

# Frequency and Timing of Antenatal Care Visits and Its Impact on Neonatal Mortality in EAG States of India

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## Abstract

The study aims to examine the association between frequency of antenatal care visits and neonatal mortality in EAG states and to explore the relationship between the timing of first antenatal care visit in the trimester and neonatal mortality in EAG states of India. The study uses data from the third round of National Family Health Survey NFHS-3. The timing of the first antenatal visit and the relative number of ANC visits received by the women is studied separately. Logistic regression is applied to find an association between continuity, the timing of ANC received and neonatal birth outcome. Results explain significant association between mothers receiving ANC 4-9 visits had experienced a lower risk of neonatal mortality. Mothers who received antenatal care visit from the first trimester experienced best pregnancy outcomes and neonatal deaths.

**Keywords:** Timing and frequency; Antenatal Care; Neonatal mortality; EAG states

**Abbreviations:** IFA: Iron/folic acid; TT: Tetanus Toxoid Injections; ANC: Anti-Natal Birth Care; EAG: Empowered Action Group; NFHS: National Family Health Survey; DHS: Demographic Health Survey; OR: Odds Ratio; CI: Confidence Interval

## Introduction

In 2010, 7.7 million child deaths occurred worldwide in which 3.1 million were neonatal deaths. Approximately 75% of neonatal deaths occur in the early neonatal period, or within seven days after delivery and 50% occur in the first 24 h. Globally, neonatal deaths contribute 41% to total under-five deaths in 2008 [1].

In many low-income countries, to overcome neonatal death in first 28 days has remained a challenge, India by far has made a modest reduction from 75 deaths per thousand live births in 1971 to 23 deaths per thousand live births in 2013 [2]. Still, neonatal mortality rates are quite high in India. Therefore, interventions to reduce the number of neonatal deaths are relevant in India. The determinants of the higher neonatal mortality rates in South Asian countries exist with a lack of Anti-natal birth care (ANC), Birth preparedness, Skilled health care at birth, Low levels exclusive breastfeeding in the initial month of life and widespread low birth weight.

According to World Health Organisation, many health problems in pregnant women is possibly prevented, detected and treated during antenatal care visits with trained health workers so all pregnant women should avail at least four antenatal visits, with the first antenatal visit, preferably in the first trimester (WHO). The further guideline suggests that every pregnant woman must consume 90 or more Iron/Folic Acid (IFA) tablets and must receive at least two tetanus toxoid (TT) injections [3].

According to Indian government guidelines, every pregnant should avail for 3 or more antenatal care visits along with 90 or more IFA tablets and 2 or more TT injections. ANC visits are crucial for providing counseling to mothers about the care they should take during pregnancy and in preparation for childbirth. Antenatal care visits provide tetanus toxoid immunization, malaria prophylaxis, iron and folic acid tablets and nutrition education. Such counseling can avert a higher degree of morbidity and mortality of both mother and newborn. Existing studies have predicted that the risk of low birth

weight and neonatal and infant mortality are higher for mothers making fewer antenatal visits [4].

The main component of antenatal care visit is to offer information and advice to women about pregnancy-related complications and possible curative measures for early detection. Specific components, which can significantly reduce maternal and neonatal mortality, including iron supplementation, tetanus toxoid immunization, early detection and treatment of pre-eclampsia, preparation for transportation to a delivery site and safe delivery education among others. Furthermore, antenatal visits raise awareness about the need for care during delivery giving women and the family to seek help more efficiently during a crisis. Antenatal care visit should be measured as starting point of entering in maternal healthcare practice.

Regular antenatal care is of utmost importance for identifying women at higher risk of adverse pregnancy outcomes. It takes preventive measures and creates a relation between the women and the health care provider [5]. The timing of the first antenatal visit is vital for pregnant women, the first visit includes weight, blood pressure, Urine test, a blood test for pregnant women for better health outcome of baby and mother. Overall the fundamental contents of antenatal care programs include history taking, abdominal palpation, blood pressure and maternal weight measuring. Other components include laboratory tests such as a test for syphilis and blood group typing. According to health experts, the first anti-natal check-up for women is from the 8<sup>th</sup> to 12<sup>th</sup> week of pregnancy. After receiving it, women would need to visit health care every 4-6 weeks of pregnancy until 28 weeks of gestation and there after every week until the baby is delivered (usually at 40 weeks).

Women receiving late timings or low frequency of pregnancy

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care in the first trimester are at a higher degree of adverse maternal outcomes, studies by Coria-Soto et al. [6], found that an inadequate number of visits are associated with 63% higher risk of intra uterine growth retardation.

Our study based on eight empowered action group states namely, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan, Uttar Pradesh and Uttarakhand and Assam also which have lagged behind in containing population growth to manageable levels. Moreover, the study aims to examine the association between frequencies of antenatal care visits, as a whole and neonatal mortality in EAG states. Subsequently, explore the relationship between the timing of first antenatal care visit (in trimester) and neonatal mortality in EAG states. The selected states, the prevalence of ANC visits are low and those states constitute a large proportion of the population of India. So we want to analyze the association between frequency of antenatal visits and neonatal mortality and also want to establish a relationship between the timing of first antenatal visit and neonatal mortality in these states.

## Survey of Literature

The first 28 days of extensive care for a new-born is of paramount importance, most of the neonatal deaths occurred in this period of which over 70% of neonatal deaths occur in the first six days of birth [7,8]. A study carried out by Singh et al. [9] also showed lack of substantial evidence on the effectiveness of the content, frequency and timing of visits in standard ANC programs in maternal and child health. Recent studies in developing countries reported that infections (e.g., sepsis/pneumonia, tetanus and diarrhea) and preterm delivery were significant contributors to neonatal mortality [10].

The most significant predictor over the years for safe delivery has been women receiving Antenatal care (ANC) [11]. Even if a few of the obstetric emergencies cannot be prevented through antenatal screening women can be familiar through the education to recognize then and be proactive on symptoms leading to potentially serious conditions [12]. Moreover, this measure has significantly reduced maternal complicacy outcomes [13]. Over the years the salient functions of ANC have been to offer health information and services which firstly improves the health of women and the new-born [14]. Secondly, receiving ANC during pregnancy has emerged to have a positive effect on the utilization of postnatal healthcare services which reduces the odds of neonatal deaths [15]. The probability for inverse pregnancy outcome gets reduced almost by 90 percent for those having ANC visits four or more. There exist a significant drop in adverse gestation problems [16]; global evidence both in developed and developing nations on effects of ANC on gestation outcomes has made World Health Organisation to recommend countries to provide at least four ANC visits during gestation.

The extensive contemporary literature on maternal health and child well-being predicts education of mother is one of the foremost predictors to adopt anti-natal and post-natal care. Mothers with the high educational level expected to accept the recommended number of ANC visits [17,18] literature suggests educated women are more probable to switch on ANC visits early than women who were less educated [19,20]. In contrast, education did not show any association with utilization of ANC services in Pakistan [21].

According to studies, higher parity among children has emerged as a barrier to adequately use ANC [18,22-26], whereas high parity women tended to use the service more often than primiparous women [27]. Similarly, studies found that women's first ANC visit was earlier in

higher parity women in India [20].

In some studies, we found that birth order and interval were significantly associated with ANC visits. Studies suggest there is an association between high birth order and delayed or insufficient use of ANC [25,28]. Births to women occurring after an interval of more than three years received more frequent visits to ANC than those who were at the preceding birth within two years [25].

Studies pertaining to Indian-sub continent reveal women who married at the age of 19 or above were more likely to adopt ANC as compared to women to married at younger ages [29]. However in some of the preliminary studies found that age at marriage was not a significant predictor of utilization of ANC [30].

It is evident that the majority of parent women aging thirties attend ANC more frequently than those women who are teenaged and older women [12,19,20,31]. Studies both using qualitative and quantitative methods confirms women experience pregnancy below 35 years of age preferred frequent clinic visits to be assured that the baby was growing well but, older women who did not experience any problems, were not concerned about having frequent visits [32]. However, some of the studies suggested that women's age not be a significant predictor of utilization of ANC [12,23,26,33].

In some literature found that religion was not a statistically significant predictor of antenatal check-ups in India [26,28]. According to some study, Place of residence was a statistically significant factor for adopting and continuing ANC. Pregnant women from urban areas used ANC more than their rural counterpart [22,24,30]. Women in urban areas were more likely to use antenatal care from a healthcare professional in Ethiopia [27]. There was no statistically significant difference between urban and slum areas regarding utilization of ANC in Pakistan [34]. Whereas living in the developed region of the country was positively and significantly associated with ANC use [23]. Some studies found that knowledge of family planning and ANC has a positive and statistically significant effect on ANC use. Women aware of the family planning were more likely to attend ANC visits in Nepal [24]. Use of family planning was positively associated with ANC in India [29].

Findings of some study conclude that financial constraint plays a profound role in non-use of ANC services. The costs of the service including transportation and necessary laboratory tests were major factors prohibiting women from service utilization [26,35]. Some published literature showed that Household economic status has a positive and significant impact on the use of ANC. Women living in higher wealth quintile were more likely to receive satisfactorily and early on ANC than those with low economic wealth quintile status [24,25,36-38]. Studies also found that health insurance coverage had a positive and significant impact on utilization of ANC. A study in rural North India tells that Women's autonomy was positively related to use of ANC [29]. Other studies found that Women from male-headed households were significantly less likely to use ANC in Nepal [36].

A qualitative study in India highlighted the perception of pregnancy as a natural process that only warranted ANC when problems arose [39]. Qualitative studies suggested that most women experienced direct benefit from ANC in various pregnancies complications [40]. Neither urban nor rural women were sure about the benefits of ANC for their health or their unborn child in Zimbabwe [32]. Similarly, ANC was not seen as essential unless there was physical discomfort during pregnancy and complications in previous pregnancy or childbirth [41].

Women's perceptions of the risk factors associated with adverse

obstetric outcomes were significantly related to the probability of seeking ANC. Women who had a prior foetal loss or neonatal death are more likely to receive ANC [12,38,42]. In India, pregnant women without previous obstetric problems were more likely to attend late [20].

The neonatal mortality rates in India have declined significantly in the last two decades, from as high as 49 per 1000 live births in 1992-93, to 39 per 1000 live births in 2005-2006, the rates are still very high [43,44]. Within India, there are considerable variations in neonatal mortality rates across the different states and socioeconomic groups, especially in Empowered Action Group (EAG) states, which lag behind in the demographic transition and have the highest infant mortality rates in the country.

## The Rationale of the Study

Survey of literature suggests that antenatal care visits are crucial in reducing neonatal mortality, especially in developing countries. In our study, Empowered Action Group (EAG) states include states of Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan, Uttar Pradesh, Uttarakhand and Assam. These states contain a larger share of country's population that is almost 45%. EAG states are lagging behind in demographic progress than the other states in India. The condition is far below the expectation in rural areas of these states. These states constitute almost 81% rural population. The socio-economic conditions have not progressed compared to other parts of the country. Literacy level, especially female share of literacy, is shallow in these states. These states have a high share of home-based deliveries and also a high percentage of neonatal and maternal mortality. Male headed households originate in these states, so female freedom (autonomy) is very less. Prevalence of 3 or more ANC visits in pregnant women is very less in these EAG states compared to other states of India. India's advancement to a higher stage of demographic transition will depend on pace achieved by the EAG states.

Though some studies have shown the importance of antenatal care programs in reducing neonatal mortality in India. However, none of the studies tried to understand the association between frequency of antenatal visits and neonatal mortality, especially in EAG states. Thus there is a need of study which explores this association between frequency of antenatal care visits and neonatal mortality and also analyzes the relation between timing of first antenatal care visit and neonatal mortality in EAG states.

## Data Source and Participants

The present study used data from the third round of National Family Health Survey in this study. NFHS-3 conducted in 2005-06 in India and this is equivalent of Demographic Health Survey (DHS) in most other countries. NFHS-3 provided information on state and national level information on fertility, Family planning, Infant and child morbidity & mortality, Maternal & Reproductive health, nutritional status of women & children and the quality of health and family welfare services.

NFHS-3 uses multistage stratified sampling design. NFHS-3 interviewed 124,385 women age 15-49 and 74,369 men age 15-49 in 29 states. In NFHS-3, the question on antenatal care was asked only to those women, who had live/still birth in preceding five years from the survey and is restricted to only last birth. In our study, we select only 8 Empowered action group states (Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Orissa and Rajasthan) and Assam.

In the present study, we included 15343 single births in preceding

five years before survey in EAG states and included 36850 single births in India. NFHS-3 provides kids file to cover essential aspects of neonatal and postneonatal care and death, birth spacing, family planning. Sampling weights are used to make appropriate results.

## Description of Variables

### Outcome variable

The outcome of this study is neonatal mortality, which is defined as the probability of dying within the first 28 days of life after birth.

### Exposure variable

In this study, we include mainly two exposure variable. First exposure variable frequency of antenatal care visit during last pregnancy. Total visit was categorized into no visits, 1-3 visits, 4-6 visits, 7-9 visits and ten visits or more. Second exposure variable is the timing of first antenatal care visit during last pregnancy. Timing was determined during the first three months (first trimester), during the 4<sup>th</sup>-6<sup>th</sup> month (second trimester) and from the 7<sup>th</sup> month until delivery (third trimester).

### Control variables

We adopted the following variables as potential confounders in our study: 5 year maternal age groups from 15-19 to 45-49; place of residence (urban or rural); highest education level (no education, primary, secondary and higher); and birth order (first child, the second child and third child or more).

## Statistical Analysis

According to our objectives, we used univariate, bivariate and multivariate techniques in the study. Uni-variate shows the frequency distribution and bi-variate show the association between control variables and exposure variables.

We first conducted descriptive analysis and then we used cross tabulation to analyze the relation between total visits during last pregnancy and neonatal mortality. We estimated the crude odds ratio (OR) and their 95% confidence interval (95% CI) for the association using no visits as a reference by using logistic regression and also estimated adjusted OR for control variables. In the second objective, we estimated both crude and adjusted odds ratio at 95% CI for the association between timing of first ANC visit in each trimester and neonatal mortality using no first visits in last pregnancy as a reference.

Maximum likelihood function commonly estimates the logistic regression model. For the dependent variable, logistic model follows the general form:

$$\text{Logit } p = \frac{\ln\{p\}}{1-p} = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_i x_i + e$$

Here  $b_1$ ,  $b_2$  and  $b_i$  represent the coefficient of each predictor's variables included in the model and  $e$  is an error term.  $(P/(1-P))$  Represent the natural logarithmic of odds of the outcome. The STATA utilized yields odd ratios which indicate the magnitude of the predictor's variables on the probability of the outcome occurring. The odds ratio are the measure of odds on the indicators of neonatal mortality as indicated by dependent variables. As regards to the direction of logit coefficients, odds greater than one indicate as an increased probability of mortality, while those less than one indicate that a decreased probability of mortality.

All the control variables were tested for possible multi-collinearity before putting in the regression model. All statistical analyses were

performed using STATA/MP version 12.0 (Stata Corporation, College Station, USA).

## Results

Empirical observations reflected from the Table 1 on descriptive characteristics receiving antenatal care visits of mothers based on utilization of ANC care in EAG states. Mothers who were in older age groups had less frequent antenatal visits and mothers who were in the younger age-group (20-24 and 25-29) had more antenatal visits in EAG states. Mostly 81% mothers lived in rural areas in EAG states and in these, 51% mothers had 1-3 ANC visits and there is a high proportion (34.30%) of mothers in no visits category while in urban areas, there is some improvement in antenatal care visits. There is a high proportion of mothers receiving more ANC visits compared to mothers lived in rural areas in EAG states. Mothers with higher level of education reported to have more antenatal visits. In EAG states, the more children the women had the less frequent antenatal care visits. Most mothers (38.87%) who had 3rd birth order were no antenatal visits.

Further investigation on the association between a total number of ANC visit during last pregnancy and neonatal mortality in EAG states computed in Table 2 shows that the odds obtained from binary logistic regression with and without adjusting control variables. The babies whose mothers, had 4-6 visits were 0.73 (95% CI 0.52-1.04) times fewer odds of dying in the neonatal period compared to those mothers who had no visits by adjusting control variables. The new-borns whose mother had 7-9 visits was 0.48 (95% CI 0.28-0.83) times fewer odds of dying in the neonatal period compared to a new-born whose mothers had no antenatal visits. There is a significant association between 7-9 ANC visits and neonatal mortality in crude and adjusted ORs. The

crude and adjusted ORs were 0.43 (95% CI 0.16-1.17) and 0.60 (95% CI 0.21-1.71) respectively in 10 or more ANC visits. As we had seen in Table 2, the number of antenatal visits increased, the chance of dying decreases among the new-born babies. The proportion of neonatal mortality in new-borns whose mother had no visits was 35/1000 live birth. This proportion decreased, as the number of ANC visits increases by mothers. The proportion of neonatal mortality in new-borns whose mothers had 1-3 visits, 4-6 visits, 7-9 visits and 10 or more visits was 29/1000, 23/1000, 13/1000 and 15/1000 live births respectively in EAG states.

Table 3 illustrates results observed from descriptive characteristics of mothers by the timing of first antenatal care visit in EAG states. Mostly mothers who were in the younger age group had first ANC visit in the first trimester. Mostly mothers in older age groups 40-44 and 45-49 had no antenatal visit and some mother in that age group had first ANC visit in the second trimester. Mostly urban mothers had a first antenatal visit in the first trimester while in rural areas, 34.14% mothers had no antenatal visits and 44.27% mothers had first ANC visit in the second trimester. As education level increase in mothers, the timing of the first ANC visit had increased in the first trimester. Mothers who were in birth order first and second had a first antenatal visit in the first trimester and mostly third child birth order mothers had no first antenatal visit in EAG states.

To understand the association, between ANC and neonatal death the timing of the first trimester in ANC visit and outcome of neonatal mortality in EAG states, logistic regression model is incorporated. The results from Table 4 explains that in first, second and third trimester the new-borns whose mothers, had a first antenatal visit in the first

Characteristics	Total number, n (%)	Total antenatal care visits				
		No visits, n (%)	1-3 visits, n (%)	4-6 visits, n (%)	7-9 visits, n (%)	10 or more, n (%)
<b>Age, 5 year groups</b>						
15-19	1039 (7.83)	280 (27.13)	568 (55.0)	124 (12.02)	53 (5.14)	7 (0.68)
20-24	4740 (31.23)	1101 (23.41)	2378 (51)	73 (16.44)	379 (8.06)	72 (1.53)
25-29	5028 (31.19)	1265 (25.39)	2211 (44.37)	838 (16.82)	563 (11.3)	106 (2.13)
30-34	2842 (17.79)	900 (31.96)	1176 (41.76)	406 (14.42)	269 (9.55)	65 (2.31)
35-39	1212 (8.35)	499 (41.69)	493 (41.0)	124 (10.36)	64 (5.35)	17 (1.42)
40-44	381 (2.82)	191 (50.66)	152 (40.0)	24 (6.37)	7 (1.86)	3 (0.8)
45-49	101 (0.78)	60 (60.0)	32 (32.0)	6 (6.0)	1 (1.0)	1 (1.0)
<b>Place of residence</b>						
Urban	4897 (18.7)	769 (15.92)	1716 (35.54)	1147 (23.75)	985 (20.4)	212 (4.39)
Rural	10446 (81.30)	3527 (33.98)	5294 (51)	1148 (11.06)	351 (3.38)	59 (0.57)
<b>Highest education level</b>						
No education	8190 (60.97)	3376 (42)	3909 (48.12)	651 (8.01)	165 (2.03)	23 (0.28)
Primary	2108 (12.99)	463 (22)	1151 (54.94)	339 (16.18)	127 (6.06)	15 (0.72)
Secondary	4013 (22.2)	441 (11)	1797 (45.15)	1009 (25.35)	629 (15.8)	104 (2.61)
Higher	1031 (3.85)	16 (1.59)	153 (15.18)	295 (29.27)	415 (41.17)	129 (12.8)
<b>Birth order number</b>						
1 <sup>st</sup> child	3727 (22.29)	566 (-15.37)	1618 (43.94)	770 (20.91)	601 (16.32)	127 (3.45)
2 <sup>nd</sup> child	3752 (22.37)	697 (18.72)	1729 (46.44)	722 (19.39)	477 (12.81)	98 (2.63)
3 <sup>rd</sup> child or more	7864 (55.34)	3033 (38.87)	3663 (46.94)	803 (10.29)	258 (3.31)	46 (0.59)

Table 1: Descriptive characteristics of mothers (n=15343) on the basis of frequency of antenatal care visits in EAG states.

	No visits (n=4296)	1-3 visits (n=7010)	4-6 visits (n=2295)	7-9 visits (n=1336)	10 or more (n=271)
<b>Neonatal mortality (1/1000)</b>	35	29	23	13	15
<b>Crude OR (95% CI)</b>	1	0.84 (0.68-1.04)	0.66 (0.48-0.91)*	0.39 (0.24-0.64)*	0.43 (0.16-1.17)**
<b>Adjusted OR (95% CI)</b>	1	0.85 (0.68-1.07)	0.73 (0.52-1.04)**	0.48 (0.28-0.83)*	0.6 (0.21-1.71)

\*p<0.05; \*\*p>0.10

Table 2: Association between total number of ANC visit during last pregnancy and neonatal mortality in EAG states.

Characteristics	Total number, n (%)		First ANC visit							
			No visit		1 <sup>st</sup> trimester		2 <sup>nd</sup> Trimester		3 <sup>rd</sup> Trimester	
<b>Age, 5 year groups</b>										
15-19	1039	(7.83)	280	(27.29)	117	(11.4)	487 (47.47)		142	(13.84)
20-24	4740	(31.23)	1101 (23.44)		776	(16.52)	2267 (48.25)		554	(11.79)
25-29	5028	(31.19)	1265 (25.39)		949	(19.05)	2252 (45.2)		516	(10.36)
30-34	2842	(17.79)	900	(32.03)	486	(17.3)	1119 (39.82)		305	(10.85)
35-39	1212	(8.35)	499	(41.41)	147	(12.2)	434 (36.02)		125	(10.37)
40-44	381 (2.82)		191	(50.93)	147	(12.2)	434 (36.02)		125	(10.37)
45-49	101 (0.78)		60 (60.0)		5 (5.0)		28 (28.0)		7 (7.0)	
<b>Place of residence</b>										
Urban	4897	(18.70)	769	(15.80)	1532 (31.48)		2132	(43.81)	433	(8.9)
Rural	10446 (81.30)		3527 (34.14)		972	(9.41)	4573	(44.27)	1258 (12.18)	
<b>Highest education level</b>										
No education	8190	(60.97)	3376 (41.68)		574	(7.09)	3142	(38.79)	1008 (12.44)	
Primary	2108	(12.99)	463	(22.22)	268	(12.86)	1102	(52.88)	251	(12.04)
Secondary	4013	(22.2)	441	(11.07)	1052 (26.41)		2089	(52.45)	401	(10.07)
Higher	1031	(3.85)	16 (1.56)		610	(59.34)	371 (36.09)		31 (3.02)	
<b>Birth order number</b>										
1 <sup>st</sup> child	3727	(22.29)	566	(15.3)	990	(26.76)	1768	(47.80)	375	(10.14)
2 <sup>nd</sup> child	3752	(22.37)	697	(18.77)	832	(22.40)	1800	(48.47)	385	(10.37)
3 <sup>rd</sup> child or more	7864	(55.34)	3033 (38.97)		682	(8.76)	3137	(40.31)	931	(11.96)

**Table 3:** Descriptive characteristics of mothers (n=15343) on basis of timing of first antenatal care visit in EAG states.

	No visit (n=4296)	First trimester (n=2504)	Second trimester (n=6705)	Third trimester (n=1691)
<b>Neonatal mortality (1/1000)</b>	35	19	26	35
<b>Crude OR (95% CI)</b>	1	0.51 (0.36-0.72)*	0.76	(0.61-0.95)*
<b>Adjusted OR (95% CI)</b>	1	0.62 (0.43-0.91)*	0.80	(0.63-1.01)**

\*p<0.05; p<0.10

**Table 4:** shows the association between timing of first ANC visit during last pregnancy (in trimester) and neonatal mortality in EAG states.

trimester were significantly 0.62 (95% CI 0.43-0.91) times fewer odds of dying in the neonatal period compared to mothers who had no first antenatal visit by adjusting control variables. The babies whose mothers had a first antenatal visit in the second trimester were 0.80 (95% CI 0.63-1.01) times fewer odds of dying in the neonatal period compared to those mothers who had no more antenatal visits and this association was insignificant. Finally, the adjusted ORs for neonatal mortality was 1.03 (95% CI 0.71-1.55) times higher odds for those babies whose mothers had first ANC visit in the third trimester compared to mothers who had no first antenatal visit. The proportion of neonatal mortality in babies whose mothers, had no antenatal visits was 35/1000 live births, this proportion of neonatal mortality in the first-trimester antenatal visit was 19/1000 live births, but proportion increased as the timing of the first ANC visit increase in pregnant mothers. The proportion of neonatal mortality in babies whose mothers, had a first antenatal visit in last trimester was 35/1000 live births.

Results from the association between total numbers of ANC, the timing of first ANC and neonatal deaths explains that mostly women (46.09%) had 1-3 antenatal visits and 28.25% pregnant mothers had no antenatal visits in EAG states. Only 25.65% mothers had 4 or more ANC visits during their last pregnancy in EAG states. As we talk about the timing of the first antenatal visit during pregnancy, nearly 28.27% newborn mothers had no antenatal visit during pregnancy in EAG states and 16.48% mothers had first ANC visit in the first trimester. Newborns mothers, who had a first antenatal visit in the second trimester was 44.12% and the proportion of mothers who had a first antenatal visit in the third trimester was only 11.13% in EAG states.

## Discussion

In the present study, the timing of the first antenatal visit and the relative number of ANC visits have been studied separately. We found that pregnant mothers who had more antenatal visits, i.e., 4-9 visits were experiencing a lower risk of neonatal mortality and there was a significant association between 7-9 antenatal visits and neonatal mortality in EAG states. However, in the case of 10 or more antenatal visits by pregnant women experienced a higher risk of neonatal mortality compared to women who had 7-9 visits. A possible reason could be higher neonatal mortality in those women; maybe those women faced some health-related complication like vaginal bleeding, preterm labor during their pregnancy.

The findings are consistent with previous studies [45,46] which shows that reported higher neonatal mortality for mothers who had a small number of antenatal or no antenatal visits during pregnancy. This study also suggests that risk of neonatal mortality in EAG states was significantly reduced in new-born babies by taking first ANC visit in the first trimester and those mothers had a first antenatal visit in the third trimester were insignificantly higher chance of neonatal mortality in EAG states. Given the paramount significance of adherence, very few studies have ever addressed this issue in EAG states. Our findings that first antenatal visit in the first trimester was important may be explained by a number of complication like obstetric and medical problem increase in the more serious form in final stages of pregnancy, in the case of no antenatal visit in starting months of pregnancy [47].

A significant strength of this study is that a nationally representative

sample of mothers in India covering 29 states and we used data from 8 empowered action group and Assam states. NFHS-3 data based on the mother's report can provide a valuable starting point for understanding the behaviour of providers in both public and private settings. The information collected in NFHS-3 are of good quality, high response rate and used for some policies regarding maternal and child health program. One important thing, NFHS-3 data are based on standardized questionnaires, manuals and field procedures.

We also have shown some critical limitation of the study. First one is a potential confounding by preterm births. Since pregnant mothers who face preterm births did not have many opportunities for antenatal care visits. Henceforth we could neither obtain information on the month of delivery nor analyze data by low birth infant weights. The second one is that we did not include the variable socioeconomic status of mothers in EAG states, so confounding by socioeconomic status is also possible. Furthermore, NFHS-3 targeted live mothers, there may be chances some mother died during or after pregnancy and their infant would experience a worse outcome. Such types of selection bias may underestimate the odds ratio.

## Conclusion

The present study showed a significant relation between 7-9 antenatal care visits and neonatal mortality in EAG states. We also find an interesting finding in EAG states that showed a significant association between timing of first antenatal care visit in the first trimester (starting three months of pregnancy) and neonatal mortality. Indian Child Survival and Safe Motherhood Programme (CSSMP) recommends that pregnant mothers have three antenatal care visits but result of this study suggest that pregnant women may require more frequent visits (e.g. 7-9 visits). Furthermore, this study suggests that first ANC visit of pregnant mothers should be in the first trimester for better health of new-borns. This finding may provide a good suggestion for the healthcare of pregnant mothers, especially in EAG states.

There are some policy recommendations on the basis of the present study. First one is, some strategies like extensive health promotion through cognizance and appropriate education of healthcare persons could help to upgrade more uptakes of ANC visits in pregnant women. Second, one recommendation is that, in EAG states, increasing level of education in women, will not only have a long term effect on more frequent antenatal care visits and also other dimensions maternal and child healthcare services.

## Ethical Statement

The present academic investigation is void of any conflicts of interest and the authors have been involved in substantive work leading to the manuscript and shall hold themselves responsible for its content. No financial support or sponsorship was financed for the research work. The present study is based on NFHS-3, The analysis presented in this study is based on secondary analysis of existing survey data with all identifying information removed. The survey received ethical reverence from the International Institute for Population Science's Ethical Review Board and the Indian government. Participation of individuals in the survey was voluntary. Prior informed written consent was obtained from each respondent.

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