ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 09 | September - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

DOES BIRTH SPACING MATTER? NEONATAL MORTALITY IN THE EMPOWERED ACTION GROUP STATES OF INDIA, NFHS-5

Economics

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ABSTRACT

World Health Organization (WHO) expert group on birth spacing recommended optimal birth spacing between live birth as 33 months in order to reduce maternal, peri-natal and infant deaths. This means the Birth Interval between two consecutive births should at least be 33 months. Using the National Family Health Survey-5 (2019-21) dataset the gain in neonatal survival in EAG states is studied among those who adhered to WHO recommended minimum birth interval compared to those who do not. Neonatal mortality rate in EAG states is 31.74 deaths per 1000 live births which is approximately 7 deaths more than national average. The National average is 24.91 deaths. Neonatal deaths in India minus EAG states are 16.76. This means rest of India excluding EAG states is well on course of achieving 2030 SDG target of 12 neonatal deaths per 1000 live births. The finding also suggests substantial gain in neonatal survival among those who adhere to WHO recommended birth spacing. The multivariate analysis using Cox proportional hazard model predicts respondents education and adherence to WHO recommended inter birth interval length in predicting neonatal deaths statistically significant as those educated higher level and adhering to WHO recommendation on inter birth interval length had relative lower risk of neonatal deaths.

KEYWORDS

Birth Interval; Neonatal Deaths, EAG States

INTRODUCTION

United Nations Sustainable Development Goals for 2030 aims at reducing neonatal mortality from its level to at least 12 per 1000 live births [1]. For the year 2023, India's medium range estimates on neonatal mortality as estimated by the UN Inter-agency Group for Child Mortality Estimation (UN-IGME) is 19.11 deaths per 1000 live births. Globally, in 2021 about 2.3 million neonates die within 28 days of birth. This translates into approx. 6400 neonatal deaths every day [2]. India accounts for disproportionately large burden of the global neonatal deaths (22%), as approximately one in five neonatal deaths occur in India [3]. Studies have shown that three quarters of these neonatal deaths occur in the first seven days of life or the early neonatal period, which are largely preventable [4]. On analyzing the data from the successive rounds of National Family Health Survey, slow rate of decline in neonatal mortality in recent years are evident as the rate declined from 48 deaths per 1000 live births in 1995 to 20 in 2021. In order of increase the neonate's survival outcomes and speed up the rate of decline of neonatal mortality rates saw a marked policy shift and the launch of National Health Mission (NHM) programs in 2005. The State received direct grant from the central government to establish across district state of art Sick Neonatal Care Unit's (SNCU) within District Hospitals. The SNCU units are established to provide medical emergencies to sick neonates (both in-born & out-born) within district to increase neonatal survival. India's progress in achieving the SDG goals hinges largely on the progress made by the eight demographically backward north Indian states, together termed as Empowered Action Group (EAG) States. Whether or not India achieves the SDG target of at least 12 neonatal deaths per 1000 live births, by year 2030, depends largely on the progress made by these States in reducing neonatal deaths.

Poor birth spacing is among the leading cause of high levels of neonatal and maternal mortality. Births in India and especially in EAG States are poorly spaced leading to high levels of maternal, infant and child mortality. Studies including those done by USAID recommend 3 to 5 years of birth spacing compared to 2 to 3 years spacing recommended by the WHO [5]. In the year 2005, in order to have a uniform recommendation on birth spacing for improved survival outcome of neonates, WHO held a technical consultation and scientific review of Birth Spacing at its headquarters in Geneva. The consultation meeting comprised of 37 international experts. The expert group recommended the optimal birth spacing between live birth and next pregnancy as 24 months atleast, in order to reduce maternal, peri-natal and infant deaths [5]. It is in this back drop that the inter-birth interval (IBI) length in EAG States is studied keeping in view the WHO recommended minimum birth interval length. This chapter therefore examines the impact of successive inter-birth interval length on neonatal mortality keeping other socio- economic and demographic variables constant using proportional hazards model.

Several risk factors that influence survival chances of neonates have been identified and reported in the literature. This include women's parity, maternal age, caste, religion, birth weight, size of the baby at birth, frequency of antenatal visits, TT injections during pregnancy, stillbirth, and previous birth interval length [6]. There are research studies that advocate birth interval length of 2 years between two consecutive births for a better child health while others advocate intervals of 3 to 5 years as safe for both the mother and the baby compared to ≤ 2 years of birth interval [7] [8]. Studies have also shown that too short birth intervals (<2 years) are associated with high levels of infant and child mortality [9-11]. Using conditional logistic regression Kozuki & Walker [12] analyzed 47 DHS country data and predicted that children that are born with less than 18 month & less than 24 months preceding birth interval have higher risk of neonatal and under-five mortality compared to those who were born with preceding birth interval greater than or equal to 24 to 60 months. Rutstein [13a], study using DHS data from 17 developing countries showed the increased risk of mortality and under-nutrition for births with birth interval less than 36 months. The study suggested optimal birth interval length to be in- between 36 and 59 months. Analyzing data from 54 countries, Rutstein and Winter [13b] identified a U-shaped relationship between birth interval and neonatal mortality. Both short intervals (less than 18 months) and long intervals (more than 59 months) were associated with higher mortality rates, while an optimal interval of 18-59 months showed lower mortality. Using the data from rural northern Indian State of Uttar Pradesh, Williams et.al, [14] examined the length of preceding birth interval and neonatal outcome. The study reported higher odds of neonatal deaths for those with birth interval less than <18 months and 18–35 months, compared to births that are spaced at 36–59 months. However, studies have also shown that too long birth intervals (>5 years) are associated with increased risk of pregnancy complications such as preeclampsia as the mother loses protective effect from the previous pregnancy [15]. Exavery et al. [16] using data from rural Tanzania studied the factors responsible for adherence to WHO recommended inter-birth interval length. It reported young maternal age, low levels of education, multiple births to the index, home delivery of the index child, being an in- migrant, higher parity and married as factors that are associated with non-adherence to the WHO recommended minimum inter-birth interval of 33 months. Analyzing data from China, Zhu et al. [17] observed that both short and long birth intervals were associated with a higher risk of neonatal mortality. Birth intervals of less than 12 months or more than 60 months had increased mortality rates compared to an optimal interval of 24-35 months. The study conducted by Rahman et al. [18] using Bangladesh data; found that birth intervals shorter than 24 months were associated with an increased risk of neonatal mortality. Infants born within shorter intervals had higher odds of preterm birth, low birth weight, and subsequently, increased mortality. Study conducted in Ethiopia by Shifti et al., predicted that birth intervals shorter than 24 months were associated with an increased risk of neonatal mortality. Infants born within shorter intervals had higher odds of being born preterm and experiencing low birth weight, leading to higher mortality. These studies suggest that short birth intervals are associated with increased risks of preterm birth, low birth weight, and other adverse outcomes. They however do not specifically suggest the role of longer birth interval to neonatal mortality and therefore require further investigation. It is in this light that the impact of adherence to WHO minimum inter-birth interval length on neonatal survival is analyzed using NFHS-5 dataset for EAG states. As the study focuses on closed birth intervals, the open birth interval i.e. the birth interval from marriage to first birth is not included in the analysis. Survival analysis is used to study the determinants of neonatal deaths.

Data and Methodology

Data collected from National Family Health Survey (NFHS-5) [20] is used to estimate neo-natal deaths in EAG states. The NFHS-5 data is used to investigate the risk of neonatal survival for the successive inter birth intervals among those who adhere to WHO recommend 33 months and those who do not keeping all other socio-economic & demographic variables constant. The data is analyzed for the EAG states comprising of Bihar, Madhya Pradesh, Odisha, Rajasthan, and Uttar Pradesh including the three splinters i.e. Chhattisgarh, Jharkhand and Uttarakhand. Complete birth history data is used to estimate the levels of neonatal mortality. Total 620,010 births were analyzed from EAG States. Off these birth 3.73 percent died within one month of birth. Thus 23,142 neonatal deaths form the basis of analysis in this paper. The state-wise sample distribution is presented in the table-1. The Cox Hazards Model is used to study the determinants of neonatal deaths for successive birth intervals. STATA is used to carry out the analysis.

Findings

The table 2 presents the estimate of neonatal mortality rate for five year periods preceding the survey by place of residence. In EAG states the neonatal mortality in urban areas is 24.87 deaths per thousand live births while in rural areas it is 33.30 deaths. EAG states as a group recorded the neonatal mortality rates of 31.74 per thousand live births. The national average as per NFHS-5 data is 24.91 deaths per thousand live births. This means EAG states have approximately 7 neonatal deaths in excess compared to National average. There have been secular declines both in urban and rural areas of the EAG states, compared to older time periods. Table-3 provides estimates of neonatal mortality by background characteristics. Schedule castes have highest neonatal mortality (36.70) compared to other caste categories. Schedule tribes have 34.46 neonatal deaths; other backward caste groups have 29.82 neonatal deaths while those belonging to other caste groups have 27.85 neonatal deaths per 1000 live births. Religion-wise, neonatal deaths among Hindus and Muslims are 31.7 deaths per 1000 live births. Neonatal death among Christians are highest at 46.19 deaths while those belong to other religious group such as Sikhs, Jain, etc have the lowest neonatal death at 28.42 deaths per 1000 live births. Respondents having no education have neonatal deaths at 36.88 deaths per 1000 live births. Those educated higher level registered lowest (19.63) neonatal deaths. Respondents having education level either incomplete primary, incomplete secondary and completed secondary have 31.59 neonatal deaths per 1000 live birth. Place of delivery being any public health facility registered the lowest neonatal deaths at 28.69 neonatal deaths per 1000 live births while the delivery at home (37.02) or at private facility (37.15) resulted in almost similar neonatal deaths. Mother's age at delivery (birth) is an important indicator for neonatal outcome. The findings from NFHS-5 suggests that women who deliver young (age <20 years) and at older ages have higher neonatal deaths. Mother's delivering at ages 40-49 have 47.10 neonatal deaths while those whose age at the time of delivery was less than 20 years registered neonatal deaths as 45.65 deaths. Mother's whose age at the time of delivery is in the ages 20-29 registered the lowest neonatal deaths (28.98) while mother aged 30-39 at the time of birth registered 34.47 neonatal deaths. Female child is born biologically stronger is re-established from the NFHS-5 findings as the neonatal deaths among female child is 29.1 deaths compared to male child with 34.2 deaths per thousand live births. Size of the baby at the time of birth is important indicator for child survival. Neonates with exceptionally large size have neo mortality as 29.14 while those larger than average size have 35.30 deaths per thousand live births. Neonates with average size (benchmark) registered the lowest neonatal mortality with 25.90 deaths per 1000 live births. Smaller than average and very small baby size have neonatal mortality as 38.51 and 93.23, respectively. This reflects more than average and less than average baby size is risk factors for neonatal mortality. First birth order (36.97) and births of order 4 or more (37.22) have almost similar neonatal mortality compared to births of order 2 to 3 which has lowest neonatal mortality at 26.11. Birth Interval between 2 to 3 years have the lowest neonatal mortality at 22.81 while those who births were birth interval is four or more years have neonatal mortality as 24.45. Birth intervals less than 2 years are associated with increased rate of neonatal mortality rates at 39.62. Having any kind of flush toilet reduces neonatal deaths by reducing neonatal sepsis that may be caused due to unhygienic conditions and is rightly reflected in the data from EAG states. Neonatal mortality is lowest among households having any kind of flush toilet facility at 28.72 deaths per 1000 live births. While those having any kind of pit/compost or have no facility registered neonatal mortality as 35.11 and 34.70 respectively.

Table 4 provides the estimates of neonatal mortality for successive birth intervals by adherence to WHO recommended inter-birth interval length of 33 months. For first birth to birth interval length the neonatal mortality is 25.86 in cases were birth interval is less than equal to 33 months compared 18.85 deaths per 1000 live births in cases were birth interval is greater than 33 months. The reduction is neonatal deaths is of 7 deaths per 1000 live births in case were WHO recommended IBI length is observed compared to those who do not adhere. Similarly, for second birth to birth interval length the neonatal mortality is 32.81 in cases were birth interval is less than equal to 33 months compared 23.67 deaths per 1000 live births in cases were birth interval is greater than 33 months. The reduction is neonatal deaths is of 9.14 deaths per 1000 live births in case were WHO recommended IBI length is observed compared to those who do not adhere. For third birth to birth interval length the neonatal mortality is 36.74 in cases were birth interval is less than equal to 33 months compared 26.27 deaths per 1000 live births in cases were birth interval is greater than 33 months. The reduction is neonatal deaths is of 10.47 deaths per 1000 live births in case were WHO recommended IBI length is observed compared to those who do not adhere. Likewise for fourth birth to birth interval length the neonatal mortality is 49.05 in cases were birth interval is less than equal to 33 months compared 24.18 deaths per 1000 live births in cases were birth interval is greater than 33 months. The reduction is neonatal deaths is of 24.86 deaths per 1000 live births in case were WHO recommended IBI length is observed compared to those who do not adhere.

Similarly, for fifth birth to birth interval length the neonatal mortality is 53.98 in cases were birth interval is less than equal to 33 months compared 30.78 deaths per 1000 live births in cases were birth interval is greater than 33 months. The reduction is neonatal deaths is of 23.20 deaths per 1000 live births in case were WHO recommended IBI length is observed compared to those who do not adhere. For sixth birth to birth interval length the neonatal mortality is 58.95 in cases were birth interval is less than equal to 33 months compared 32.40 deaths per 1000 live births in cases were birth interval is greater than 33 months. The reduction is neonatal deaths is of 26.54 deaths per 1000 live births in case were WHO recommended IBI length is observed compared to those who do not adhere. For seven and higher order birth to birth interval length the neonatal mortality is 68.28 in cases were birth interval is less than equal to 33 months compared 43.73 deaths per 1000 live births in cases were birth interval is greater than 33 months. The reduction is neonatal deaths is of 24.55 deaths per 1000 live births in case were WHO recommended IBI length is observed compared to those who do not adhere. Findings suggest that there is reduction is neonatal deaths if the WHO recommended inter birth interval length is adhered. This reduction is more pronounced in the higher order inter birth interval length though the levels of neonatal mortality is quite high for higher order inter birth interval lengths among those to adhere too as well as those who do not.

Table 5 presents the hazard ratios by background characteristics. The model-1 presents the social characteristics while model-2 include the biological characteristics and model three include the environmental factors. Having controlled the effect of socio-economic, biological and environmental characteristics under model 4 and 5 in table 6 hazards ratio estimates by inter birth interval length for first and second birth to birth intervals are presented. The model 5 and model 6 were obtained by running two different set of Cox proportional hazards model controlling for background characteristics. Under model-1 in table 5 the place of residence, caste and religion were not significant factors in explaining the variation in neonatal deaths. Under the religion category the risk of neonatal deaths were lower among Christians compared to Hindus and is significant at 5 % level of significance. This is paradoxical situation, because the estimates of neonatal deaths were very high compared to Hindus or the Muslims but the hazards ratio is significantly lower. This may be due to less number of cases as the estimates of SE are little on higher side compared to other categories. However the place of delivery was highly significant and the risk of neonatal deaths were significantly lower in case if delivered at any public institution compared to delivering at home. Similarly the risk of delivering at private institution or an NGO was also significantly lower compared to home deliveries.

Mother's age at delivery is not significant factor in determining the variations in the neonatal deaths and the estimates of hazard ratios. Respondent's education significantly determines the variations in the estimates of hazard ratios and is highly significant. Those educated upto incomplete primary, incomplete secondary and secondary complete have significant less risk of neonatal deaths compared to respondents with no education. Similarly those educated higher levels have even less risk of neonatal deaths compared to respondents with no education. As next step under model-2 biological factors were controlled. The findings suggest that after controlling for biological factors the risk of neonatal deaths among Muslims were statistically significantly less compared to Hindus. The risk was statistically significantly less among Christians compared to Hindus too. The remaining social characteristics remain unchanged as they were under model-1 after the introduction of the biological factors in the model. Though the levels of neonatal mortality by Child's sex were different and female child had lesser rate of neonatal mortality, the findings from Cox model suggest no statistical difference in the risk of neonatal deaths by sex of the child. Baby size less than average was highly statistically significant compared babies having size greater than average. Birth of order two to three have statistically significant lower risk of neonatal deaths compared to births of order one. In model three after having controlled the socio-economic/demographic and biological variables, environmental factors were controlled. The findings from the model- 3 in table 5 suggests no statistically significant changes in the factors predicting neonatal mortality as predicted under model-2 after having controlled for environmental factor. This suggest that environmental variable do not mediate or interact with the socio- demographic and biological factors, however those who have no toilet facility have higher risk of neonatal deaths compared to those household having flush toilet and is statistically significant at 5 percent level of significance. In table 6 under model 4 & 5 after controlling for background characteristics the impact of inter birth interval length for first two births were studied. As the piece wise constant hazard model did not converge, two separate Cox models were estimated one each for first inter birth interval length and second inter birth interval length after controlling for background characteristics. The degree of prediction under model-4 remained statistically same as is under model-3. However, those cases were the first inter-birth interval length was greater than 33 months or those adhered to WHO recommended the risk of neonatal deaths was statistically significantly lower compared to those who do not adhered too. Under model 5 while controlling for second inter birth interval length, some of the variable categories became statistically significant in predicting the variation in neonatal deaths. Under religious group Muslims respondents have lower risk of neonatal deaths compared to Hindus and are statistically highly significant. Mothers age at delivery in the age bracket 30-39 have statistically significantly lower risk compared to mothers who delivered young (<20 years). Those cases were the second inter-birth interval length was greater than 33 months or those adhered to WHO recommended, the risk of neonatal deaths was statistically significantly lower too compared to those who do not adhered too. The findings are suggestive of significantly lower risk of neonatal deaths among cases where the inter birth interval length is greater than 33 months and thus validate the WHO recommendation.

DISCUSSION

The findings from this study reaffirm the established U-shaped relationship between inter-birth interval length and neonatal survival documented in the wider literature. The observed excess neonatal mortality in EAG states, particularly the steep gradient across successive birth orders, is consistent with Rutstein and Winter's [13b] cross-national evidence linking both short and prolonged intervals to elevated risk, and closely mirrors the North Indian findings of Williams et al. [14], who reported higher neonatal death rates for intervals below 36 months. The pronounced gain in survival among higher-order births adhering to the WHO-recommended 33-month threshold parallels results from Bangladesh [18] and Ethiopia [19], where short spacing was similarly linked to preterm birth and low birth weight. The non-significance of caste and religion once socio-economic and biological factors were controlled echoes Exavery et al.'s [16] Tanzanian findings that maternal education, rather than social category, is the stronger determinant of adherence and outcome. Notably, the persistence of high mortality among higher-order births even when spacing recommendations were followed suggests that birth spacing alone cannot offset the cumulative biological and economic risks of high parity, reinforcing calls from USAID [5] for combined birth-spacing and family-size interventions in high-burden settings.

CONCLUSIONS

The success of achieving the Sustainable Development Goal target for 2030 of 12 neonatal deaths per thousand live births is possible for the country provided faster reduction in neonatal mortality is brought through health care intervention in EAG states. The rest of India minus EAG states is well within reach of achieving the SDG 2030 target, perhaps even before 2030. Strong IEC policies educating couples (or families) to space births at-least 33 months apart and limit the family size by restricting higher order births needs to be devised. The gain in neonatal survival among higher order inter-birth intervals is strikingly high for those who adhere to WHO recommended birth to birth interval length compares to who does not.

Table 1: Sample Distribution: Neonatal Deaths: EAG States 2019-21

EAG States	Total Births	Number of Neonatal Deaths in the Sample	State-wise % sample (Neonatal Deaths)
Uttarakhand	23,423	624	2.7
Odisha	46,041	1,856	8.02
Chhattisgarh	47,800	1,548	6.69
Jharkhand	52,563	1,978	8.55
Rajasthan	77,777	2,174	9.39
Madhya Pradesh	93,114	3,590	15.51
Bihar	97,677	4,033	17.43
Uttar Pradesh	1,81,615	7,339	31.71
Total	6,20,010	23,142	100

Table 2: Neonatal Mortality Rates for Five-year Periods Preceding the Survey by Residence, EAG States, 2019-21

Years preceding the survey		Neonatal mortality Rate
0-4	Urban	24.87
5-9		28.33
10-14		29.22
0-4	Rural	33.3
5-9		34.23
10-14		36.35
0-4	Total	31.74
5-9		33.09
10-14		34.9

Note: All Estimates are for the 5 Years Preceding the Survey.

Table 3: Neonatal Mortality Rates for the Five-year Period Preceding the Survey, by Background Characteristics, EAG States, 2019-21

Background characteristic	Neonatal Mortality Rate (per 1000 LB)
Place of Residence	
Urban	24.87
Rural	33.3
Caste	
Schedule caste	36.7
Schedule Tribe	34.46
Other backward caste	29.82
Others	27.85
Religion	
Hindu	31.7
Muslim	31.65
Christians	46.19
Others	28.42
Educational attainment	

No education	36.88
Incomplete primary/secondary & completed secondary	31.59
Higher	19.63
Delivery Place	
Home	37.02
Public any	28.69
Private/NGO/Others	37.15
Mother age at delivery	
<20 years	45.65
20-29	28.98
30-39	34.47
40-49	47.1
Childs Sex	
Male	34.19
Female	29.08
Baby Size	
Very large	29.14
Larger than average	35.3
Average	25.9
Smaller than average	38.51
Very small	93.23
Don't know	134.25
Birth order	
1	36.97
2-3	26.11
4 or more	37.22
Birth Interval	
<2 years	39.62
2-3 Years	22.81
4 Years or more	24.45
Toilet Facility	
Flush any	28.72
Pit/compost	35.11
Open/bush/field	34.7
Others	35.76
EAG states	31.74

Table 4: Neonatal Mortality Rates for the Five-year Period Preceding the Survey, by WHO Recommended Inter Birth Interval Length, EAG States, 2019-21

Successive Birth Interval	Neonatal Mortality Rate (per 1000 LB)
Birth Interval	
First birth to birth interval length	
<=33 months	25.86
>33 months	18.85
Second birth to birth interval length	
<=33 months	32.81
>33 months	23.67
Third birth to birth interval length	
<=33 months	36.74
>33 months	26.27
Fourth birth to birth interval length	
<=33 months	49.05
>33 months	24.18
Fifth birth to birth interval length	
<=33 months	53.98
>33 months	30.78
Sixth birth to birth interval length	
<=33 months	58.95
>33 months	32.4
Seven & higher order birth to birth interval length	
<=33 months	68.28
>33 months	43.73
EAG states	31.74
India minus EAG states	16.76
India	24.91

Table 5 Hazard Ratios by Background Characteristics EAG States: 2019-21

Model 1						
Variables	**Haz. Ratio**	**SE**	**z**	**P>|z|**	**[95% Conf. Interval]**	
					Lower	**Upper**
Place of Residence						
Urban (Ref.)	1					
Rural	0.99	0.07	-0.17	0.87	0.86	1.14
Caste						
SC (Ref.)	1					
ST	1.11	0.08	1.37	0.17	0.96	1.27
OBC	0.9	0.05	-1.85	0.07	0.8	1.01
Others	0.91	0.08	-1.1	0.27	0.77	1.08
Religion						
Hindu (Ref.)	1					
Muslims	0.86	0.07	-1.82	0.07	0.74	1.01
Christians	0.55	0.17	-1.95	0.05	0.3	1
Others	0.92	0.2	-0.37	0.71	0.61	1.4
Delivery Place						
Home (Ref.)	1					
Public	0.7	0.04	-6.26	0	0.62	0.78
Private/NGO	0.73	0.06	-3.82	0	0.62	0.86
Mothers Age at Delivery						
<20 (Ref.)	1					
20-29	0.9	0.07	-1.5	0.13	0.78	1.03
30-39	0.93	0.09	-0.79	0.43	0.78	1.11
40-49	1.27	0.27	1.15	0.25	0.84	1.92
Respondents Education						
No education (Ref.)	1					
Incomplete primary/ secondary & completed secondary	0.66	0.03	-7.95	0	0.6	0.73
Higher	0.44	0.05	-7.58	0	0.36	0.55

Model 2						
Variables	**Haz. Ratio**	**SE**	**z**	**P>|z|**	**[95% Conf. Interval]**	
					Lower	**Upper**
Place of Residence						
Urban (Ref.)	1					
Rural	1.02	0.09	0.19	0.85	0.85	1.22
Caste						
SC (Ref.)	1					
ST	1.2	0.1	2.05	0.04	1.01	1.42
OBC	0.96	0.07	-0.57	0.57	0.83	1.1
Others	1.01	0.1	0.07	0.95	0.82	1.23
Religion						
Hindu (Ref.)	1					
Muslims	0.79	0.07	-2.49	0.01	0.66	0.95
Christians	0.31	0.16	-2.32	0.02	0.12	0.83
Others	0.73	0.21	-1.09	0.28	0.41	1.29
Delivery Place						
Home	1					
Public	0.76	0.05	-4.12	0	0.66	0.87
Private/NGO	0.82	0.08	-1.93	0.05	0.67	1
Mothers Age at Delivery						
<20 (Ref.)	1					
20-29	0.89	0.12	-0.88	0.38	0.68	1.16
30-39	0.96	0.15	-0.24	0.81	0.71	1.31
40-49	1.27	0.32	0.96	0.34	0.78	2.08
Respondents Education						
Home (Ref.)	1					
Incomplete primary/secondary & completed secondary	0.73	0.05	-5.12	0	0.64	0.82
Higher	0.49	0.08	-4.57	0	0.36	0.67
Baby Size						
> Average (Ref.)	1					
Average	1.04	0.08	0.43	0.67	0.88	1.21
<Average	1.55	0.16	4.17	0	1.26	1.9
Child's Sex						
Male (Ref.)	1					
Female	1.03	0.06	0.6	0.55	0.93	1.15
Birth Order						

1 (Ref.)	1					
2-3	0.79	0.05	-3.5	0	0.69	0.9
Birth Interval						
<2 years (Ref.)						
2-3 Years	0.62	0.04	-7.83	0	0.55	0.7
4 Years or more	0.53	0.05	-7.26	0	0.44	0.63

Model 3						
Variables	**Haz. Ratio**	**SE**	**z**	**P>|z|**	**[95% Conf. Interval]**	
					Lower	**Upper**
Place of Residence						
Urban (Ref.)	1					
Rural	0.99	0.09	-0.1	0.93	0.83	1.19
Caste						
SC (Ref.)	1					
ST	1.18	0.10	1.92	0.06	1	1.4
OBC	0.97	0.07	-0.5	0.63	0.84	1.11
Others	1.02	0.11	0.23	0.82	0.84	1.25
Religion						
Hindu (Ref.)	1					
Muslims	0.8	0.08	-2.3	0.02	0.67	0.97
Christians	0.31	0.16	-2.3	0.02	0.11	0.83
Others	0.72	0.21	-1.1	0.27	0.41	1.29
Delivery Place						
Home	1					
Public	0.76	0.05	-4	0	0.67	0.87
Private/NGO	0.83	0.09	-1.8	0.08	0.68	1.02
Mothers Age at Delivery						
<20 (Ref.)	1					
20-29	0.88	0.12	-0.9	0.37	0.67	1.16
30-39	0.96	0.15	-0.3	0.79	0.71	1.3
40-49	1.26	0.32	0.93	0.35	0.77	2.06
Respondents Education						
Home (Ref.)	1					
Incomplete primary/secondary & completed secondary	0.74	0.05	-4.7	0	0.66	0.84
Higher	0.51	0.08	-4.3	0	0.38	0.7
Baby Size						
> Average (Ref.)	1					
Average	1.04	0.08	0.46	0.65	0.89	1.21
<Average	1.55	0.16	4.19	0	1.26	1.9
Child's Sex						
Male (Ref.)	1					
Female	1.03	0.06	0.59	0.56	0.93	1.15
Birth Order						
1 (Ref.)	1					
2-3	0.79	0.05	-3.4	0	0.69	0.91
Birth Interval						
<2 years(Ref.)	1					
2-3 Years	0.62	0.04	-7.9	0	0.55	0.69
4 Years or more	0.53	0.05	-7.2	0	0.45	0.63
Toilet Type						
Flush any (Ref.)	1					
Pit/compost	1.06	0.1	0.68	0.5	0.89	1.27
Open/bush/field	1.14	0.07	1.95	0.05	1	1.29

Table 6 Hazards Ratio Estimates for First and Second Inter-birth Interval Length After Controlling for Background Characteristics: EAG states (2019-21)

Model 4						
Variables	**Haz. Ratio**	**SE**	**z**	**P>|z|**	**[95% Conf. Interval]**	
					Lower	**Upper**
Place of Residence						
Urban (Ref.)	1					
Rural	0.99	0.14	-0.09	0.93	0.75	1.3
Caste						
SC (Ref.)	1					
ST	1.11	0.16	0.72	0.47	0.84	1.47
OBC	0.89	0.1	-0.99	0.32	0.71	1.12
Others	0.82	0.14	-1.21	0.23	0.59	1.13
Religion						
Hindu (Ref.)	1					
Muslims	1.07	0.17	0.43	0.67	0.79	1.45
Christians	0.23	0.23	-1.48	0.14	0.03	1.61
Others	0.66	0.34	-0.81	0.42	0.25	1.79
Delivery Place						
Home	1					
Public	0.81	0.1	-1.76	0.08	0.64	1.02
Private/NGO	0.88	0.14	-0.8	0.43	0.63	1.21
Mothers Age at Delivery						
<20 (Ref.)	1					
20-29	0.87	0.14	-0.86	0.39	0.64	1.19
30-39	0.98	0.23	-0.09	0.93	0.61	1.56
40-49						
Respondents Education						
Home (Ref.)	1					
Incomplete primary/secondary & completed secondary	0.7	0.07	-3.4	0	0.58	0.86
Higher	0.6	0.11	-2.7	0.01	0.41	0.87
Baby Size						
> Average (Ref.)	1					
Average	1.09	0.14	0.68	0.5	0.85	1.41
<Average	1.48	0.26	2.23	0.03	1.05	2.08
Child's Sex						
Male (Ref.)	1					
Female	0.86	0.08	-1.71	0.09	0.72	1.02
Toilet Type						
Flush any	1					
Pit/compost	1.1	0.16	0.64	0.52	0.82	1.47
Open/bush/field	1.28	0.14	2.3	0.02	1.04	1.59
First IBI Length						
<=33 months	1					
>33 months	0.64	0.06	-4.44	0	0.52	0.78

Model 5						
Variables	**Haz. Ratio**	**SE**	**z**	**P>|z|**	**[95% Conf. Interval]**	
					Lower	**Upper**
Place of Residence						
Urban (Ref.)	1					
Rural	0.96	0.17	-0.24	0.81	0.67	1.37
Caste						
SC (Ref.)	1					
ST	1.32	0.21	1.73	0.08	0.96	1.82
OBC	1.04	0.14	0.29	0.78	0.8	1.36
Others	1.31	0.25	1.39	0.16	0.9	1.92
Religion						
Hindu (Ref.)	1					
Muslims	0.55	0.11	-2.91	0	0.37	0.82
Christians	0.28	0.28	-1.27	0.21	0.04	2.01
Others	0.8	0.41	-0.43	0.67	0.29	2.19
Delivery Place						
Home	1					
Public	0.82	0.1	-1.6	0.11	0.64	1.05
Private/NGO	0.81	0.17	-1.02	0.31	0.54	1.21
Mothers Age at Delivery						
<20 (Ref.)	1					
20-29	0.57	0.18	-1.82	0.07	0.31	1.04
30-39	0.4	0.14	-2.56	0.01	0.2	0.81
40-49	0.7	0.54	-0.47	0.64	0.15	3.18
Respondents Education						
Home (Ref.)	1					
Incomplete primary/secondary & completed secondary	0.76	0.08	-2.47	0.01	0.61	0.94
Higher	0.33	0.14	-2.62	0.01	0.14	0.76
Baby Size						
> Average (Ref.)	1					
Average	1.07	0.16	0.47	0.64	0.8	1.44
<Average	1.41	0.29	1.7	0.09	0.95	2.1
Child's Sex						

Male (Ref.)	1				
Female	1.08	0.11	0.69	0.49	0.87	1.32
Toilet Type						
Flush any	1					
Pit/compost	1.05	0.18	0.28	0.78	0.75	1.46
Open/bush/field	1.15	0.14	1.14	0.25	0.9	1.46
Second IBI Length						
<=33 months	1					
>33 months	0.66	0.08	-3.49	0	0.53	0.83

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