle	57.3	65.6	93.8	14.5	43.0	11.5	21.2	47.8	84.3	125.5
Richer	66.7	76.2	96.3	14.2	26.4	18.3	28.8	53.8	57.4	86.8
Richest	85.2	91.3	98.9	7.2	8.3	46.8	55.5	71.3	18.6	28.5
Watching TV***										
Not at all	42.4	51.1	85.1	20.5	66.5	7.3	13.6	33.9	86.3	149.3
Less than once a week	58.3	63.6	92.5	9.1	45.4	13.3	20.0	45.5	50.4	127.5
At least once a week	60.1	79.8	96.6	32.8	21.1	14.3	38.3	58.8	167.8	53.5
Almost Every Day	82.0					41.6				
Birth Order Number***										
First	65.6	74.3	94.4	13.3	27.1	24.5	32.5	52.6	32.7	61.8
Second	55.3	58.4	87.5	5.6	49.8	14.3	19.1	41.2	33.6	115.7
Third	37.3	37.9	77.2	1.6	103.7	5.4	6.3	19.2	16.7	204.8
Pregnancy Wanted***										
Then	58.9	69.1	92.5	17.3	33.9	19.9	28.2	50.2	41.7	78.0
Later	61.1	68.2	92.0	11.6	34.9	19.4	28.2	46.1	45.4	63.5
No more	49.0	51.5	85.5	5.1	66.0	9.6	14.9	31.7	55.2	112.8
Decision on Health Care*										
Respondent alone	58.1	70.9	92.8	22.0	30.9	20.5	25.6	46.5	24.9	81.6
Respondent & Husband	59.2	67.9	91.8	14.7	35.2	20.6	31.5	49.4	52.9	56.8
Husband alone	56.2	61.8	90.9	10.0	47.1	16.2	22.6	45.4	39.5	100.9
Other	63.8	71.4	94.3	11.9	32.1	19.6	28.8	45.9	46.9	59.4
National		**66.6**	**91.9**	**15.4**	**38.0**	**18.2**	**26.4**	**48.2**	**45.1**	**82.6**

***p-values <0.001, **p-values<0.01 and *p-values<0.05.

Prevalence percentages are 5.4%, 6.3%, and 19.2%. The number of 1+ANC visits for mothers declines as the number of children grows, particularly in the third number of children, when 4+ANC visits are extremely low. The tendency of 1+ANC visits over time has increased as a result of men and wives working together to make health care decisions, as opposed to making decisions separately. A dumbbell plot is used to illustrate the findings in Table 2. Figure S1(a, b) displays the changes in prevalence for 1+ANC and 4+ANC visits from 2011 to 2018. Additionally, Figure S1(c,d) contrasted the proportion of 1+ANC visits with the WHO-recommended 4+ANC visits.

According to the Mixed Effect Hurdle Negative Binomial Model with extra random effects (MHNBR.ERE) place of residence, divisions, women's education, caesarean section at last birth, partner's education level, partner's occupation, wealth status, mass media exposure, birth order number, pregnancy wanted and decision on health care are significantly associated with the frequency of 1^{+}ANC visits in all the three different years 2004, 2011 and 2017-2018. The counting part of the model has the significance of how the selected factors affect the frequency of 1^{+}ANC visits, represented as the Incidence Rate Ratio (IRR) (Table 3 and Table 4). In contrast, the zero-part of the model depicts the effects of selected determinants on women making 1^{+}ANC visit or

not during their pregnancy period. As 4^+ANC visits are essential for safe delivery, we also considered the effects of our selected factors on 4^+ANC visits.
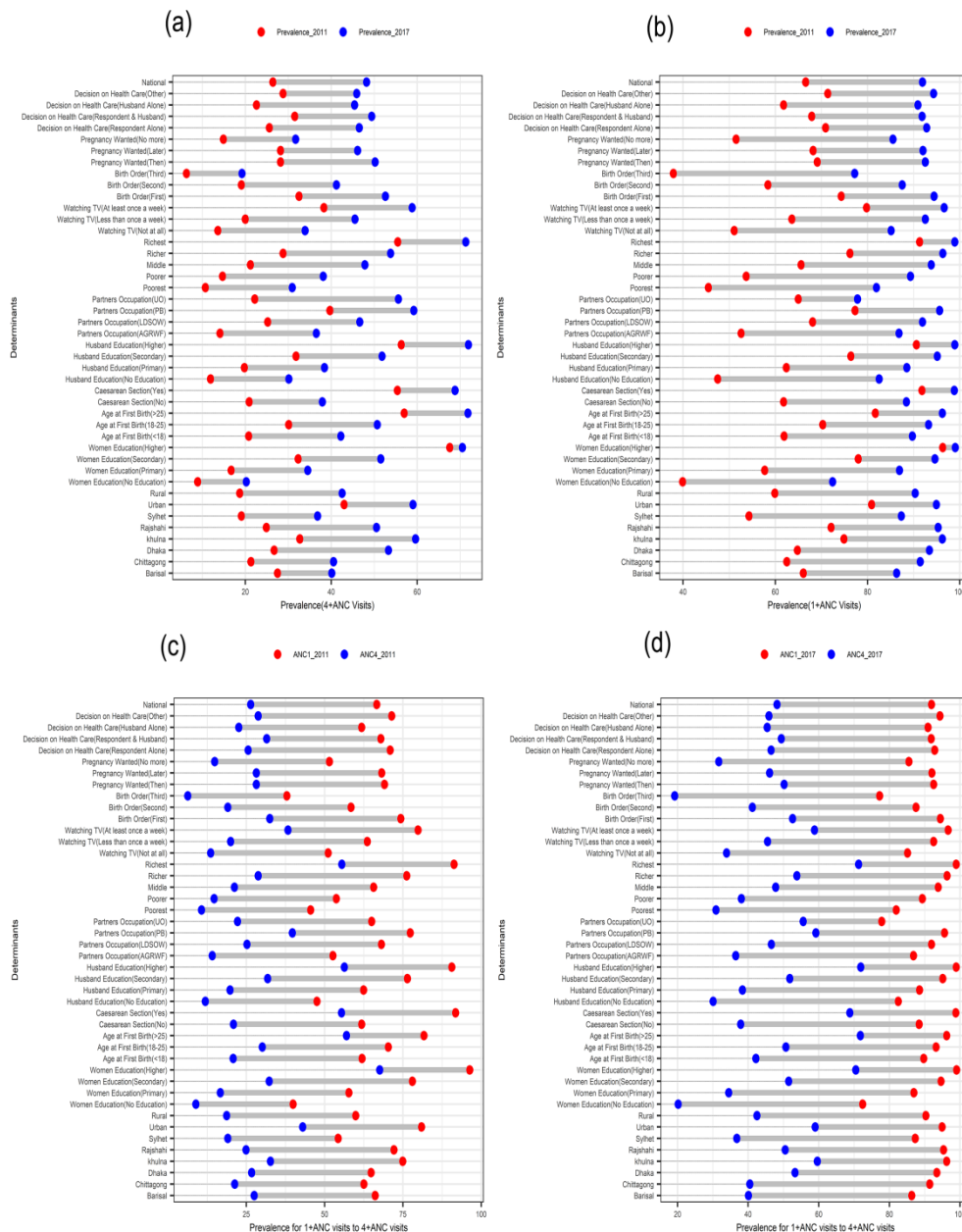

Figure S1. Prevalence and its changes across associated factors (a) Prevalence for 4^+ANC visits from 2011 to 2018 (b) Prevalence for 1^+ANC visits from 2011 to 2018 (c) Prevalence for 1^+ANC visits to 4^+ANC visits for 2011 (d) Prevalence for 1+ANC visits to 4+ANC visits for 2018.

From the count part of the model (Table 3), it is found that in 2017-2018, women living in Khulna (IRR: 1.10, CI:0.99-1.23) and Rangpur (IRR:1.24, CI:1.11-1.38) division, primary (IRR:1.17, CI: 1.05-1.30), secondary (IRR:1.29, CI:1.16-1.48) and higher educated women (IRR: 1.34, CI: 1.19-1.51), last birth caesarean section (IRR:1.24, CI:1.19-1.30), higher educated partners (IRR:1.16, CI:1.06-1.26) and unemployed partners (IRR:1.52, CI: 1.00-2.31), women whose family status richest (IRR:1.13, CI:1.03-1.23) and watching TV at least once a week (IRR:1.15, CI:1.09-1.20), women who were currently working (IRR:1.10, CI:1.00-1.20) are significantly positively associated with the increasing frequency of 1^+ANC visits. In comparison, women living in Chittagong division (IRR:0.88, CI:0.79-0.98) and rural areas (IRR:0.89, CI:0.84-0.94), women poorest wealth status (IRR:0.97, CI:0.91-1.04), increasing birth order number (for third baby birth, IRR: 0.89, CI: 0.78-1.02) and women who did not want any more children (IRR for later: 0.90, CI: 0.85-0.96 and no more:0.84, CI:0.77-0.94) have significant negative impacts on the increasing number of 1^+ANC visits. The count part of the model reflects approximately similar results for almost all the factors in 2004 and 2011 (Table 4). Incidence Rate Ratio for 1^+ANC visits frequency with 95% confidence interval for different factors and comparison between 2011 and 2018 are displayed in the Figure S2.

In comparison with zero part (No 1^+ANC and No 4^+ANC) of the model in 2017-2018 (Table 3), outcomes shows that women who living in Chittagong (OR:1.19, CI:0.83-1.70), Sylhet division (OR:1.10, CI:0.75-1.60) and rural areas (OR:1.36, CI:1.11-1.67), poorest women (OR:1.06, CI:0.85-1.33), women with third baby birth (OR:1.74, CI:1.16-2.61) and pregnancy wanted (for later, OR:1.31, CI:1.07-1.60 and no more, OR:1.51, CI:1.13-2.02) are less likely to contact with 4^+ANC visits. Analogous explanations are suitable for No 1^+ANC visits in 2017. On the other way, women having more chances to receive 4^+ANC visits with the followings characteristics: living in Khulna (OR:0.55, CI:0.38-0.81) and Rangpur (OR:0.33, CI:0.22-0.48) divisions, secondary (OR:0.37, CI:0.26-0.53) and higher (OR:0.33, CI:0.22-0.49) educated women whom last birth was caesarean section (OR:0.43, CI:0.37-0.51), higher educated (OR:0.55, CI:0.41-0.75) and Business or public services (OR:0.80, CI:0.60-1.00) partners, richer (OR: 0.77, CI:0.59-0.99) and richest (OR:0.59, CI:0.43-0.80) wealth status, watching TV at least once a week (OR: 0.68, CI:0.58-0.81) and Businessman or public services women (OR:0.67, CI:0.43-1.06). The interpretations of results are approximately parallel for 1^+ANC visits in 2017-2018 (Table 3). We also found that there are noticeable differences between the odds of zero 4^+ANC visits and zero 1^+ANC visits with the respective reference categories for all the factors. An analogous comparison of results has been conducted among the years 2004, 2011 and 2017-2018 (Table 3 & Table 4). Although, the likelihood of no 1^+ANC visits has been decreasing gradually but it is still alarming for no 4^+ANC visits. Figure S3 represented the odds ratio of no 1^+ANC and no 4^+ANC visits with 95% confidence interval over 2011 to 2017-2018 for different factors.
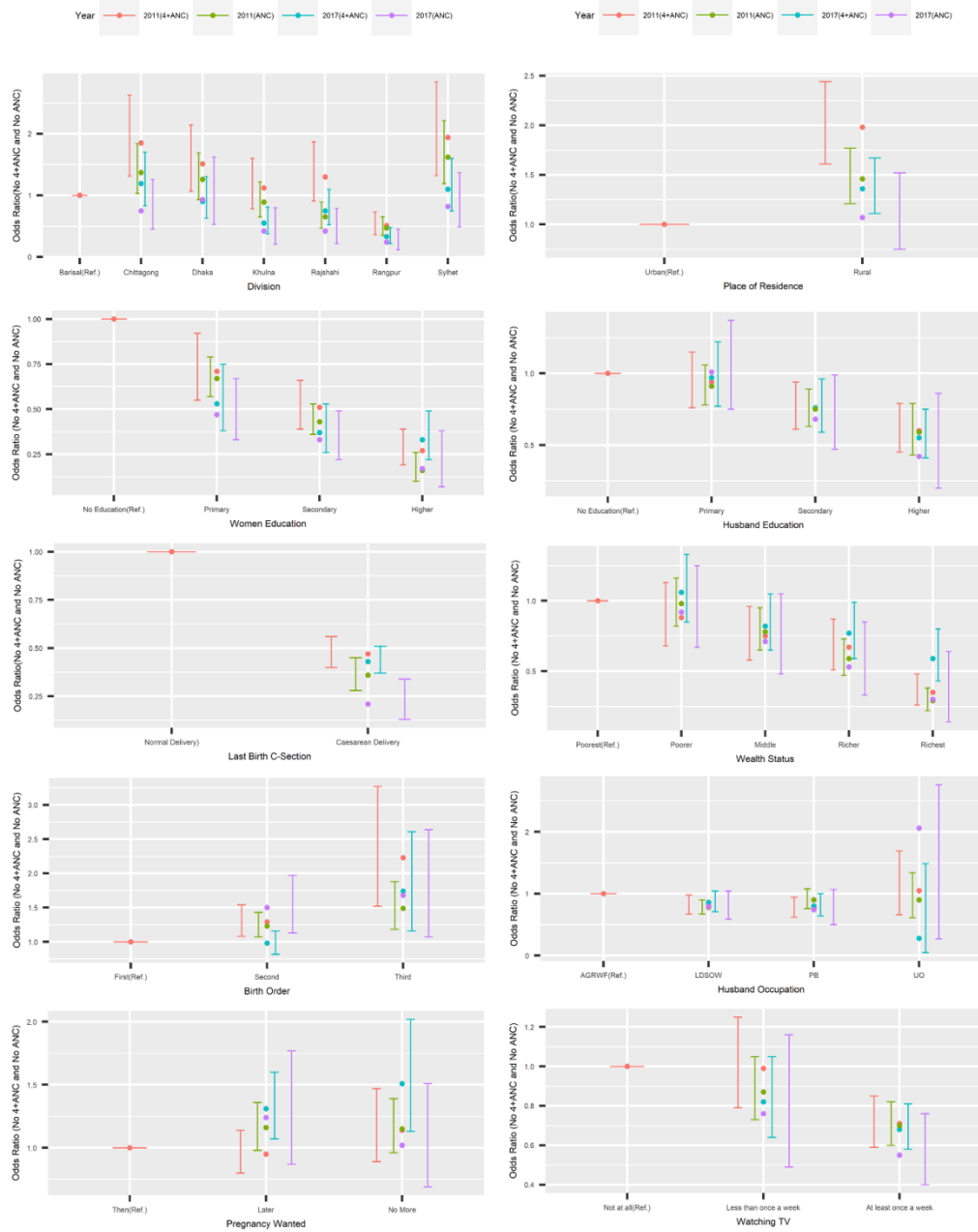
Figure S2. Incidence rate ratio (95% confidence interval) of 1^{+}ANC visits frequency for the significant determinants and comparison between 2011 and 2018.
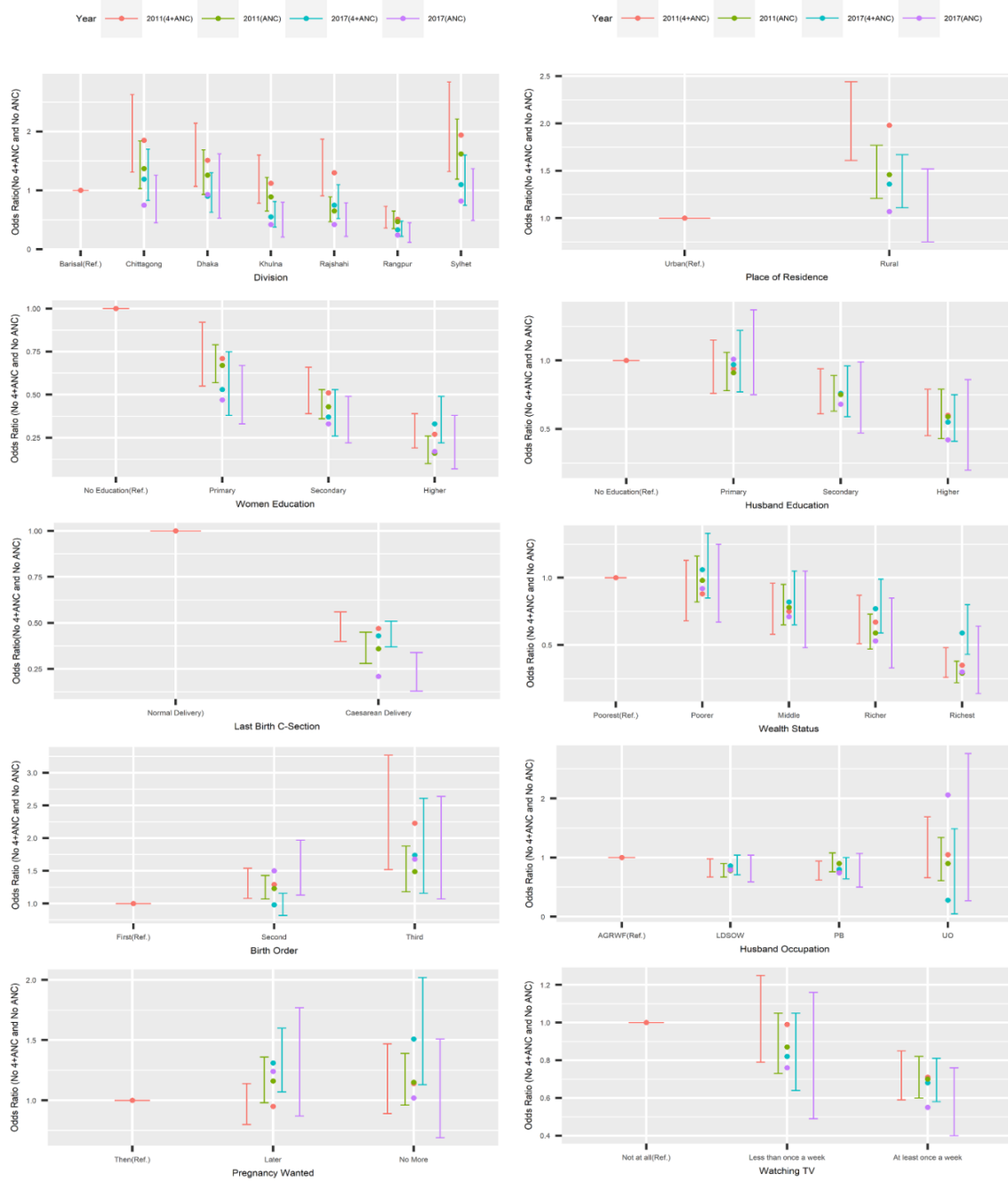
Figure S3. Odds ratio (95% confidence interval) of no 4$^+$ANC and no 1$^+$ANC visits for the significant determinants and comparison between 2011 and 2018.

4. Discussion

The primary goal of the study is to use nationally representative survey data to track the trend and progressive status of prenatal care visits in Bangladesh across the related components. To investigate the distinction between 1^+ANC and 4^+ANC, this study has methodically recorded the prevalence of 1^+ANC and 4^+ANC for the most recent consecutive survey year. Furthermore, since the number of zeros ANC visits exists in the data set generated from two processes, zero mixed hurdles negative binomial regression with extra random effects is considered for modeling purposes.

The prevalence percentage of reproductive-age women who received 1^+ANC and 4^+ANC increased over the study periods. However, the prevalence percentage for 4^+ANC is not increased at the same rate as 1^+ANC. The results from Regression Model (Table 4), with respect to the Barisal division women living in Rajshahi and Khulna, had the highest likelihood of having 1^+ANC in 2004, while in 2011, Chittagong and Sylhet divisions women had a significant frequency of getting no 1^+ANC visits. These suggested that ANC-related programs work well in less economically improved areas than economically developed ones, for example, Chittagong and Sylhet, and this scenario remains the same until 2017-2018 (Table 3). One explanation could be the geographical location of these two districts since Chittagong is the hilly tract area and Sylhet is the haor area, where these different ANC programs cannot reach properly.

Urban women tend to attend the ANC visits more than rural women[24] and in our study it is found that this difference is statistically significant. Married women who live in urban areas tend to take help from skilled maternal services, which are more easily accessible during the pregnancy period than women living in rural areas[21,22,25]. Moreover, higher educated women living in urban areas and have a touch of health-related different sources; for example, seminars, health related advertisements, and health centers make them more conscious about their health than women living in rural areas. Women's education is one of the most important determinants of having ANC utilization and it's positively associated with seeking prenatal care and ANC visits[24]. The analysis of our present study found that education level is more strongly and significantly associated with the 1^+ANC and 4^+ANC visits frequency. Women who are higher educated had significantly more frequency of 1^+ANC visits compared to the women with other level of education.

Try to lower pregnancy complications with routine ANC visits after both the husband and woman, or at least one of them, are educated and aware of the risks. ANC utilization 26 has been found to be positively correlated with educated partners in numerous additional research, including Rahman et al. Additionally, under the guidance of knowledgeable parents, a newborn infant might benefit from more health facilities. Compared to women who did not have a caesarean section during the whole study year, women who had a caesarean section for their last birth were less likely to attend no 1^+ANC and 4^+ANC. They become more conscious about ANC visits when the last birth is a caesarean section, which raises various pregnancy-related complications.

Household wealth status has a positive association with ANC visits[9,24,25] and it's indifference between urban and rural areas[27]. This is in line of our study results, where no 1^+ANC and 4^+ANC odds ratio for wealthy family women has less than the poorer families. Since rich families' women's are generally educated and they are more influenced by media's like TV news related to antenatal care, the frequency of ANC visits is higher. Moreover, in our study it's reveals that the women who are watching TV almost every day have higher probability to have more number of ANC visit compared to those who are not watching TV at all. It is also found that the chance of receiving 1^+ANC and 4^+ANC is higher for women during the first birth compare to second and third birth. In our study it's reveals that the number of the ANC visits for women who have not any desire in future pregnancy were found to be more likely visits to the ANC services. It's indicate that the contraceptive use at birth break as a part of family planning increase mother's in realizing the importance of the ANC visits[28]. The contraceptive using increasing one's knowledge about

reproduction and their own health, which would be so much helpful in future engagement of ANC visits[29,30]. After all, on the basis of above discussion, it can be inferred that wealthiest educated women with educated husband in Khulna, Rangpur region who watching TV at least once a week, caesarean section and working as business or public services having more chances to get 4^+ANC visits and positively effects on 1^+ANC visits frequency. On the other hand, poorest rural women who living in Chittagong, Sylhet division, want no more children and for third baby birth have significant negative impacts on increasing the 1^+ANC visits frequency and are less likely to receive 4^+ANC visits. Finally, the rural and less educated women are the targeted group for policy implication.

Table 3: Estimated incidence rate ratio (IRR) and odds ratio (OR) with 95% confidence interval (CI) for mixed hurdle negative binomial regression with extra random effects (2011-2018

Survey Year	2011			2018		
	Count-part	Zero-part		Count Part	Zero-part	
	1^+ANC Visits Frequency	No 1^+ANC Visits	No 4^+ANC Visits	1^+ANC Visits Frequency	No 1^+ANC Visits	No 4^+ANC Visits
Category	IRR	OR	OR	IRR	OR	OR
Division (Ref: Barisal)						
Chittagong	0.82*(0.73,0.93)	1.37*(1.03,1.84)	1.85*(1.31,2.63)	0.88*(0.79,0.98)	0.75(0.45,1.26)	1.19(0.83,1.70)
Dhaka	0.89*(0.80,1.00)	1.26(0.93,1.69)	1.51*(1.07,2.14)	1.01(0.91,1.13)	0.93(0.53,1.62)	0.90(0.63,1.30)
Khulna	0.95(0.84,1.07)	0.89(0.65,1.22)	1.12(0.78,1.60)	1.10*(0.99,1.23)	0.42*(0.21,0.80)	0.55*(0.38,0.81)
Mymensingh				1.09(0.98,1.22)	0.62*(0.36,1.06)	0.61*(0.42,0.89)
Rajshahi	0.87*(0.78,0.99)	0.65*(0.47,0.89)	1.30(0.91,1.87)	1.04(0.93,1.16)	0.42*(0.22,0.79)	0.75(0.52,1.10)
Rangpur	1.20*(1.07,1.35)	0.47*(0.35,0.65)	0.51*(0.36,0.73)	1.24*(1.11,1.38)	0.24*(0.12,0.45)	0.33*(0.22,0.48)
Sylhet	0.86*(0.76,0.98)	1.62*(1.19,2.21)	1.94*(1.32,2.84)	0.93(0.83,1.04)	0.82(0.49,1.37)	1.10(0.75,1.60)
Place of Residence (Ref: Urban)						
Rural	0.82*(0.76,0.87)	1.46*(1.21,1.77)	1.98*(1.61,2.44)	0.89*(0.84,0.94)	1.07(0.75,1.52)	1.36*(1.11,1.67)
Women's Education (Ref: No Education)						
Primary	1.03(0.94,1.12)	0.67*(0.57,0.79)	0.71*(0.55,0.92)	1.17*(1.05,1.30)	0.47*(0.33,0.67)	0.53*(0.38,0.75)
Secondary	1.14*(1.04,1.24)	0.43*(0.36,0.53)	0.51*(0.39,0.66)	1.29*(1.16,1.44)	0.33*(0.22,0.49)	0.37*(0.26,0.53)
Higher	1.28*(1.15,1.44)	0.16*(0.10,0.26)	0.27*(0.19,0.39)	1.34*(1.19,1.51)	0.17*(0.07,0.38)	0.33*(0.22,0.49)
Last Birth a C-Section (Ref: No)						
Yes	1.27*(1.21,1.34)	0.36*(0.28,0.45)	0.47*(0.40,0.56)	1.24*(1.19,1.30)	0.21*(0.13,0.34)	0.43*(0.37,0.51)
Partner's Education Level (Ref: No Education)						
Primary	1.04(0.96,1.12)	0.91(0.78,1.06)	0.94(0.76,1.15)	1.00(0.94,1.08)	1.01(0.75,1.37)	0.97(0.77,1.22)
Secondary	1.09*(1.01,1.18)	0.75*(0.63,0.89)	0.75*(0.61,0.94)	1.09*(1.01,1.17)	0.68*(0.47,0.99)	0.76*(0.59,0.96)
Higher	1.20*(1.09,1.31)	0.59*(0.43,0.79)	0.60*(0.45,0.79)	1.16*(1.06,1.26)	0.42*(0.20,0.86)	0.55*(0.41,0.75)
Partner's Occupation (Ref: AGRWF)						
LDSOW	1.07*(1.00,1.14)	0.78*(0.67,0.90)	0.81*(0.67,0.98)	1.04(0.98,1.10)	0.79*(0.59,1.04)	0.86(0.71,1.04)
PB	1.09*(1.02,1.17)	0.90(0.76,1.08)	0.77*(0.62,0.94)	1.05(0.99,1.12)	0.74(0.50,1.07)	0.80*(0.64,1.00)
UO	0.97(0.83,1.13)	0.90(0.61,1.34)	1.05(0.66,1.69)	1.52*(1.00,2.31)	2.06(0.27,15.65)	0.28*(0.05,1.49)
Wealth Status (Ref: Poorest)						
Poorer	1.04(0.95,1.14)	0.98(0.82,1.16)	0.88(0.68,1.13)	0.97(0.91,1.04)	0.92(0.67,1.25)	1.06(0.85,1.33)
Middle	1.06(0.96,1.16)	0.78*(0.65,0.95)	0.75*(0.58,0.96)	1.04(0.97,1.11)	0.71*(0.48,1.05)	0.82(0.65,1.05)
Richer	1.13*(1.03,1.24)	0.59*(0.47,0.73)	0.67*(0.51,0.87)	1.04(0.97,1.12)	0.53*(0.33,0.85)	0.77*(0.59,0.99)
Richest	1.35*(1.22,1.50)	0.29*(0.22,0.38)	0.35*(0.26,0.48)	1.13*(1.03,1.23)	0.30*(0.14,0.64)	0.59*(0.43,0.80)
Watching TV (Ref: Not at all)						
Less than once a week	1.01(0.93,1.09)	0.87(0.73,1.05)	0.99(0.79,1.25)	1.07(1.00,1.15)	0.76(0.49,1.16)	0.82(0.64,1.05)
At least once a week	1.08*(1.02,1.15)	0.70*(0.60,0.82)	0.71*(0.59,0.85)	1.15*(1.09,1.20)	0.55*(0.40,0.76)	0.68*(0.58,0.81)
Birth Order Number (Ref: First)						
Second	0.94*(0.89,0.99)	1.23*(1.07,1.43)	1.29*(1.08,1.54)	1.03(0.98,1.08)	1.50(1.13,1.97)	0.98(0.82,1.16)
Third	0.87*(0.76,0.98)	1.49*(1.18,1.88)	2.23*(1.52,3.27)	0.83*(0.73,0.94)	1.68(1.07,2.64)	1.74*(1.16,2.61)
Pregnancy Wanted (Ref: Then)						
Later	1.07*(1.01,1.13)	1.16(0.98,1.36)	0.95(0.80,1.14)	0.90*(0.85,0.96)	1.24(0.87,1.77)	1.31*(1.07,1.60)
No more	0.94(0.87,1.03)	1.15(0.96,1.39)	1.14(0.89,1.47)	0.84*(0.77,0.92)	1.02(0.69,1.51)	1.51*(1.13,2.02)
Decision on Health Care (Ref: Respondent alone)						
Respondent & Husband			0.83(0.67,1.04)			
Husband alone	Insignificant		0.91(0.72,1.15)		Insignificant	
Other			0.76*(0.56,1.04)			
Respondent Occupation (Ref: Not Work)						
AGRWF and LDSOW	Insignificant			1.11*(1.04,1.19)	0.79(0.50,1.26)	0.70*(0.54,0.90)
PB				1.10*(1.00,1.21)	0.66(0.18,2.43)	0.67*(0.43,1.06)

*indicates p-values less than or equal 0.05.

5. Conclusion

Overall, the study's findings showed that while the frequency of 1^+ANC among women increase throughout the course of the trial, the standard-guided 4^+ANC did not rise to the anticipated level. The study demonstrates the need for strategies to enhance 4^+ANC visits. Rural areas, Chittagong and Sylhet divisions, women's education and employment status with their partners, lower-income households, TV watching, desired pregnancy, birth order, previous caesarean section, and women's involvement in health decision-making are some of the factors that should be prioritized in order to increase 4^+ANC visits. Furthermore, the frequency of ANC visits data with excess zeros and greater variability in the non-zero part were better explained by the mixed hurdle negative binomial model, which helped identify the risk variables. Along with identifying risk factors for skipping ANC visits during pregnancy, this model assisted policymakers in deciding which socioeconomic aspects should be given priority in order to increase the number of 4^+ANC visits. In the end, the government and policymakers of Bangladesh pay attention to the target group of women selected by this study (based on the discussion part) and undertake interventions on a priority basis.

Conflicts of Interest: The authors declare that there is no conflict of interest.

Ethical Approval: Data were collected by National Institute of Population Research and Training (NIPORT) and ICF. They received ethical approval from the Ministry of Health and Family Welfare, Bangladesh and also received written consent from each individual under the study. We have taken the dataset use approval from the Demographic and Health Surveys (DHS) program under ICF.

Abbreviation List:

ANC: Antenatal Care
WHO: World Health Organization
ANOVA: Analysis of Variance
SDG: Sustainable Development Goal
BDHS: Bangladesh Demographic and Health Survey
PR: Poisson Regression
NBR: Negative Binomial Regression
ZIPR: Zero Inflated Poisson Regression
ZINBR: Zero Inflated Negative Binomial Regression
HPR: Hurdle Poisson Regression
HNBR: Hurdle Negative Binomial Regression
SBA: Skilled Birth Attendant

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APPENDIX

Table 4: Estimated incidence rate ratio (IRR) and odds ratio (OR) with 95% confidence interval (CI) for mixed hurdle negative binomial regression with extra random effects (2004-2011).

Survey Year	2004			2011		
	Count part	Zero-part		Count part	Zero-part	
	1*ANC Visits Frequency	No 1*ANC Visits	No 4*ANC Visits	1*ANC Visits Frequency	No 1*ANC Visits	No 4*ANC Visits
Category	IRR	OR	OR	IRR	OR	OR
Division (Ref: Barisal)						
Chittagong	0.98(0.84,1.16)	0.76(0.50,1.14)	1.12(0.70,1.81)	0.82*(0.73,0.93)	1.37*(1.03,1.84)	1.85*(1.31,2.63)
Dhaka	1.04(0.89,1.22)	0.69*(0.46,1.04)	0.94(0.59,1.50)	0.89*(0.80,1.00)	1.26(0.93,1.69)	1.51*(1.07,2.14)
Khulna	1.08(0.91,1.28)	0.61*(0.39,0.94)	0.92(0.56,1.50)	0.95(0.84,1.07)	0.89(0.65,1.22)	1.12(0.78,1.60)
Mymensingh						
Rajshahi	1.14(0.97,1.34)	0.46*(0.31,0.70)	0.67*(0.42,1.07)	0.87*(0.78,0.99)	0.65*(0.47,0.89)	1.30(0.91,1.87)
Rangpur				1.20*(1.07,1.35)	0.47*(0.35,0.65)	0.51*(0.36,0.73)
Sylhet	0.91(0.75,1.11)	0.75(0.47,1.21)	1.28(0.72,2.25)	0.86*(0.76,0.98)	1.62*(1.19,2.21)	1.94*(1.32,2.84)
Place of Residence (Ref: Urban)						
Rural	0.80*(0.72,0.88)	2.13*(1.64,2.77)	2.13*(1.60,2.83)	0.82*(0.76,0.87)	1.46*(1.21,1.77)	1.98*(1.61,2.44)
Women's Education (Ref: No Education)						
Primary	1.06(0.96,1.17)	0.58*(0.49,0.69)	0.80(0.60,1.06)	1.03(0.94,1.12)	0.67*(0.57,0.79)	0.71*(0.55,0.92)
Secondary	1.16*(1.05,1.29)	0.35*(0.28,0.43)	0.47*(0.34,0.63)	1.14*(1.04,1.24)	0.43*(0.36,0.53)	0.51*(0.39,0.66)
Higher	1.33*(1.15,1.54)	0.05*(0.02,0.10)	0.20*(0.13,0.31)	1.28*(1.15,1.44)	0.16*(0.10,0.26)	0.27*(0.19,0.39)
Age at First Birth (Ref: < 18)						
18 to 25	1.07*(1.00,1.14)	0.98(0.85,1.13)	Insignificant		Insignificant	
>25	1.08(0.91,1.27)	1.02(0.59,1.76)				
Last Birth a C-Section (Ref: No)						
Yes	1.37*(1.25,1.50)	0.12*(0.05,0.26)	0.34*(0.24,0.49)	1.27*(1.21,1.34)	0.36*(0.28,0.45)	0.47*(0.40,0.56)
Partner's Education Level (Ref: No Education)						
Primary	1.02(0.93,1.13)	0.93(0.79,1.11)	0.88(0.67,1.15)	1.04(0.96,1.12)	0.91(0.78,1.06)	0.94(0.76,1.15)
Secondary	1.15*(1.04,1.26)	0.75*(0.62,0.92)	0.69*(0.52,0.91)	1.09*(1.01,1.18)	0.75*(0.63,0.89)	0.75*(0.61,0.94)
Higher	1.30*(1.15,1.47)	0.65*(0.45,0.92)	0.53*(0.36,0.76)	1.20*(1.09,1.31)	0.59*(0.43,0.79)	0.60*(0.45,0.79)
Partner's Occupation (Ref: AGRWF)						
LDSOW	1.11*(1.01,1.22)	0.81*(0.68,0.97)	0.70*(0.53,0.92)	1.07*(1.00,1.14)	0.78*(0.67,0.90)	0.81*(0.67,0.98)
PB	1.11*(1.00,1.23)	0.93(0.76,1.14)	0.65*(0.49,0.88)	1.09*(1.02,1.17)	0.90(0.76,1.08)	0.77*(0.62,0.94)
UO	1.11(0.92,1.34)	1.09(0.71,1.67)	0.59*(0.35,0.99)	0.97(0.83,1.13)	0.90(0.61,1.34)	1.05(0.66,1.69)
Wealth Status (Ref: Poorest)						
Poorer	1.05(0.91,1.20)	0.79*(0.64,0.97)	0.76(0.50,1.14)	1.04(0.95,1.14)	0.98(0.82,1.16)	0.88(0.68,1.13)
Middle	1.13*(0.99,1.29)	0.58*(0.47,0.72)	0.58*(0.39,0.87)	1.06(0.96,1.16)	0.78*(0.65,0.95)	0.75*(0.58,0.96)
Richer	1.26*(1.10,1.44)	0.53*(0.42,0.67)	0.48*(0.32,0.71)	1.13*(1.03,1.24)	0.59*(0.47,0.73)	0.67*(0.51,0.87)
Richest	1.42*(1.23,1.64)	0.43*(0.32,0.59)	0.31*(0.20,0.48)	1.35*(1.22,1.50)	0.29*(0.22,0.38)	0.35*(0.26,0.48)
Watching TV (Ref: Not at all)						
Less than once a week	1.10(0.98,1.24)	0.77*(0.60,0.97)	0.74(0.52,1.06)	1.01(0.93,1.09)	0.87(0.73,1.05)	0.99(0.79,1.25)
At least once a week	1.02(0.93,1.12)	0.92(0.76,1.11)	0.93(0.71,1.23)	1.08*(1.02,1.15)	0.70*(0.60,0.82)	0.71*(0.59,0.85)
Almost every day	1.27*(1.16,1.39)	0.62*(0.50,0.78)	0.52*(0.40,0.68)			
Birth Order Number (Ref: First)						
Second	0.95(0.88,1.03)	0.94(0.79,1.11)	1.11(0.89,1.39)	0.94*(0.89,0.99)	1.23*(1.07,1.43)	1.29*(1.08,1.54)
Third	0.89*(0.78,1.02)	1.35*(1.07,1.70)	1.92*(1.29,2.87)	0.87*(0.76,0.98)	1.49*(1.18,1.88)	2.23*(1.52,3.27)
Pregnancy Wanted (Ref: Then)						
Later	0.97(0.90,1.05)	0.95(0.79,1.15)	1.08(0.85,1.37)	1.07*(1.01,1.13)	1.16(0.98,1.36)	0.95(0.80,1.14)
No more	0.86*(0.77,0.96)	0.91(0.73,1.13)	1.36*(0.97,1.90)	0.94(0.87,1.03)	1.15(0.96,1.39)	1.14(0.89,1.47)
Decision on Health Care (Ref: Respondent alone)						
Respondent & Husband	0.96(0.88,1.05)	1.03(0.83,1.28)	1.18(0.90,1.56)			0.83(0.67,1.04)
Husband alone	0.92*(0.85,1.00)	0.99(0.82,1.20)	1.23(0.96,1.57)	Insignificant		0.91(0.72,1.15)
Other	0.86*(0.75,0.98)	1.12(0.82,1.15)	1.44*(0.97,2.14)			0.76*(0.56,1.04)