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Exploring the factors influencing repeated C-section deliveries in India: insights from the National Family Health Survey 2019–21

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Abstract

Background "Once a Caesarean, always a Caesarean," according to the World Health Organisation (WHO), a caesarean section is a surgical procedure that can save the life of a woman and her baby when undertaken for medical reasons. With this backdrop, the goal of this study is to identify the prevalence of repeated C-section deliveries and the factors related to increased C-section deliveries by type of institution.

Methods This study used a nationally representative sample from the fifth round of the National Family Health Survey (2019–21). The study includes 5965 respondents who had a repeated C-sections among the 7760 births. Univariate and bivariate analysis was performed for the level of repeated C-sections, and binary logistic regression was performed to determine the influencing factors of caesarean deliveries.

Results The 78% birth delivered by the repeated C-section, where 79% in private hospitals followed by 76 in public health care facilities. Sikkim and Telangana have the highest level of repeated C-sections, whereas Meghalaya, Ladakh, and Assam have the lowest repeated C-sections deliveries. For public facilities, Kerala has the highest and Bihar has the lowest level of repeated C-section deliveries; Sikkim, Goa, and Telangana have the highest, and Meghalaya. The regression results show that mothers age greater than 35 years were [AOR = 1.918, 95% CI (1.076 3.42)], the wealthiest women had the highest odds [AOR = 1.775, 95% CI (1.397 2.256)], women who had undergone ultrasonography were significantly [AOR = 1.469, 95% CI (1.16 1.861)], were more likely to be delivered by repeat C-section than their counterpart.

Conclusions The findings of this study suggest that repeated C-section deliveries in India have been significantly decreased in India, and private facilities play a significant role in repeated C-sections as compared to public facilities of delivery. The study recommended that the doctors prioritize normal delivery procedures at the first stage and then only control repeated C-section delivery.

Keywords Repeat c-section, Delivery type, Delivery facilities, India

1 Introduction

A caesarean delivery (C-section) is a surgical procedure that can save the life of a woman and her baby when undertaken for medical reasons [1]. According to the World Health Organisation (WHO), a caesarean section is a surgical procedure that can save the life of a woman and her baby when undertaken for medical reasons [2]. Thus, it has been recommended to undergo C-section delivery only in complicated pregnancies [3]. C-section is one of the most commonly performed surgical procedures in obstetrics and is undoubtedly one of the oldest operations in surgery. One of the most dramatic features of modern obstetrics is the increase in the C-section rate [4]. Based on previous literature we observed that both primary and repeated C-section delivery rates have been reported to be increasing in developed as well as developing countries. The reasons for the increase are multifaceted. Foetal distress, especially detected by continuous electronic foetal monitoring, more liberal use of C-section for breech presentation, abdominal delivery of growth-retarded infant, delayed childbearing, increasing maternal body mass, multiple gestations, prematurity, and improved safety of C-section are commonly cited causes [5]. Edwin Cragin's (1916) century-old opinion, "once a Caesarean, always a Caesarean," is correct and present research shows that the growing number of caesarean sections leads to a higher number of repeat caesarean sections [6]. The main concern regarding vaginal delivery after a previous caesarean section is the greater risk of uterine rupture during labour and delivery [7]. The proportion of C-sections in the first and subsequent delivery is relatively high [8]. Women who attended perinatal medical visits more than ten times had a higher chance of repeating C-section delivery compared to those who had a lesser number of visits, since more visits help to identify the early complication and have the C-section [9]. According to a cross-sectional study, variables influencing a repeat caesarean surgery included the baby's life being in danger, a history of previous caesarean sections, and awareness of the technique. Additionally, age and parity were vital considerations when deciding whether to have an elective C-section [10].

C-section is a globally accepted life-saving surgical technique to deal with pregnancy complications and reduce maternal and neonatal mortality and morbidity. However, excessive use of C-section deliveries is becoming a new normal in many developing countries. A recent global prevalence of C-section delivery consisting of 169 countries was estimated to be 21.1%, which substantially exceeds the WHO limit of 10–15% of all births [11].

A favourable correlation between private healthcare facilities and C-section delivery has been reported in previous studies [12]. The socioeconomic status of the women and the type of healthcare facilities admitted for delivery were important contributors to the use of C-section delivery [13]. In fact Neuman et al., Singh et al. [14, 15] reported that women with higher socioeconomic status and admitted to private healthcare facilities are more likely to give birth via C-section than women of lower socioeconomic status. The difference in the prevalence of C-section delivery between public and private healthcare facilities was also higher among women with lower levels of education and socioeconomic status [16]. Additionally, Divyamol, Raphael and Koshy [17] reported multiparity, having more than three ultrasonograms, and higher employment status of women also significantly influence the use of C-section delivery. With this backdrop, the

goal of this study is to identify the prevalence of repeated C-section deliveries and the factors related to increased C-section deliveries by type of institution.

2 Methods

Data from the fifth round of the National Family Health Survey (NFHS-5) has been used for the study. NFHS-5 is a nationally representative survey conducted in 2019–21 across all 36 states and union territories of India providing enormous information on demographic, health, and social indicators. NFHS-5 included 636,699 households and interviewed 724,115 women aged 15–49 adopting a two-stage stratified sampling procedure. Detailed information on the sampling procedure used in NFHS-5 can be found elsewhere in IIPS & ICF (International Institute for Population Sciences (IIPS) and ICF 2021).

NFHS-5 collects detailed information from women aged 15–49 years about all the deliveries that they have had in the five years preceding the survey, including the delivery assistance, place of delivery, whether the delivery was a C-section, if the delivery was conducted through a C-section when the decision was made to have the C-section, and so on. This information was used to study the repeated deliveries through C-sections in India. Of the 724,115 women, 176,843 women had delivered in the five years preceding the survey, and from these, 50,252 had two deliveries. Of the women who had two deliveries, 7760 women opted for C-section delivery in their first childbirth. Therefore, 7760 women were included in the study.

2.1 Variable description

2.1.1 Dependent variable

Repeated C-section is the dependent variable, which is binary in nature. A woman who opted for C-section delivery in her index child birth as well as in her previous child birth are defined as having repeated C-section delivery.

2.1.2 Independent variable

A set of background characteristics has been considered to find out how prevalence varies across the background characteristics. These are the age of women at first birth, children ever born, body mass index, interval between subsequent delivery, educational level, exposure to mass media, caste, religion, wealth index, place of residence, and region. An independent variable in this study is categorized into five factors: demographic, socioeconomic, institutional, children, and maternal factors. Mothers' age at childbirth, babies' gender, and religion are the demographic factors. The socio-economic factors include maternal education, place of residence, caste, and wealth status. Financial assistance for delivery, antenatal care more than four times, and ultrasound tests are the institutional factors. Children's birth order, baby birth size, and baby birth weight are the children's factors, and women's BMI and miscarriage, abortion, or stillbirth are the maternal factors.

2.2 Statistical analysis

Both bivariate and multivariate analyses have been used to determine the factors responsible for subsequent delivery through the C section in India. The Univariate and bivariate analysis has been performed for the level of repeated C-sections overall and by the

delivery facility in India and its states. Binary logistic regression was performed to determine the influencing factors of caesarean deliveries.

A binary logistic regression model can be written as follows:

$$Logit\ (pi) = ln\left(\frac{pi}{1-pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k$$

Where β_0 is the intercept, $\beta_1, \beta_2, \ldots\ldots\ldots\ldots, \beta_k$ are the regression coefficients indicating the relative effect of a particular explanatory variable on the outcome, $x_1, x_2, \ldots\ldots\ldots\ldots, x_k$, are the control variables (Ryan 2008). The statistical package STATA for Windows version 16.1 (StataCorp 2015) was used for all statistical analyses. The proper individual-level sampling weights were used to make the results representative.

3 Results

Figure 1 shows the percentage of repeated C-section delivery from 2015 to 16 to 2019–21. The research reveals that repeated C-section delivery reported 77.6% in 2019–21 followed by 88.1% in 2015–16. Over the time observed slightly declining in repeated C-section delivery.

3.1 State-specific repeated C-section deliveries percentage in India, overall, and the type of delivery facility

Table 1 shows India's state-specific repeated C-section percentage (2019–21) overall and by the delivery facility type. The results suggest that among the bigger states, Telangana (89%), Kerala (88%), and Tamil Nadu (85%) have the higher level of repeated C-sections, whereas Assam (64%), Rajasthan (about 69%) and Odisha (about 71%) have the lower level of repeated C-sections. Additionally, in the case of smaller states/UTs, Sikkim (95%) and Chandigarh (90%) have a higher level of repeated C-sections, whereas Meghalaya (about 51%) and Ladakh (53%) have a lower level of repeated C-section.

Regarding the type of delivery facilities, among the bigger states, Kerala (94%) and Telangana (88%) have a higher proportion of delivery performed in the public facilities,

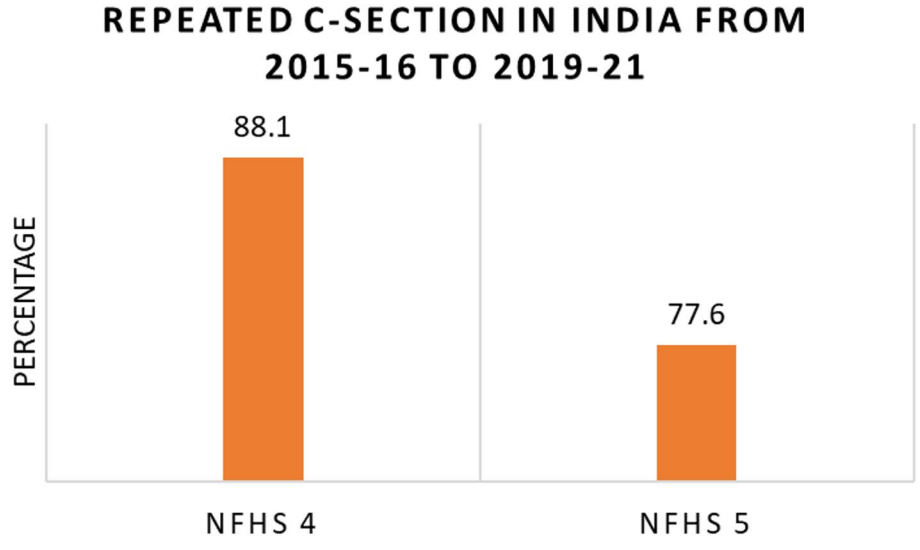

Fig. 1 Change of repeated C-section delivery from 2015–21

Table 1 State-specific repeated C-section percentage in India 2019–2021, overall and by the type of delivery facility

State	Overall			Public			Private		
	Total births	Repeated C-section *N*	%	Total births	Repeated C-section *N*	%	Total births	Repeated C-section *N*	%
Andaman & Nicobar	12	7	77.8	11	7	90.5	1	0	0.0
Andhra Pradesh	289	243	84.8	105	85	81.3	184	158	86.9
Arunachal Pradesh	123	77	62.0	104	65	62.5	19	12	59.2
Assam	142	85	64.3	97	55	60.1	45	30	73.8
Bihar	494	362	70.5	97	63	58.7	397	299	73.3
Chandigarh	9	8	89.7			100.0	3	2	68.7
Chhattisgarh	185	128	73.0	82	57	73.5	103	71	72.6
Dadra & Nagar Haveli	33	29	84.3	21	19	88.8	12	10	78.1
Delhi	94	70	73.7	50	34	68.3	44	36	79.9
Goa	19	15	77.1	8	5	58.3	11	10	94.0
Gujarat	295	214	74.7	99	67	73.5	196	147	75.3
Haryana	219	168	76.7	87	65	73.0	132	103	79.1
Himachal Pradesh	68	51	78.3	48	36	78.2	20	15	78.5
Jammu & Kashmir	334	261	77.3	298	230	76.8	36	31	80.5
Jharkhand	215	162	77.6	65	45	71.1	150	117	80.3
Karnataka	499	392	78.3	253	199	77.9	246	193	78.6
Kerala	139	122	88.4	46	43	94.4	93	79	85.1
Ladakh	26	14	53.2	26	14	53.2	*	*	*
Lakshadweep	9	6	69.3	3	2	65.8	6	4	71.1
Madhya Pradesh	353	271	78.5	213	157	75.0	140	114	83.0
Maharashtra	375	282	73.4	211	148	65.8	164	134	80.8
Manipur	83	56	66.2	48	30	56.0	35	26	82.2
Meghalaya	105	51	50.6	59	33	63.6	46	18	36.9
Mizoram	44	26	61.1	31	16	51.8	13	10	86.5
Nagaland	15	11	59.7	8	6	49.6	7	5	74.5
Odisha	168	120	70.8	105	75	71.8	63	45	69.4
Puducherry	68	57	83.5	41	34	88.1	27	23	70.7
Punjab	321	263	81.3	174	143	79.6	147	120	83.3
Rajasthan	287	195	68.7	165	115	70.4	122	80	66.5
Sikkim	10	9	94.9	7	6	91.8	3	3	100.0
Tamil Nadu	499	429	85.2	288	243	82.8	211	186	88.5
Telangana	1080	951	89.2	512	448	88.0	568	503	90.1
Tripura	23	17	73.5	18	13	71.0	5	4	87.4
Uttar Pradesh	880	631	72.1	225	158	71.5	655	473	72.3
Uttarakhand	110	88	75.8	53	44	85.6	57	44	69.4
West Bengal	135	94	72.7	82	54	70.9	53	40	75.1
India	**7760**	**5,965**	**77.6**	**3,746**	**2,820**	**75.7**	**4,014**	**3,145**	**79.0**

whereas Bihar (59%) and Assam (60%) have the lower level of proportion of delivery performed in the public facilities. After that, in the case of smaller states/UTs, Chandigarh (100%) and Sikkim (92%) have a higher proportion of delivery performed in public facilities, whereas Nagaland (50%) and Mizoram (52%) have a lower proportion of delivery performed in public facilities. Regarding repeated C-sections performed in private facilities, among the bigger states, Telangana (90%) and Tamil Nadu (89%) have a higher proportion of delivery performed in private facilities, whereas Rajasthan (66.5%), Uttarakhand (69%) and Odisha (69%) have the lower level of the proportion of delivery performed in the private facilities. After that, in the case of smaller states/UTs, Sikkim

(100%) and Goa (94%) have a higher proportion of delivery performed in private facilities, whereas Meghalaya (37%) and Arunachal Pradesh (59%) have a lower proportion of delivery performed in private facilities.

3.2 Profile of repeated C-section deliveries with socio-demographic characteristics of the Indian women, overall and by the type of delivery facility

Table 2 indicates the percentage distribution of Indian women according to their characteristics and repeated C-section deliveries according to overall and the type of delivery facility. Results show that about 78% (5965 births) of births are delivered by repeated C-sections in India, and approximately 76% and 79% of birth deliveries have been delivered in public and private facilities, respectively. The results show that women aged 25–34 have the highest percentage (78%) of repeated C-sections. According to the gender of the born children, 79% of female children delivered the repeated C-section, and 76% of male children delivered the repeated C-section. In addition, 77% of female and 75% of male children were delivered in public facilities, and about 81% of female and 78% of male children were delivered in private facilities. For total births, women of other religions had the highest percentage (86%) of repeat C-deliveries, followed by about 78% of births delivered by Hindu women as repeated C-sections. A similar pattern was found for delivery facilities. Most births were delivered in public and private facilities; about 76% of repeat C-sections were performed in a public facility, and 79% were performed in a private facility by Hindu women.

Regarding maternal education, 86% of births are delivered by repeated C-sections among women with higher education. In addition, the results show a positive association between repeated C-sections and education. It has been shown that as women's education increased, repeated C-sections also increased. The same pattern of repeated C-sections has been found for women whose delivery has been performed at public or private facilities. Urban women (about 81%) have higher repeated C-sections than rural women (76%), and those women whose delivery performed at private facilities and belonged to urban areas have a higher (82.5%) repeated C-sections than women whose delivery has performed at public facilities (77.5%) or belonged to rural area (77%). In the case of caste, women belonging to scheduled tribes have a lower level (69%) of repeated C-sections whether their delivery has been performed at the public (67%) or private (71.5%) facility rather than other castes. Afterward, the poorest wealth status women have a lower level (64%) of repeated C-sections whether their delivery has been performed at a public (64%) or private (about 65%) facility rather than women from another wealth status. Now, in the case of institutional factors, the results show that those women who did not get financial assistance for delivery have a slightly higher level (77.8%) of C-section delivery than those women (76.8%) who get financial assistance for delivery and the same results have been found for the women whose delivery has been performed at a private facility, in contrast, those women's delivery has been performed at the public facility and get financial assistance for delivery have a higher level (77%) of C-section than those women (74.6%)who did not get financial assistance for the delivery. An interesting result has been found that those women who visited more than four times for their antenatal care have a higher level (78.6%) of repeated C-sections whether their delivery has been performed at the public (77.4%) or private (79.6%) facility than those women who did not visit more than four times for antenatal care. Additionally, the same pattern of

Table 2 Individual characteristics and repeated C-section deliveries percentage for Indian women in the NFHS-5 (2019–2021), overall and by the type of delivery facility

Variable	Overall			Public			Private		
	Total births	Repeated C-section *N*	%	Total births	Repeated C-section *N*	%	Total births	Repeated C-section *N*	%
India	7760	5965	77.6	3746	2820	75.7	4,014	3145	79.0
Demographic factors									
Mother's age at childbirth (years)									
15–19	72	51	70.4	40	31	73.8	32	20	65.7
20–24	2268	1736	76.2	1188	896	74.9	1080	840	77.4
25–34	4925	3798	78.4	2278	1709	76.3	2647	2089	79.9
35–49	495	380	76.7	240	184	73.9	255	196	78.3
Baby gender									
Male	4181	3170	76.4	1956	1462	74.5	2225	1708	77.8
Female	3579	2795	79.0	1790	1358	77.1	1789	1437	80.5
Religion									
Hindu	5704	4421	77.6	2629	2004	75.7	3075	2417	79.1
Muslim	1272	961	74.4	657	483	72.1	615	478	76.0
Other	784	583	85.7	460	333	85.1	324	250	86.3
Socioeconomic factors									
Maternal education									
No education	848	557	62.6	477	312	60.3	371	245	64.6
Primary	694	468	65.0	392	266	64.0	302	202	66.2
Secondary	4458	3445	78.5	2344	1800	78.6	2114	1645	78.4
Higher	1760	1495	86.2	533	442	83.1	1227	1053	87.3
Type of residence									
Urban	2255	1815	80.5	964	760	77.5	1291	1055	82.5
Rural	5505	4150	76.0	2782	2060	74.8	2723	2090	76.9
Caste									
Scheduled caste	1612	1220	75.7	901	692	76.5	711	528	74.9
Scheduled tribe	847	552	68.9	544	349	66.8	303	203	71.5
Other backward class	3450	2692	78.6	1456	1122	77.1	1994	1570	79.6
Others	1851	1501	79.1	845	657	74.9	1006	844	81.8
Wealth level									
Poorest	797	489	64.1	468	281	63.6	329	208	64.7
Poorer	1425	1008	71.9	832	584	71.1	593	424	72.8
Middle	1899	1486	76.9	1028	806	76.6	871	680	77.2
Richer	1995	1596	80.0	902	718	79.5	1093	878	80.3
Richest	1644	1386	84.7	516	431	82.8	1128	955	85.4
Institutional factors									
Financial assistance for delivery									
No	5895	4564	77.8	2199	1650	74.6	3696	2914	79.3
Yes	1865	1401	76.8	1547	1170	77.3	318	231	74.9
Antenatal care more than 4 times									
No	2582	1903	75.4	1186	841	71.9	1396	1062	77.8
Yes	5178	4062	78.6	2560	1979	77.4	2618	2083	79.6
Ultrasound test									
No	363	217	65.5	187	108	61.3	176	109	68.7
Yes	7397	5748	78.1	3559	2712	76.3	3838	3036	79.4
Children factors									
Baby birth order									
Second	5640	4563	81.8	2752	2193	80.8	2888	2370	82.7
Third	1526	1092	72.0	717	484	64.8	809	608	76.7
Four or more	594	310	47.4	277	143	45.7	317	167	48.7

Table 2 (continued)

Variable	Overall			Public			Private		
	Total births	Repeated C-section *N*	%	Total births	Repeated C-section *N*	%	Total births	Repeated C-section *N*	%
Baby birth size									
Very large	595	423	71.0	326	233	74.0	269	190	68.1
Larger than average	935	715	78.1	468	354	77.5	467	361	78.6
Average	5313	4102	77.6	2556	1935	75.5	2757	2167	79.3
Smaller than average	659	542	83.9	287	223	79.1	372	319	87.0
Very small	258	183	71.7	109	75	69.4	149	108	73.3
Maternal factors									
BMI (kg/m)									
< 16.00	174	138	80.1	87	68	77.2	87	70	82.8
16.01–18.49	884	659	76.6	461	342	75.6	423	317	77.5
18.50–24.99.50.99	4279	3215	75.2	2159	1590	73.6	2120	1625	76.5
25.01–29.99	1550	1236	80.7	707	557	79.6	843	679	81.5
≥ 30.00	873	717	83.0	332	263	79.9	541	454	84.6
Miscarriage, abortion or stillbirth									
No	6868	5262	77.3	3361	2527	75.7	3507	2735	78.6
Yes	892	703	79.5	385	293	75.8	507	410	81.8
Pregnancy complication									
No	2615	2024	77.8	1258	956	74.59	1357	1068	80.2
Yes	5145	3941	77.5	2488	1864	76.28	2657	2077	78.4

results has been found for the women who go out for their Ultrasound test, and it means those women who go for ultrasound test have been found to have a higher level (78%) of repeated C-sections whether their delivery has been performed at the public or private facility than those women who did not go for an ultrasound test.

In the case of children factors, second-birth order women have a higher level (81.8%) of repeated C-sections whether their delivery has been performed at a public (80.8%) or private (82.7%) facility than other birth order women. Mothers whose children's birth sizes were smaller than average have the highest level (84%) of repeated C-sections than mothers with other birth sizes of children and also the same results have been found for those women whose delivery has been performed at the public (79%) or private (87%) facility. Furthermore, for the maternal factors, women with a BMI greater than 30 kg/m^2, women who experienced miscarriage, abortion, or stillbirth, and women with a weight more than 55 kg have a higher level of repeated C-sections whether their delivery has been performed at the public or private facility.

3.3 Association of the repeated caesarean deliveries with socio-demographic characteristics

Table 3 shows the odds ratio of repeated C-section deliveries with selected background characteristics in India. The odds ratio highly significant found with mothers aged 35–49 years [AOR = 1.918, 95% CI (1.076 3.42)] were more likely to have a repeat C-section than mothers whose age at delivery was 15–19 years, similar findings observed in the private hospital that women age 35–49 years [2.172 (0.952 4.956)] were more likely to have a repeated C-section delivery. Subsequently, those born females were found to be [AOR = 1.236, 95% CI (0.952 4.956)] more likely to have had a repeat C-section than those born males in private health care facility. Regarding maternal education, mothers

Table 3 Logistic regression odds ratio of repeated C-section by selected background characteristics in India (2019–2021)

Background characteristics	Repeated C-section	Public	Private
	Adjusted OR (95% CI)		
Demographic factors			
Mother's age at childbirth (years)			
15–19®			
20–24	1.293 (0.761 2.197)	0.883 (0.407 1.913)	1.922*(0.901 4.099)
25–34	1.462 (0.861 2.483)	1.062 (0.491 2.299)	2.088*(0.98 4.447)
35–49	1.918**(1.076 3.42)	1.777 (0.766 4.123)	2.172*(0.952 4.956)
Baby gender			
Male®			
Female	1.117*(1 1.248)	1.032 (0.884 1.206)	1.236***(1.054 1.451)
Religion			
Hindu®			
Muslim	0.931 (0.795 1.091)	0.888 (0.708 1.115)	0.977 (0.779 1.227)
Other	1.071 (0.876 1.31)	1.055 (0.81 1.374)	1.093 (0.797 1.499)
Socioeconomic factors			
Maternal education			
No education®			
Primary	0.933 (0.746 1.167)	0.96 (0.712 1.294)	0.92 (0.654 1.295)
Secondary	1.159 (0.972 1.381)	1.14 (0.901 1.442)	1.204 (0.921 1.575)
Higher	1.464***(1.171 1.831)	1.225 (0.88 1.707)	1.72***(1.252 2.363)
Type of residence			
Urban®			
Rural	1.024 (0.891 1.176)	0.996 (0.816 1.216)	1.055 (0.867 1.283)
Caste			
Scheduled caste®			
Scheduled tribe	0.686***(0.562 0.837)	0.665***(0.514 0.862)	0.692**(0.503 0.952)
Other backward class	1.06 (0.914 1.23)	0.985 (0.799 1.214)	1.15 (0.928 1.425)
Others	1.198**(1.001 1.433)	1.031 (0.799 1.33)	1.42***(1.097 1.838)
Wealth Index			
Poorest®			
Poorer	1.253**(1.033 1.519)	1.274*(0.991 1.638)	1.254 (0.923 1.703)
Middle	1.614***(1.327 1.962)	1.779***(1.372 2.307)	1.448**(1.07 1.959)
Richer	1.565***(1.273 1.925)	1.717***(1.293 2.28)	1.433**(1.05 1.954)
Richest	1.775***(1.397 2.256)	2.061***(1.452 2.925)	1.554**(1.1 2.196)
Institutional factors			
Financial assistance for delivery			
No®			
Yes	0.88*(0.774 1.001)	0.976 (0.832 1.145)	0.632***(0.482 0.83)
Antenatal care more than 4 times			
No®			
Yes	1.09 (0.97 1.225)	1.186**(1.005 1.399)	1.013 (0.858 1.198)
Ultrasound test			
No®			
Yes	1.469***(1.16 1.861)	1.457**(1.051 2.02)	1.501**(1.062 2.123)
Children factors			
Baby birth order			
Second®			
Third	0.623***(0.543 0.716)	0.541***(0.445 0.659)	0.723***(0.593 0.882)
Four or more	0.307***(0.252 0.374)	0.301***(0.226 0.402)	0.303***(0.23 0.399)
Baby birth size			
Very large®			
Larger than average	1.377**(1.081 1.754)	1.296 (0.927 1.813)	1.501**(1.053 2.139)

Table 3 (continued)

Background characteristics	Repeated C-section	Public	Private
	Adjusted OR (95% CI)		
Average	1.348***(1.107 1.64)	1.189 (0.908 1.558)	1.559***(1.167 2.083)
Smaller than average	1.911***(1.449 2.519)	1.373 (0.936 2.014)	2.691***(1.792 4.04)
Very small	1.075 (0.768 1.505)	0.945 (0.576 1.551)	1.251 (0.784 1.996)
Maternal factors			
BMI (kg/m)			
< 16.0®			
16.0–18.4.0.4	0.812 (0.539 1.222)	0.947 (0.538 1.665)	0.695 (0.382 1.266)
18.5–24.9	0.763 (0.519 1.122)	0.849 (0.499 1.443)	0.679 (0.386 1.194)
25.0–29.9.0.9	0.881 (0.59 1.316)	0.997 (0.573 1.737)	0.773 (0.43 1.388)
≥ 30	0.983 (0.645 1.497)	0.971 (0.537 1.756)	0.971 (0.529 1.781)
Miscarriage, abortion or stillbirth			
No®			
Yes	1.009 (0.846 1.203)	0.889 (0.688 1.149)	1.142 (0.893 1.46)
Pregnancy complication			
No®			
Yes	0.986 (0.877 1.108)	0.953 (0.807 1.124)	1.015 (0.859 1.198)
Constant	0.975 (0.463 2.051)	1.469 (0.512 4.212)	0.574 (0.195 1.691)

®: Reference category; ***p-value < 0.01; **p-value < 0.05; level of significant respectively

with higher education were significantly [AOR = 1.464, 95% CI (1.171 1.831)] more likely to have to repeat C-sections than mothers without education. In addition, women from scheduled tribes and other castes had a significant association with repeat C-section deliveries. Women who belonged to a scheduled tribe were [AOR = 0.686, 95% CI (0.562 0.837)] less likely to have a repeat C-section than women who belonged to a scheduled caste, and women who belonged to the others category were more likely to have a repeat C-section [AOR = 1.253, 95% CI (1.033 1.519)] than women who belonged to scheduled casts. Wealth status showed a significant positive association with repeated C-section delivery; the wealthiest women had the highest odds [AOR = 1.775, 95% CI (1.397 2.256)] of repeated C-section delivery than the poorest women. Financial support at delivery showed a significant association, and women who received financial support at delivery had a lower likelihood of repeated C-sections [AOR = 0.88, 95% CI (0.774 1.001)] than women who did not receive financial support at delivery. Women who had undergone ultrasonography were significantly [AOR = 1.469, 95% CI (1.16 1.861)] more likely to have a repeat C-section than those who had not. Subsequently, children with third and fourth birth order were significantly [AOR = 0.623, 95% CI (0.543 0.716)] and [AOR = 0.307, 95% CI (0.252 0.374)] less likely to have been born by repeat C-section, respectively. Infant birth size showed a significant association with repeated C-section deliveries; among all categories of infant birth size, infant size smaller than average showed a highly significant association, indicating that babies smaller than average [AOR = 1.911, 95% CI (1.449 2.519)] were more likely to be delivered by repeat C-section. Similarly, for the private hospital baby's size smaller than average are significantly [AOR = 2.691, 95% CI (1.792 4.04)] more likely to have a repeat C-section than the baby size very large.

4 Discussion

This study explored the factors that influence repeated C-section deliveries in India. This study considers both the timing of C-section like before the onset of labor pain and after the onset of labour pain. The results of this study suggest that more than three-fourths

(78%) of births were delivered by repeated C-section, and 76 and 79% of birth deliveries have been delivered in public and private facilities. Earlier study conducted by the Sengupta found the odds of cesarean section delivery higher in private institutions compared to public hospitals [18]. The percentage of repeated C-section delivery has dropped during the last two rounds of demographic health survey in India. The southern states of Telangana, Kerala, and Tamil Nadu reported the highest repeated C-section delivery rates among the states. Similar findings were found in a previous study conducted by Sahoo, the southern state having higher repeated C-section delivery [19]. When we see the health facility-wise proportion of repeated C-section deliveries, private hospitals reported a higher proportion of C-section deliveries. Private hospitals are the driving factors that increase repeated C-section delivery findings from previous studies [20].

In the smaller state and union territories, Sikkim and Goa reported a higher proportion of repeated C-section deliveries in private hospitals. There are various demographic and socio-economic determinants of repeated C-section deliveries in India. Women aged 25–34 at the time of delivery reported the highest incidence of repeated C-section deliveries. A recent study by Singh further reveals that a mother's age at childbirth plays a significant role in the likelihood of opting for a voluntary C-section [18, 21]. Furthermore, almost four-fifths of repeated C-sections were reported among women with no religion. As the women's education increased, the proportion of repeated C-section deliveries increased, and similar results were found, with the women living in the urban areas also reporting higher repeated C-section deliveries. C-section deliveries are performed more in private hospitals among educated mothers and women living in urban areas [16]. Women belonging to lower socio-economic class and poorest households are less likely to have repeated C-section delivery compared to those in the upper socio-economic class and the richest households. Previous research reveals that C-section delivery increases the number of women belonging to higher socio-economic classes [22]. The women who opted for ultrasound tests and antenatal care services during the pregnancy reported higher repeated C-section delivery compared to women who didn't undergo ultrasound tests and less antenatal care visits. The second-birth order child reported a higher percentage of repeated C-section delivery at private hospitals; on the other side, children on the third and fourth orders were less likely to have a repeated C-section delivery. Sarkar reveals that the likelihood of performing C-section delivery is lower for the first birth order [23]. Socio-economic factors indicate that women receiving financial assistance for delivery reported a higher incidence of repeated C-sections compared to normal deliveries. Financial support provided through various schemes has contributed to an increase in institutional deliveries and, consequently, surgical procedures such as C-sections.

5 Conclusion

The findings of this study suggest that the prevalence of repeated C-section deliveries in India has significantly declined. However, private healthcare facilities continue to play a greater role in repeated C-sections compared to public facilities. Considerable state-level differences were observed, with smaller states showing a higher proportion of repeated C-section deliveries. Major determinants associated with repeated C-sections

include maternal age, mother's education, urban residence, household wealth, financial assistance for delivery, regular antenatal check-ups, and the use of ultrasound tests.

Since this study relies solely on secondary data, it was not possible to explore the underlying reasons for repeated C-section deliveries. Therefore, future research should focus on regions with higher rates of repeated C-sections and employ mixed-method approaches to better understand the reasons and determinants behind this issue in India.

Acknowledgements
Not applicable.

Author contributions
RK SKP RS & DB designed the study. RK SKP RS & DB wrote and revised the paper. The author read and approved the final manuscript.

Funding
Not funding was received for the present study.

Data availability
This study uses secondary data which is publicly available on request to International Institute for Population Sciences Mumbai on link [https://www.nfhsiips.in/nfhsuser/nfhs5.php](https:/www.nfhsiips.in/nfhsuser/nfhs5.php).

Declarations

Ethics approval and consent to participate
All the methods were carried out in accordance with relevant guidelines and regulations and ethical approval was taken from Indian Council for Medical research (ICMR)(Ethics Committee) for conducting the survey. Consent to participate is not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 17 August 2025 / Accepted: 28 November 2025
Published online: 06 December 2025

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