ORIGINAL RESEARCH ARTICLE

Trends and Associated Risk Factors of Caesarean Deliveries in Northeast State of India

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ABSTRACT

Background: Caesarean (C-section) deliveries are rising across India, with National Family Health Survey (NFHS-4, 2015–16) reporting 17.2% of births by C-section. This study investigates the variations in C-section prevalence and the associated factors in the Northeastern states compared to the rest of the country.

Methods: This study analyses data collected from 232920 mothers under NFHS-5 (2019-2021). Bivariate analysis followed by logistic regression model was used to determine the risk factors associated with the C-sections based on the different criteria.

Results: In NFHS-4 and NFHS-5, Telangana reported the highest rates at 57.7% and 60.7%, respectively, and Nagaland reported the lowest at 5.7% and 5.2% respectively. C-section rates rise steadily up to age 39, then decline among mothers aged 40–49. C-section deliveries rise sharply among highly educated women, a trend consistent in both the Northeast and the rest of India. Mothers with high blood pressure, birth order of one, six or more antenatal visits, a past terminated pregnancy show higher rates of C-section in both Northeast and the rest of India.

Conclusion: Medical risk factors like antenatal visits and birth order strongly predict C-sections. This study highlights the complex interplay of medical and socio-economic factors influencing C-section rates across different regions.

Keywords: C-sections, Antenatal visits, Birth order, Terminated pregnancy

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INTRODUCTION

The role of C-section deliveries is acknowledged worldwide for dealing with complications related to childbirth and reducing the mortality rate of mother and foetus.[1] In obstetrical care, C-section is the most routinely performed surgery where fetus is delivered through a surgical incision in a pregnant woman's abdominal wall and uterine wall. It is commonly done for maternal or fetal reasons to avert maternal and neonatal morbidity and mortality rates.[2] C-section delivery rate is rapidly increasing worldwide.[3,4] It is estimated that more than one in five births globally are delivered by C-section.[4]

The high rate of C-section deliveries in both developed and developing countries reflects the increasing medicalization of childbirth.[5] In recent years, increased reliance on medical technology to address childbirth complications has contributed to higher rates of C-section deliveries.[6,7] The medicalization of childbirth has raised concerns about potential malpractice, as some doctors may perform unnecessary C-sections for convenience, quick handling to save time or economic incentives.[8] Moreover, expectant mothers' inadequate knowledge about childbirth complications is likely to increase the chance of their exploitation for economic gain. In such situations, doctors and hospital authorities may easily persuade patients to opt for C-section deliveries by associating the method with the security of the mother and child's health, even when a normal delivery is possible.[9]

Since 1985, the World Health Organization and the international healthcare community have considered the ideal C-section rate between 10% and 15%. Since then, C-sections have become increasingly common in both developed and developing countries. When medically justified, a C-section can effectively prevent maternal and perinatal mortality and morbidity. However, there is no evidence showing the benefits of C-section delivery for women or infants who do not require the procedure. As with any surgery, C-sections are associated with short- and long-term risks that can extend to many years beyond the current delivery and affect the health of the woman, her child, and future pregnancies. The likelihood of these risks increases among women lacking adequate obstetric care.[10]

C-section delivery rate is also increasing nationally in India. The 2015–2016 India National Family Health Survey (NFHS-4) estimates that 17.2% of all births nationwide are delivered by C-section. The estimated rural and urban residence rates are 12.9% and 28.3%, respectively.[11] Another study using National Family Health Survey (NFHS) data shows that in India the percentage of C-section deliveries in public hospitals has gone down from 15.2% to 11.9% during 2005–06 to 2015–16, an increase can be seen from nearly 25% to around 40% in private health care providers during the same period.[12] States like Tamil Nadu and Telangana have C-section rates exceeding 50%, while Bihar and Uttar Pradesh report much lower rates.[13]

Several factors have been found to have an impact on C-section rates across the world and in India. Certain obstetric risks such as dystocia, previous C-section, foetal distress, breach births, post-term pregnancy, multiple pregnancy and hypertensive disorder are considered to be justifiable medical reasons for C-section deliveries.[14,15] However, the effect of these factors vary depending on individual characteristics of the mother, such as age at delivery and at marriage, obesity, education levels and exposure to media; the child, such as birth order and the size of the child at birth, demographic and community-level factors such as caste, place of residence, wealth, the number of antenatal care visits and most importantly the nature of the hospital (private or public) where the delivery happened. Some studies suggest that mothers' preferences, either due to fear related to prolonged labour and vaginal delivery pain or to beliefs in auspicious times, can also lead to delivery by C-section.[16]

In India, Nagaland has the lowest C-section delivery rate among the Northeast states, while Telangana reports the highest C-section rate among the other states. Therefore, this analysis relooks at the C-section dynamics in India across selected socio-demographic factors and pregnancy complications, presenting a comparative picture between Northeast India and the rest of India. This study investigates the variations in C-section prevalence and the associated factors in the Northeastern states compared to the rest of the country.

METHODOLOGY

The data for analysis is sourced from the 'Birth File' of the National Family Health Surveys (NFHS)-3, NFHS-4, and NFHS-5, conducted during 2005–2006, 2015–2016, and 2019–2021, respectively.[17,11,18] NFHS surveys are conducted periodically and encompass a representative sample of households, covering over 97% of the Indian population. These surveys provide reliable statistics on various socio-demographic aspects such as fertility, mortality, morbidity, reproductive health, family planning, maternal and child health, and domestic violence within the Indian context.

During NFHS surveys, mothers were asked whether they had delivered via C-section during the five years preceding the survey, seeking a dichotomous (yes/no) response. The analysis was conducted based on all live births during the last five years prior to the surveys. NFHS-5 collected information from 636,699 households, an increase from 601,509 households in NFHS-4 and 109,041 households in NFHS-3. During the NFHS-3 survey, 10,443 mothers from Northeast India and 41,112 from the rest of India were interviewed. In NFHS-4, the respondents were 37,167 from the Northeast and 222,460 from the rest of India. In NFHS-5, 232,920 respondents were interviewed, of which 34,222 were from the Northeast and 198,698 from other states.

Measurement of variables

Dependent variables: Our primary dependent variable was C-section delivery. Eligible women defined as women of reproductive age (15–49 years) who reported a live birth within the five years preceding the survey were asked the question: "Was the baby delivered by C-section, that is, did they cut your belly open to take the baby out?" Women who answered "yes" were classified as having undergone a C-section delivery. The dependent variable was categorized as a dichotomous outcome, coded as C-section = 1 and non-C-section = 0.

Independent variables: Independent variables that are considered potential to explain the dependent variable in the present study are categorized into two groups: (i) Socio-demographic factors and (ii) Maternal risk factors

(i) Socio-demographic factors: In the study, various demographic factors were examined, including the current age of the mother, which was categorized into four groups: 15-20 years, 21-29 years, 30-39 years, and 40-49 years. Additionally, the mother's age at first birth was divided into four categories: up to 18 years, 19-25 years, 26-35 years, and 35 years and above. The type of place of residence was distinguished between urban and rural areas. At the same time, the wealth index[18] was segmented into five groups based on economic status: poorest, poorer, middle, richer, and richest. The highest educational level attained by the mother was classified into four levels: no education, primary education, secondary education, and higher education. Furthermore, religion was modified and grouped into Hindu, Muslim, Christian, and others. The respondent's current employment status was categorized as either no (not currently working) or yes (currently working), and caste was classified into scheduled caste, scheduled tribe, other backward class, and others.

(ii) Maternal risk factors: In analyzing the data, various maternal risk factors were considered, such as whether high blood pressure occurred during pregnancy (no/yes), the birth order (one, two, three & above), the birth weight (<2.5kg, 2.5kg & above, or not weighed), the birth size (smaller than average, average, larger than average, or unknown), the mother's body mass index (BMI) (underweight, normal, or overweight), the occurrence of vaginal bleeding during pregnancy (no/yes), convulsions during pregnancy (no/yes), prolonged labour (no/yes), abdominal pain during pregnancy (no/yes), any other pregnancy complications (no/yes), the frequency of antenatal visits (categorized as no visits, 1-5 visits, six visits and above, or unknown), whether there was a history of child abortion (classified as either no or yes), and whether there was a history of terminated pregnancy (classified as either no or yes). Finally, the place of delivery was differentiated between public and private healthcare facilities.

Statistical analysis: An initial bivariate analysis was performed to identify significant associations between types of delivery (C-section vs. non-C-section) and a series of independent variables. Dichotomous variables were analyzed by the $\chi 2$ test or Fisher exact test, where appropriate. Logistic regression model is used to determine the risk factors associated with the C-section based on the different criteria. Logistic Regression model is the most frequently used for analyzing data in epidemiological and clinical studies. The logistic regression is analogous to multiple linear regressions where the dependent measure is dichotomous (coded by the values 0 and 1), whereas the Cox proportional regression model assumes that the effects of the predictor variables (names of variables that we expect to predict survival time) are constant over time. Maternal, socio-demographic and other relevant variables were treated as independent variables, while the dependent variables were already mentioned in the above section. The value of $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 illustrates the state-wise percentage distribution of deliveries by C-section in Indian states between the surveys conducted from 2005-2006 to 2019-2021. Overall, in India, C-section delivery rates were 8.5% in NFHS-3, 17.2% in NFHS-4, and 21.5% in NFHS-5, respectively. The percentage change from NFHS-3 to NFHS-4 is 102.4%, and from NFHS-4 to NFHS-5 is 25%. In NFHS-3, Kerala reported the highest rate of C-sections in India at 30%, while Nagaland reported the lowest at 2.1%. In NFHS-4 and NFHS-5, Telangana reported the highest rates at 57.7% and 60.7%, respectively, and Nagaland reported the lowest at 5.7% and 5.2% respectively.

Table 2 illustrates the influence of various background characteristics, such as socio-economic factors and maternal risk factors on C-section deliveries in the Northeastern states compared to the rest of India. Significant differences are observed between the two groups regarding several variables. These variables include the current age of mothers, the age of the mother at the time of birth, the place of residence (urban or rural), the family's wealth category, the educational levels of the women, their religion, their current employment status, and their caste.

Among the socio-economic factors, mothers' current age and the mother's age at first birth show significant differences in C-section deliveries. In the Northeastern states, the age group of 30-39 years exhibits a higher rate of C-sections at 22%. Similarly, in the rest of India, the highest rate of C-sections is observed in the age group of 30-39 years, with a rate of 24.9%. The percentage of C-section cases increases consistently till 39 years whereas a decrease can be seen in the age group of 40-49 years. The rate of C-sections among mothers aged 35 years and above at the time of their first birth was higher with 46.8% in the Northeast states and 61.5% in the rest of the states.

Table 1: State-wise percent distribution of deliveries by caesarean section in India during NFHS-3, NFHS-4 & NFHS-5

	NFHS-3	NFHS-4	% Change (NFHS-3 – NFHS-4)	NFHS-5	% Change (NFHS-4 – NFHS-5)
Northern					
Chandigarh	Nil	22.4	0	31.3	39.7
Delhi	13.7	26.7	94.9	23.6	-11.6
Haryana	5.3	11.7	120.8	19.4	65.8
Himachal Pradesh	12.5	16.7	33.6	21	25.7
Jammu & Kashmir	13.6	33.1	143.4	41.7	26.0
Ladakh	Nil	Nil	0	37	11.7
Punjab	16.5	24.6	49.1	38.5	56.5
Rajasthan	3.8	8.6	126.3	10.4	20.9
Southern					
Andaman & Nicobar Islands	Nil	20		30	50.0
Andhra Pradesh	22.2	40.1	80.6	42.4	5.7
Karnataka	15.5	23.6	52.3	31.5	33.5
Kerala	30	35.8	19.3	38.9	8.7
Puducherry	Nil	33.7		36.3	7.7
Tamil Nadu	20.3	34.1	68.0	44.9	31.7
Telangana	Nil	57.7	0	60.7	5.2
Lakshadweep	Nil	38.5	0	30	-22.1
Central					
Chhattisgarh	4.1	9.9	141.5	15.2	53.5
Madhya Pradesh	3.5	8.6	145.7	12.1	40.7
Uttar Pradesh	4.4	9.4	113.6	13.7	45.7
Uttarakhand	8.2	13.1	59.8	20.4	55.7
Eastern					
Bihar	3.1	6.2	100.0	9.7	56.5
Jharkhand	3.8	9.9	160.5	12.8	29.3
Odisha	5.1	13.8	170.6	21.6	56.5
West Bengal	10.2	23.8	133.3	32.6	37
Western					
Dadra & Nagar Haveli and Daman & Diu	Nil	16.2	0	22.7	40.1
Goa	25.9	31.3	20.8	39.3	25.6
Gujarat	8.9	18.4	106.7	21	14.1
Maharashtra	11.6	20.1	73.3	25.4	26.4
North-Eastern					
Arunachal Pradesh	3	8.9	196.7	14.5	62.9
Assam	5.3	13.4	152.8	18.1	35.1
Manipur	9.2	21.2	130.4	25.6	20.8
Meghalaya	3.9	7.6	94.9	8.2	7.9
Mizoram	5.9	12.7	115.3	11.1	-12.6
Nagaland	2.1	5.7	171.4	5.2	-8.8
Sikkim	12	21.3	77.5	32.8	54.
Tripura	13	20.4	56.9	25.1	23
India	**8.5**	**17.2**	**102.4**	**21.5**	**25**

Table 2: Percent distribution of deliveries by caesarean section in India by background characteristics during 2019-21

Background characteristics	Northeast states Delivery by caesarean section NFHS-5 (N= 34222)		Other states Delivery by caesarean section NFHS-5 (N= 198698)	
	Yes (%)	p-value	yes (%)	p-value
Current age of mother				
15-20	13.2	0.0001	18	0.0001
21-29	15.8		20.8	
30-39	22		24.9	
40-49	18.5		21	
Mother age at 1st birth				
Upto-18	9	0.0001	13.4	0.0001
19-25	16.8		20.8	
26-35	36.1		40.9	
35+	46.8		61.5	
Type of place of residence				
Urban	35	0.0001	32.2	0.0001
Rural	14.6		17.7	

Background characteristics	Northeast states Delivery by caesarean section NFHS-5 (N= 34222)		Other states Delivery by caesarean section NFHS-5 (N= 198698)	
	Yes (%)	p-value	yes (%)	p-value
Wealth index combined				
Poorest	6.8	0.0001	7.4	0.0001
Poorer	15.4		15	
Middle	28.2		23.8	
Richer	42.5		30.2	
Richest	60.1		39	
Highest educational level				
No education	4.8	0.0001	7.8	0.0001
Primary	8.6		12.8	
Secondary	19.1		23.7	
Higher	52.6		40.5	
Modified religion				
Hindu	26.2	0.0001	21.3	0.0001
Muslim	9.9		20.4	
Christian	9.5		37	
Others	21.4		31.1	
Respondent currently working				
No	19.8	0.0001	21.7	0.0001
Yes	15.1		21	
Caste				
Scheduled caste	22.1	0.0001	18.5	0.0001
Scheduled tribe	12.8		11	
Other backward class	25.7		22	
Others	28.9		28.5	
Place of delivery				
Public	15.7	0.0001	14.3	0.001
Private	63.4		47.1	
Maternal risk factors				
High blood pressure				
No	16.9	0.0001	21.4	0.0001
Yes	25.4		23	
Birth order				
One	23.5	0.0001	28	0.0001
Two	19		24	
Three & above	6.7		9.6	
Birth weight				
<2.5kg	18.5	0.0001	23.8	0.0001
2.5kg & above	19.4		23.2	
Not weighed	2.8		5.4	
Birth size				
Smaller than average	18.8	0.0001	22.4	0.0001
Average	17.7		21.1	
Larger than average	18.2		24.4	
Don't know	1.7		6.6	
Body mass index				
Underweight	12.5	0.0001	13.5	0.0001
Normal	15.2		18.8	
Overweight	34.4		36.3	
Vaginal bleeding				
No	20.2	0.917	22.3	0.0001
Yes	20.1		25.9	
Convulsions				
No	20.2	0.841	23.2	0.0001
Yes	20		25.3	
Prolonged labour				
No	20.6	0.467	23.2	0.0001
Yes	19.8		25.2	
Abdominal pain				
No	21.1	0.177	22.9	0.0001
Yes	19.7		25.3	
Any pregnancy complications				
No	20.8	0.449	22.1	0.0001
Yes	19.9		25.7	
Antenatal visits				
No visits	8.5	0.0001	13.4	0.0001

Background characteristics	Northeast states Delivery by caesarean section NFHS-5 (N= 34222)		Other states Delivery by caesarean section NFHS-5 (N= 198698)	
	Yes (%)	p-value	yes (%)	p-value
1-5	16.1		19.2	
6 & above	35.4		34.3	
Don't know	16.3		30.1	
Ever had child aborted				
No	16.9	0.0001	21.2	0.0001
Yes	25		25	
Ever had a terminated pregnancy				
No	16.6	0.0001	21	0.0001
Yes	24.2		24.9	
Total	**13.5**		**20.2**	

Table 3: Multivariate Logistic Regression of factors independently associated with cesarean section among women aged 15–49 years

Variables	Northeast states		Other states	
	Odd ratios	95% C.I.	Odd ratios	95% C.I.
Socio-demographic variables				
Current age of mother				
15_20	Ref.		Ref.	
21_29	0.696	(0.296-1.634)	0.927	(0.809-1.062)
30_39	0.966	(0.389-2.397)	0.858*	(0.738-0.998)
40_49	0.948	(0.224-4.013)	0.787	(0.589-1.053)
Mother age at 1st birth				
Upto_18	Ref.		Ref.	
19_25	1.649	(0.922-2.947)	1.304*	(1.195-1.422)
26_35	3.548*	(1.756-7.17)	2.634*	(2.334-2.972)
35+	2.002	(0.178-22.53)	9.649*	(6.028-15.44)
Type of place of residence				
Urban	Ref.		Ref.	
Rural	0.728	(0.448-1.181)	0.831*	(0.778-0.888)
Wealth index combined				
Poorest	Ref.		Ref.	
Poorer	1.082	(0.644-1.817)	1.855*	(1.651-2.084)
Middle	2.027*	(1.138-3.612)	2.986*	(2.665-3.346)
Richer	2.363*	(1.218-4.584)	3.412*	(3.032-3.84)
Richest	2.216	(0.815-6.027)	3.591*	(3.16-4.08)
Highest educational level				
No education	Ref.		Ref.	
Primary	2.149*	(0.865-5.34)	1.449*	(1.268-1.655)
Secondary	2.598*	(1.137-5.93)	2.392*	(2.157-2.652)
Higher	5.802*	(2.13-15.77)	2.972*	(2.636-3.351)
Modified religion				
Hindu	Ref.		Ref.	
Muslim	0.754	(0.354-1.607)	1.037	(0.954-1.128)
Christian	0.44*	(0.227-0.853)	1.388*	(1.12-1.719)
Others	0.845	(0.333-2.142)	1.469*	(1.243-1.735)
Respondent currently working				
No	Ref.		Ref.	
Yes	0.739	(0.457-1.195)	1.087*	(1.006-1.174)
Caste				
Scheduled caste	Ref.		Ref.	
Scheduled tribe	0.563	(0.291-1.091)	0.664*	(0.578-0.764)
Other backward class	0.849	(0.486-1.482)	1.07	(0.993-1.153)
Others	1.127	(0.6-2.117)	1.213	(1.112-1.324)
Medical risk factors				
High blood pressure				
No	Ref.		Ref.	
Yes	1.74*	(1.348-2.247)	1.152*	(1.096-1.211)
Birth order				
One	Ref.		Ref.	
Two	0.737*	(0.641-0.847)	0.764*	(0.743-0.785)
Three & above	0.259*	(0.212-0.318)	0.292*	(0.282-0.303)
Birth weight				
<2.5kg	Ref.		Ref.	

Variables	Northeast states		Other states	
	Odd ratios	95% C.I.	Odd ratios	95% C.I.
2.5kg & above	1.098	(0.902-1.338)	1.923*	(0.892-0.956)
Not weighed	0.206*	(0.117-0.365)	0.327*	(0.3-0.357)
Birth size				
Smaller than average	Ref.		Ref.	
Average	0.914	(0.732-1.141)	0.92*	(0.882-0.961)
Larger than average	0.948	(0.737-1.219)	1.062*	(1.012-1.115)
Don't know	0.721	(0.161-3.234)	0.99	(0.792-1.237)
Body mass index				
Underweight	Ref.		Ref.	
Normal	1.348*	(1.107-1.641)	1.48*	(1.426-1.535)
Overweight	3.371*	(2.678-4.244)	3.47*	(3.333-3.614)
Vaginal bleeding				
No	Ref.		Ref.	
Yes	1.061	(0.848-1.327)	1.15*	(1.103-1.202)
Convulsions				
No	Ref.		Ref.	
Yes	1.095	(0.869-1.38)	0.977	(0.933-1.023)
Prolonged labour				
No	Ref.		Ref.	
Yes	0.935	(0.723-1.209)	0.84*	(0.804-0.893)
Abdominal pain				
No	Ref.		Ref.	
Yes	0.934	(0.72-1.211)	0.97	(0.927-1.031)
Any pregnancy complications				
No	Ref.		Ref.	
Yes	0.965	(0.743-1.252)	1.14*	(1.084-1.203)
Antenatal visits				
No visits	Ref.		Ref.	
5-Jan	2.389*	(2.076-2.75)	1.74*	(1.697-1.785)
6 & above	1.021	(0.642-1.623)	1.48*	(1.342-1.645)
Ever had child aborted				
No	Ref.		Ref.	
Yes	0.751	(0.533-1.059)	0.731*	(0.685-0.779)
Ever had a terminated pregnancy				
No	Ref.		Ref.	
Yes	1.91*	(1.423-2.565)	1.579*	(1.494-1.668)

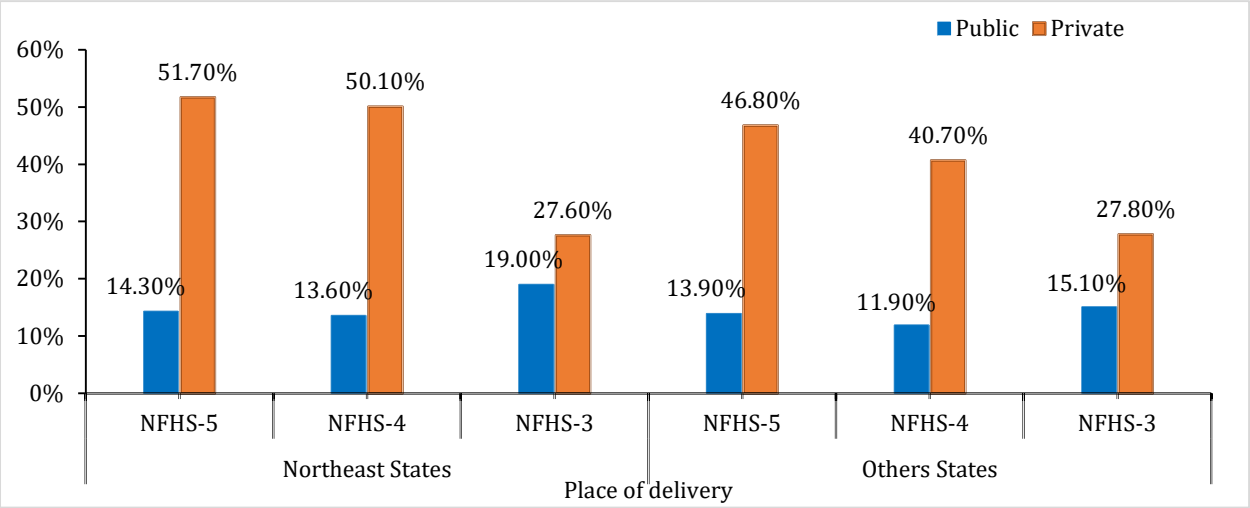

Figure 1: Proportion of C-section delivery in public and private institution for NFHS-3,4, &5

Urban women in the Northeast have a higher rate of C-sections compared to rural women which is shown by the respective rates of 35% and 32.2%. In contrast, the rural-urban gap in C-section rates has narrowed in the rest of India. Notably, in the Northeastern states, the percentage of C-section deliveries among urban women is more than two times higher than that of rural women.

In both the Northeastern states and the rest of India, a higher percentage of C-section deliveries are observed among women in the higher wealth category, with rates of 60% and 39%, respectively, indicating a

difference of 21%. The sharp increase in C-section deliveries is notable among women with higher levels of education and this trend is consistent in Northeastern states as well as the rest of India. In the Northeast, Hindu women have a higher percentage of C-section deliveries at 26.2% whereas women of other religions have a higher rate of C-sections in the rest of India, with 31%. Regarding the current working status of women, there is no difference in C-section deliveries between working and non-working women in the rest of India. However, in the Northeast, non-working women have a higher rate of C-sections at 4.7% compared to working women. The increase in C-section deliveries has been more among other caste/tribe categories. The distribution patterns of C-section deliveries across various maternal or biological risk factors, such as high blood pressure (BP), birth order, birth weight, body mass index (BMI), number of antenatal visits, history of previous abortions (ever had child aborted), and terminated pregnancies (ever had a terminated pregnancy), are similar in Northeast Indian states and the rest of India.

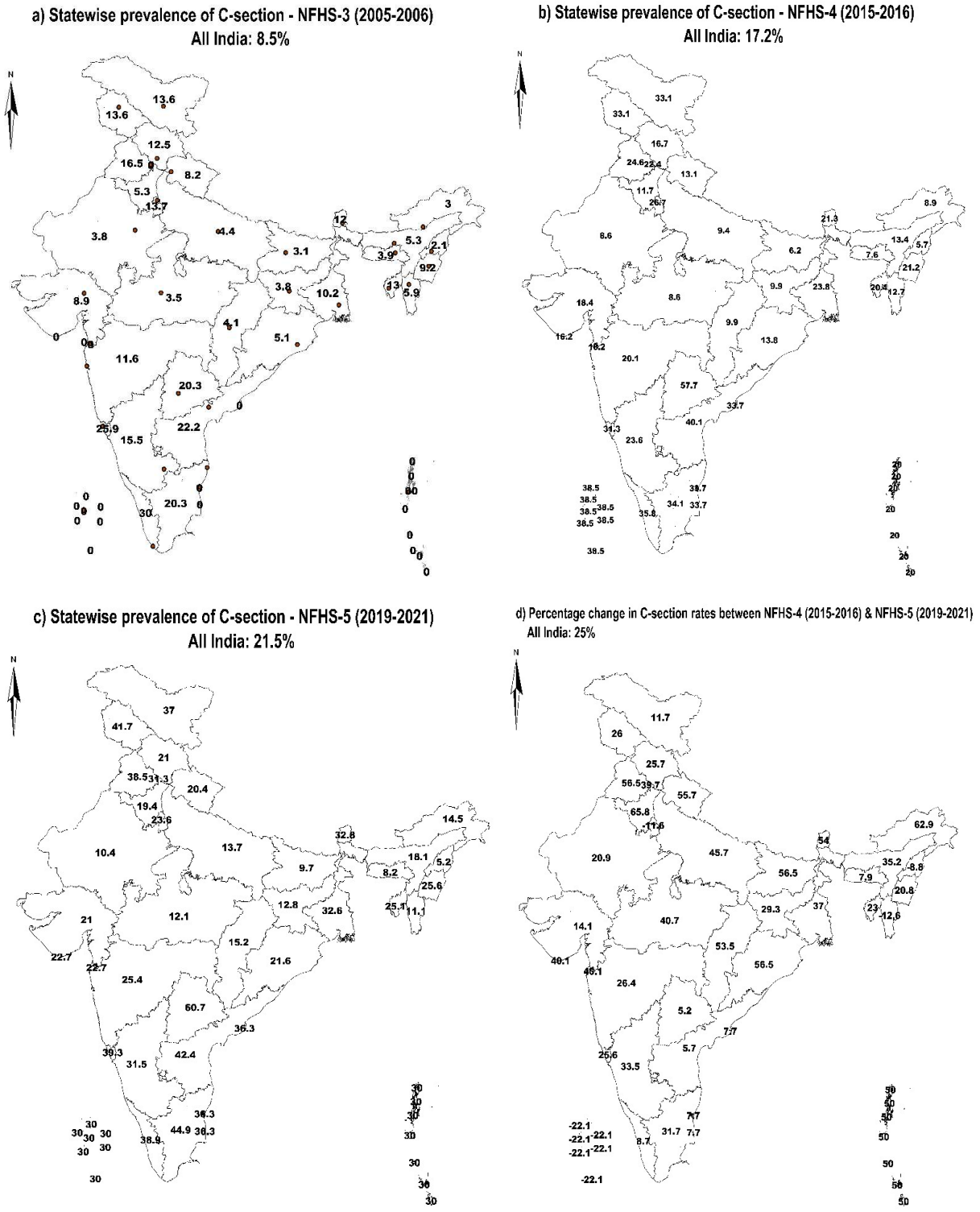

Figure 2: Prevalence of C-Section deliveries across the states of India (NFHS-3, NFHS-4 and NFHS-5)

Mothers with high blood pressure, birth order of one, six or more antenatal visits, a history of previous abortions, and those who have ever had a terminated pregnancy tend to have higher rates of C-section deliveries in both Northeastern states and the rest of India.

Table 3 displays the outcomes of multivariate logistic regression model. According to the result of analysis, mothers with 2 to 3+ birth orders experience a reduction in the rate of C-section deliveries ranging from 26% to 76% as compared to those with a birth order of one in both the groups of states.

At the same time, in both the Northeast and other parts of India, overweight and normal BMI mothers demonstrate a higher rate of C-section deliveries compared to underweight BMI mothers. Mothers who had antenatal visits exhibited higher rates of C-section deliveries compared to those who did not have any antenatal visits, both in the Northeast and the rest of India. Additionally, a history of terminated pregnancies is associated with a higher likelihood of C-section deliveries in both the state.

Discussion

Socio-demography risk factors: The percentage of C-section deliveries is unacceptably high in private institutions. In private hospitals, the rate of C-sections is significantly higher, with 47.7% in the Northeast and 32.8% in the rest of the states, compared to public hospitals/institutions. Table 3 displays the logistic regression analysis results in which odds ratios (OR) and their 95% confidence intervals are estimated. Mothers in the higher age group (35+ years) have a greater likelihood of C-section deliveries compared to those in lower age categories. The older age groups (35+ and 26–35 years) show an increasing trend in C-sections over time, which is more pronounced in both the Northeast and the other states of India. A similar pattern was observed in Boston, Massachusetts where the risk of C-section deliveries rose consistently with age, from 11.6% for women under 25 years old to 43.1% for women aged 40 years or older.[19]

A low probability of C-section was also associated with the place of residence in other states of India, particularly among women living in rural areas. Similarly, C-section deliveries were more common in urban areas than in rural areas of Bangladesh.[20] Across all wealth categories, richer women have higher chances of undergoing C-sections, indicating a greater likelihood of C-section deliveries. Similarly, women with higher levels of education are more likely to have C-sections, particularly in the Northeast. Additionally, our model confirms that possession of higher level of wealth and education are instrumental in increasing the of C-section deliveries. A similar pattern was observed in Oman, where women with high family income were at greater risk of undergoing C-sections deliveries compared to those with lower family income.[21] Likewise, in Iran, similar findings revealed that older maternal age, higher levels of education, higher socioeconomic status, and hospitalization in private hospitals result in an increased rate of C-sections deliveries.[22]

Religious difference also plays a pivotal role in determining the mode of child birth. In Northeast, Christian women have significantly lower risk of C-section whereas Muslim and Christian women from other states of India have a higher risk. In the southern part of India, Karnataka, Christian women had the highest C-section rate at 44.8%, followed by Hindus (31.6%) and Muslims (28.3%).[18] Figure 1 shows that C-sections were more common in private hospitals than in public hospitals. In public hospitals, the highest odds ratios for C-sections deliveries were observed among women aged 30 years and above compared to those aged 25 years and below. However, it was also found that women facing delivery-related complications (such as a woman who had a previous C-section, pregnancy-induced leg swelling, or prolonged labour) admitted in public hospitals had a higher risk of undergoing a C-section than those who delivered in private hospitals.[23]

Medical risk factors: Our model shows that high blood pressure is an important risk factor, with increased odds for C-sections. In particular, the odds ratio (OR) of high blood pressure is 1.74 in the Northeast and 1.152 in other states of India, indicating a considerable increase in probability. High blood pressure (hypertension) during pregnancy is a key medical reason for performing a C-section, especially when it leads to complications that endanger the mother or baby. Studies show that 60% to 80% of women with severe preeclampsia or eclampsia undergo delivery by C-section to prevent maternal and fetal complications.[24,25] Birth order significantly influences whether a C-section would happen or not. Women with two births have lower odds (OR: 0.737 in the Northeast, OR =0.764 for other states).

The possibility of C-section delivery of a baby is also affected by birth weight. Other regions have slightly higher chances (OR 1.923) for C-sections associated with babies who weigh over 2.5 kg, although this does not significantly affect the odds ratios in Northeastern states. Likewise, in Oman, fetuses weighing less than 2.5 kg or more than 4 kg were more likely to be delivered via C-section compared to those with a normal neonatal birth weight.[21] Another important factor is birth size. Greater than average, birth size slightly raises the odds (OR 1.062) of C-section in other states. Weight problems or obesity of the expecting mother play a vital role where BMI becomes crucial; consequently, overweight women exhibit higher odds (OR 3.371 vs OR 3.47). C-sections are more likely to occur among overweight women. Women with a higher BMI are more likely to experience complications such as gestational diabetes, which can necessitate surgical delivery.[21]

In other states, vaginal bleeding during pregnancy results in higher chances (OR =1.15) of receiving C-

section surgery. Prolonged labour is associated with a decreased likelihood of C-sections in other states, with odds (OR 0.84) significantly lower than those without prolonged labour. Pregnancy complications are another significant factor. In other states, complications increase the odds (OR 1.14) of C-sections.

The number of antenatal visits also plays a crucial role. Women with 1-5 antenatal visits have significantly higher odds (OR 2.389 in the Northeast and 1.74 in other states) of C-sections. A history of abortion or terminated pregnancy also affects the likelihood of C-sections. The history of terminated pregnancy increases the odds (OR 1.91 in the Northeast and 1.579 in other states). Conversely, in other states, the history of abortion reduces the odds (OR 0.731). Likewise, the study reported that women with an induced abortion in their first pregnancy faced higher maternal and perinatal risks compared to those with a previous live birth.[26]

Conclusion

Trend analysis reveals a consistent rise in C-section delivery rates across both Northeast states and other regions of India over the past five years, though with notable regional variations. Socio-economic factors such as higher wealth and education are associated with increased odds of C-sections across all regions, while women in rural areas have lower odds compared to their urban counterparts, highlighting the urban–rural disparity. The analysis identifies high blood pressure as a significant risk factor for C-sections in both the Northeast and other states, with increased odds ratio indicating a higher likelihood of C-section deliveries. The study calls for increasing awareness about clinical and public health measures that can help prevent risk factors associated with a higher likelihood of C-section, such as maintaining a normal BMI and preventing high blood pressure. Antenatal care programs should be enhanced to provide comprehensive education and counseling to pregnant women, including information about the benefits and risks of different delivery methods. This helps women make informed choices and encourages normal delivery in first pregnancies to avoid repeat C-sections. This will prioritize maternal health and ensure better outcomes for mothers and newborns nationwide.

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