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RESEARCH ARTICLE

Caesarean deliveries, subsequent reproductive behaviour and children ever born in India

Rakesh Mishra[1], Srinivas Goli[2,3]*, Swastika Chakravorty[4] and Anu Rammohan[5]

[1]ME and Data Analysis RCH Consultant, UNICEF, New Delhi, India, [2]Australia India Institute, the University of Western Australia, Perth, Australia, [3]Population Studies, Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi, India, [4]Centre for the Study of Regional Development, School of Social Sciences, Jawaharlal Nehru University, India and [5]Department of Economics, University of Western Australia, Crawley, Australia
*Corresponding author: srinivas.goli@uwa.edu.au

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Abstract

Against the backdrop of the alarming rise in Caesarean section (C-section) births in India, this study aimed to examine the association between C-section births, fertility decline and female sterilization in the country. A cross-sectional design was used to investigate the association between C-section delivery and subsequent reproductive behaviour in women in India. Data were from the National Family Health Survey (NFHS-4). The study sample comprised 255,726 currently married women in the age group of 15–49 years. The results showed a strong positive relationship between C-section births and female sterilization. The predicted probabilities (PP) from the multivariate regression model indicated a higher chance of female sterilization in women with C-section births (PP = 0.39, $p<0.01$) compared with those with non-C-section births (PP = 0.20, $p<0.01$). Both state-level correlation plots and Poisson regression estimates showed a strong negative relationship between C-section births and mean children ever born (CEB). Based on the results, it may be concluded that the use of C-sections and sterilization were strongly correlated in India at the time of the NFHS-4, thus together contributing to fertility decline. A strong negative association was found between the occurrence of C-sections and CEB. The increased and undesired use of C-section births and consequent female sterilization is a regressive socio-demographic process that often violates women's rights. Fertility decline should happen through informed choice of family planning and must protect the reproductive rights of women.

Keywords: Fertility; Family Planning; Female sterilization; C-section delivery; India

Introduction

Worldwide, socioeconomic transitions have shaped the trajectory of human reproduction, and in general, have predicted reproductive behaviour and fertility change (Bongaarts, 2009). However, unlike global trajectories of fertility transition, in India, changes in fertility have not been entirely driven by progress in socioeconomic and health status. The country has been experiencing an unusual process of fertility transition, where a rapid decline in fertility levels occurs irrespective of slow socioeconomic development (Goli *et al.*, 2021). Fertility decline in India has occurred even in many socioeconomically less-developed regions with relatively high infant mortality rates (IMR). Demographic research in India has reported that the women from economically weaker and illiterate sections of society with relatively low age at marriage have significantly contributed to fertility decline in the country (Drèze & Murthi, 2001; Bhat, 2002; McNay *et al.*, 2003; Dommaraju & Agadjanian, 2009; James, 2011; Basu & Desai, 2016). Thus, the convergence of

India's TFR towards replacement level fertility is majorly attributed to the success of the intensive family planning (FP) programme initiated in the late 1960s and continued up to the mid-1990s, which resulted in a tremendous decline in fertility levels (Alagarajan, 2003; Spoorenberg & Dommaraju, 2012; James & Goli, 2016).

This peculiar process of fertility transition has invited considerable attention from many researchers, especially to find out the reasons behind such a process. Several factors have been discussed as likely pathways to fertility decline in India, including improved health outcomes, mortality decline, policy and programmes promoting late marriages, delayed childbearing, birth spacing and sterilization (James, 2011; Spoorenberg & Dommaraju, 2012; De Oliveira *et al*., 2014; Dharmalingam *et al*., 2014; Vlassoff *et al*., 2016). In this direction, studies have also reported that a key reason for the changes in reproductive behaviour of women of lower socioeconomic status is the diffusion of institutionalized FP policies and, thereby, the increased use of female sterilization (Bhat, 2002; McNay *et al*., 2003; Dommaraju & Agadjanian, 2009; Srinivasan, 2017).

In the Indian context, several studies have identified the defining factors of FP use. Alongside programme factors (incentive and disincentive policies), female education, employment, age at marriage, exposure to mass media and autonomy have been suggested to be significantly related to the use of contraception among married women (James, 1999; Dharmalingam *et al*., 2014; Basu & Desai, 2016; Srinivasan, 2017). The adoption of contraception is also associated with age at first birth, sex composition of children as well as the regional and residential status of women (Jayaraman *et al*., 2009). Some studies have argued that the government in some states is involuntarily enforcing women to opt for sterilization through denial of government entitlements on having more than two children (Sharma, 2014; Goli, 2021). The majority of these states have limited outreach of diverse FP methods, especially spacing methods. However, a few studies have suggested that the high popularity of female sterilization in some demographically advanced states is related to cultural and contextual factors such as son preference (Rajaretnam & Deshpande, 1994; Clark, 2000; Ghosh & Chattopadhyay 2017), religious norms (Srikanthan & Reid, 2008), women's domestic power (León 2011) and familial power relations (Saavala, 2013). Also, women's inclination towards contraceptive use, particularly female sterilization, depends on a range of correlates from individual factors to social- and community-level factors (Dyson & Moore, 1983; Moursand & Kravdal, 2003). Although voluminous literature has provided sufficient evidence on the association of socioeconomic and cultural variables with female sterilization, the contribution of bio-demographic factors such as C-section births has been largely ignored.

Global studies that have tested the linkages between mode of delivery and subsequent fertility intentions almost unanimously agree that women who undergo C-section delivery for a previous birth are less likely to have subsequent live births than women who previously had a vaginal birth (Oral & Elter, 2007; Ma *et al*., 2010; Evers *et al*., 2014). Empirical evidence across the world suggests that C-section birth is highly associated with the increased use of contraception and lowered fertility compared with vaginal birth (Murphy et al., 2002; O'Neill *et al*., 2013). Another study by Smith *et al.* (2006) based in Scotland found an increased risk of women who had a history of C-section birth not opting for a second birth. They also found C-section births to be associated with longer inter-pregnancy intervals. In the context of the United Kingdom, previous studies reported that a higher rate of C-section births among women is associated with an increased risk of delayed pregnancy or high inter-pregnancy interval (Murphy *et al*., 2002). In the specific context of Scotland, women who underwent C-sections were found to have compromised subsequent pregnancy and experienced involuntary sterilization to avoid risks in future pregnancies (Mollison *et al*., 2005). In the USA, the rate of C-section is high but the trend of tubal litigations following C-section births had decreased as women are increasingly opting for effective reversible contraception over permanent sterilization. However, female sterilization was found to be common among the women living in the South, among Black and Hispanic women, and women with lower income, lower education and higher parity (Chan & Westhoff, 2010). In contrast to the USA,

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demand for female sterilization following C-section was found to be high in Brazil among women from higher socioeconomic status. Even though female surgical sterilization is not officially accepted in the country, it is performed at a high rate during C-section surgeries (Barros *et al.*, 1991; Faúndes & Cecatti, 1993). However, in countries of sub-Saharan Africa, C-section is associated with lowered natural fertility and increased use of contraception. In particular, female sterilization was found to be much more prevalent among women whose delivery of previous birth was through C-section mode compared with vaginal births (Collin *et al.*, 2006). India also highly relies on female sterilization as the primary mode of contraception, rather than modern reversible birth control measures. The National Family Health Survey (NFHS) reported that the prevalence of female sterilization was 35.7% in 2015–16, which accounts for about 62.4% of the total contraceptive use in India (IIPS & ICF, 2017). Many studies have also reported that the poor quality of female sterilization facilities, such as inadequate sterilization of instruments, bacterial infections, no use of anaesthesia, unhygienic hospital wards, and so on, is causing serious health risks or even deaths of women undergoing tubal litigations. This raises serious concerns about the increased rates of female sterilization, and particularly the increased rate of undesirable C-section-led female sterilization, which is the primary focus of this paper. Although it has been speculated that C-section births are increasingly contributing to lower fertility intentions, as indicated by the increase in female sterilizations and lower mean CEB, there is a paucity of empirical evidence on this subject from India.

Over the last few decades, there has been a dramatic increase in the rate of C-section births across the world, including in India (Betran *et al.*, 2007). According to NFHS-4 data from 36 Indian states and UTs, the rate of C-section births in some states was as high as 57.7% in 2015–16. Data from successive NFHS rounds have shown an increasing trend in the percentage of women having C-section births – from a low level of 2.9% in 1992–93 to 9.0% in 2005–06, doubling to 17.2% in 2015–16 (IIPS & ICF, 2017; Guilmoto & Dumont, 2019). The current C-section levels in the country in 2015–16 were way higher than the WHO recommended 10–15% (WHO, 2015). The recent NFHS (2015–16) also reported state-level variation in the occurrence of C-section births, and higher rates in many demographically advanced southern states compared with northern states, with Telangana having the highest rate (58%) followed by Andhra Pradesh (40.1%), Tamil Nadu (34.1%), Puducherry (33.6%) and Goa (31.4%).

A largely under-researched phenomenon in human reproduction in India is the role of bio-demographic factors, such as C-section births, in shaping subsequent reproductive behaviour and how this influences overall fertility decline. The main aim of this study was to identify the likelihood of female sterilization after C-section birth among married women in India. The study hypothesized that the high rate of female sterilization in India cannot be attributed to individual and social factors alone, but that bio-demographic factors such as C-section also contribute significantly and is a key factor linked to the higher rate of female sterilizations and consequent smaller family size in the advanced states of India. If the hypothesis holds, this would indicate a lack of choice for women in terms of methods of FP and an intentional over-reliance on female sterilization for fertility decline in India.

Against this backdrop, this study attempted to test for the association between C-section births and fertility decline using data from a pooled sample of Indian states with data available about C-section births, female sterilization and CEB.

Methods

Data

The study used a cross-sectional perspective to estimate the association between C-section and subsequent reproductive behaviour in women. The data for this analysis came from NFHS-4 – a nationwide survey conducted in India during 2015–16 by the Ministry of Health and Family

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Welfare (MoHFW) and the International Institute for Population Science (IIPS). It used multi-stage stratified random sampling, and the sample size was sufficient to perform robust statistical analyses. This study was based on 255,726 currently married women from demographically advanced and less-advanced states of India. Information on family planning, type of birth and CEB, along with socioeconomic and demographic characteristics, were used in the analyses. NFHS data are available in the public domain, so ethical approval was not required for this study.

Statistical analysis

Bivariate tabulations, correlation plots and multivariate regression models were carried out to investigate: (i) the association between C-section births and female sterilizations, and (ii) the association of C-section births and female sterilization with CEB. The bivariate distribution of using any FP method or female sterilization after last birth was shown with disaggregation of C-section and non-C-section births and by order of last birth. The robustness of the estimates was checked through their distribution within the 95% confidence interval. Adjusted predicted probabilities of having female sterilization for C-section and non-C-section births were estimated through logistic regression, and post-regression estimates were performed to measure the predicted probabilities. Given the distribution of births data, the study used Poisson regression to estimate the relative effect of C-section birth compared with non-C-section birth of the preceding birth on CEB net of other socioeconomic covariates.

Poisson regression is a generalized linear model where the outcome variable is linked with logarithmic function. The natural logarithm of mean CEB is expressed as the linear function of a set of independent variables. In this model, birth is assumed to be a Poisson process whose probability of occurrence is constant at any point in time and the mean number of CEB and its variance are equal:

$$P(Y_i = y_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} y_i = 0,\ 1,\ 2, \ldots, \quad \lambda_i > 0$$

Mathematical proofs of the models are reported below following Engelhardt *et al.* (2009). It is postulated that the mean CEB depends on a set of predictors $x_1, x_2, \ldots x_p$ such that:

$$\begin{aligned}\log(\text{CEB}_i) = \alpha + \ & \beta_0 \text{ Type of birth} + \beta_1 \text{ Use of contraception} + \beta_2 \text{ Age of mothers} \\ & + \beta_3 \text{ Religion} + \beta_4 \text{ Caste} + \beta_5 \text{ Woman's education attainment} \\ & + \beta_6 \text{ Partner's education attainment} + \beta_7 \text{ Woman's work status} \\ & + \beta_8 \text{ Place of residence} + \beta_9 \text{ Wealth status} + \beta_{10} \text{ Development regions} + \in_k\end{aligned}$$

where $i = 1, 2, 3, \ldots, n$ and $j = 1, 2, 3, \ldots, p$. Also, the β_i values indicate the regression coefficients corresponding to each covariate included in the study and $\in_k$ is the error term, which is independently and identically normal-distributed:

$$\in_i \sim N(0, \sigma^2 I_n).$$

Figure 1 shows the analytical plan and sample selection process for all the models estimated in the study.

Results and Discussion

The analysis by state (Table 1) presents alarming levels of C-section births in India in 2015–16, whereby eighteen states and Union Territories (UTs) had levels way above the global threshold of 10–15% designated by the World Health Organization (WHO, 2015). The rate of C-section births was higher in most south Indian states and UTs where fertility levels were already below the replacement level. In addition, several states with below replacement fertility level had

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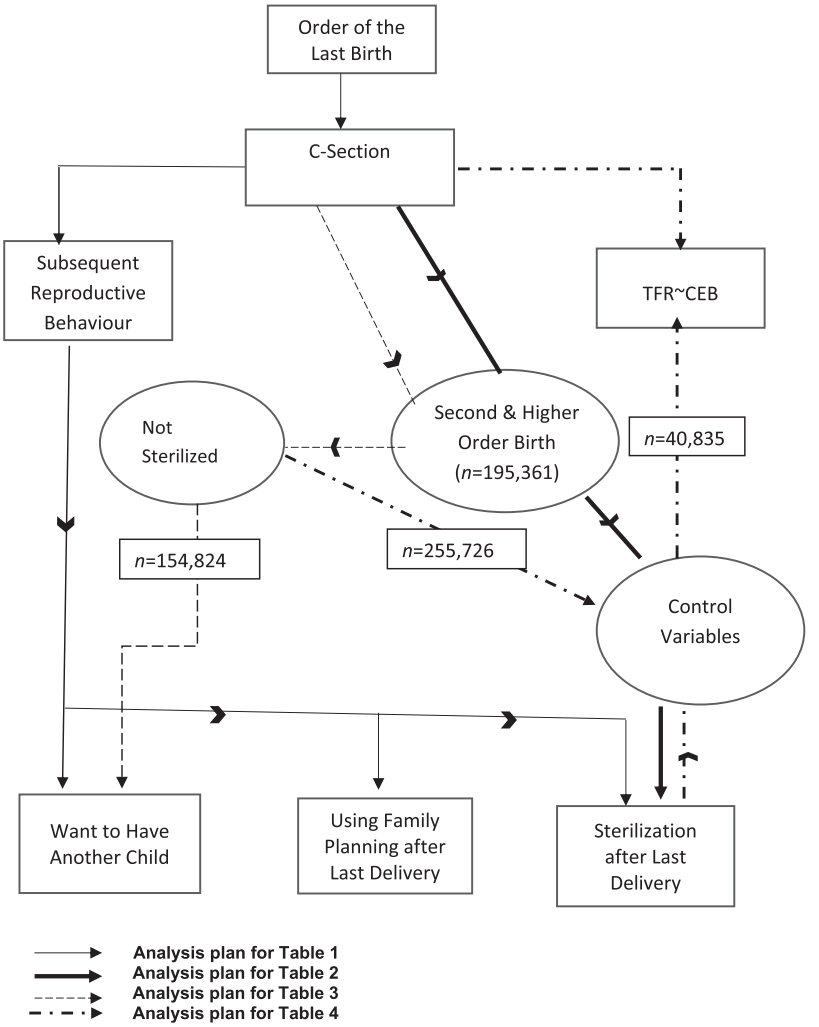

Figure 1. Analysis plan for assessing association between C-section and fertility behaviour.

conspicuously higher levels of C-section births than WHO guidelines, including Jammu Kashmir, Gujarat, Punjab, West Bengal, Himachal Pradesh and Delhi. Also, a noteworthy share of sterilization was seen in the states and UTs with higher levels of C-section births and below replacement level fertility, especially in south India for second- or higher-order births. Thus, the relationships between C-section births, female sterilization (a fertility-limiting behaviour) and fertility levels are examined in the next section.

Association between C-section births and female sterilizations

The macro (state) level analysis of the association between C-section births and female sterilizations shows a positive linear relationship ($r = 0.57$). In other words, an increasing trend in C-section births is related to a monotonically increasing trend in female sterilizations (Figure 2). However, the incidence of sterilization following C-section at the last birth presents an incomplete picture of overall reproductive behaviour. Fertility levels and corresponding stopping behaviour are mostly guided by future fertility intentions and type of delivery at the previous

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Table 1. Percentage of C-section deliveries at the last birth, female sterilization rate and total fertility rate (TFR) by state, India, 2015–2016

State	C-section delivery (%)[a]	TFR[a]	Sterilization (%)[a]	*n*[b]
Andaman & Nicobar Island	19.28	1.44	19.30	633
Andhra Pradesh	40.10	1.83	55.25	3082
Arunachal Pradesh	8.93	2.10	3.05	4874
Assam	13.41	2.21	4.97	10,175
Bihar	6.23	3.41	12.42	25,214
Chandigarh	22.59	1.57	6.11	193
Chhattisgarh	9.88	2.23	21.57	9138
Dadra and Nagar Havel	16.23	2.32	13.50	317
Daman and Diu	15.75	1.68	11.09	403
Goa	31.42	1.66	11.91	413
Gujarat	18.40	2.03	15.74	7607
Haryana	11.66	2.05	16.40	7806
Himachal Pradesh	16.67	1.88	13.77	2901
Jammu & Kashmir	33.10	2.01	8.89	8165
Jharkhand	9.88	2.55	15.28	12,040
Karnataka	23.55	1.80	33.53	7692
Kerala	35.80	1.56	28.72	2440
Lakshadweep	38.35	1.82	7.53	306
Madhya Pradesh	8.64	2.32	24.82	24,334
Maharashtra	20.09	1.87	27.55	9229
Manipur	21.14	2.61	1.79	5521
Meghalaya	7.60	3.04	3.00	4130
Mizoram	12.67	2.27	7.20	4356
Nagaland	5.79	2.74	3.43	4467
Delhi	26.71	1.78	5.74	1561
Odisha	13.79	2.05	14.24	10,926
Puducherry	33.57	1.70	41.29	1073
Punjab	24.57	1.62	13.03	5149
Rajasthan	8.59	2.40	19.24	16,703
Sikkim	20.87	1.17	7.83	988
Tamil Nadu	34.08	1.70	37.55	7803
Tripura	20.47	1.68	6.30	1302
Uttar Pradesh	9.38	2.74	6.78	41,360
Uttarakhand	13.12	2.07	9.68	5767
West Bengal	23.81	1.77	14.89	5268
Telangana	57.72	1.78	44.21	2390

[a]Based on weighted cases.
[b]Unweighted samples.

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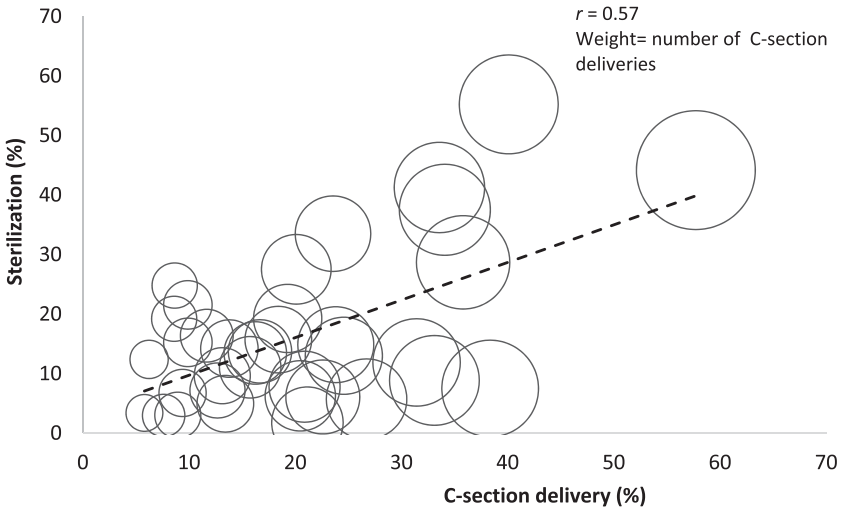

Figure 2. Association between C-section delivery and female sterilization by state.

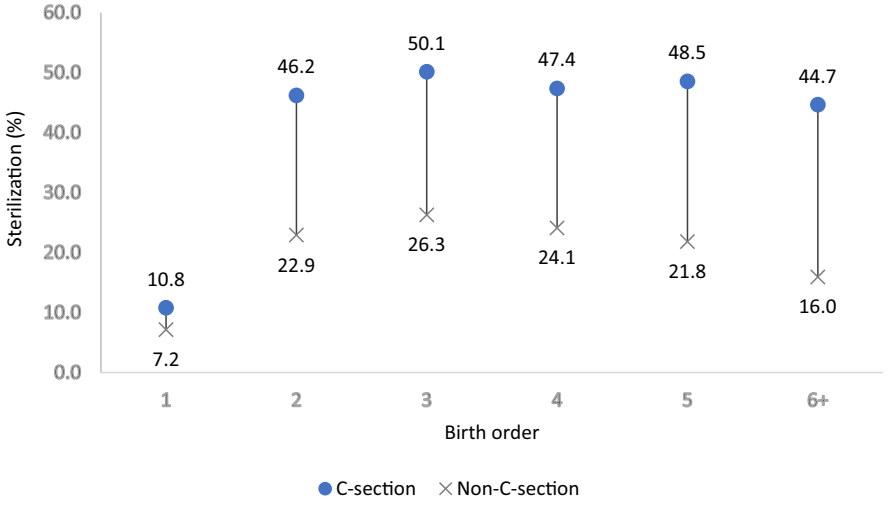

Figure 3. Female sterilization by birth order and type of delivery for last birth.

birth. Thus, an explicit quantitative assessment of the association between C-section births and sterilizations by birth order can provide more insight into the mechanisms defining completed fertility.

This section presents plausible empirical evidence through bivariate differences in female sterilization and CEB by type of birth at specific birth order. Irrespective of the order of birth, women who had a C-section delivery had a higher prevalence of sterilization than women who had a normal delivery, except for first-order births (Figure 3). Furthermore, female sterilization was higher in women with C-section births compared with non-C-section births; the difference was large for second and higher-order births (Table 2). For women with birth order second and above, the female sterilization rate was 45.3% (95% CI 44.7–45.9) compared with 22.3% (95% CI 22.3–22.5) in non-C-section births. Similarly, the intention to have an additional child was also significantly less in women with C-section births (13%, 95% CI 12.6–13.4) than

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Table 2. Future fertility intention and sterilization of women after last delivery by type of delivery and birth order of last birth

Outcome variable	First order ($N = 60,365$)		Second order or more ($N = 195,361$)	
	C-section (%)	Non-C-section (%)	C-section (%)	Non-C-section (%)
Wanted another child	69.69	74.41	13.04	20.5
	(69.90, 70.47)	(74.01, 74.81)	(12.63, 13.45)	(20.30, 20.69)
Sterilized after last delivery	0.71	0.65	45.31	22.30
	(0.59, 0.85)	(0.58, 0.73)	(44.71, 45.92)	(22.30, 22.51)
Total	39.66	21.72	60.34	78.28
	(39.20, 40.12)	(21.55, 21.90)	(59.88, 60.80)	(78.10, 78.45)
N	13,996	46,369	21,188	174,173

Figures in parentheses are 95% confidence intervals.

non-C-section births (20.5, 95% CI 12.6–13.4) for the preceding birth. This noteworthy difference in sterilization may be an indication of stopping behaviour after two or higher-order births.

Besides the estimation of crude differences in sterilization and future fertility intentions by C-section births, an exercise to explore the relationship between C-section births and sterilization after first birth was carried out. Logistic regression was applied to estimate the net effect of C-section birth on sterilization at two or higher-order births. The adjusted results are in sync with the unadjusted estimates (Table 3). The predicted probability (PP) of female sterilization after second and higher-order births was nearly doubled in the case of C-section births ($PP = 0.37$, $p<0.001$) compared with non-C-section births ($PP = 0.19$, $p<0.001$) after controlling for socio-demographic factors and regions. The results also indicate that C-section births in India lead to female sterilizations independent of socio-demographic factors.

In the Indian context, explanations of pathways to C-section-induced sterilization may include both medical and non-medical factors. In a global context, there is evidence that women of low body mass index (BMI) and of shorter height should not have more than two or three C-section births – and this probably applies to India (Stulp *et al.*, 2011; Xiong *et al.*, 2016). Most often, a low BMI in women raises their risk of emergency obstetric complications and consequently the rate of C-section births (Sebire *et al.*, 2001; Ehrenberg *et al.*, 2003). There is evidence that the rise in institutional births in India under the Safe Motherhood Scheme has also contributed to increasing the rate of C-section births (Mishra & Ramanathan, 2002). Thus, if a woman opts for a C-section birth, it is easier to convince them to accept sterilization as a cost-effective strategy – both for the state and the woman's household.

The association between C-sections and female sterilizations can be attributed to the affordability of C-section birth. Females from lower socioeconomic backgrounds may opt for sterilization soon after a C-section birth as the cost is lower if it is performed then. Thus, C-section-led sterilization may prevent even wanted subsequent births and contributes to involuntary fertility decline. Women with low socioeconomic backgrounds tend to have low level of education and are therefore, less likely to be able to give their informed consent to sterilization. Other factors explaining the high level of post-C-section sterilization among women in the demographically advanced states of India include increased awareness and a strong policy supporting sterilization (Baveja *et al.*, 2000) and women's ambitions (Saavala, 2013). Institutional factors such as a shortage of emergency obstetric care and trained surgeons in public hospitals (Evans *et al.*, 2009), the trauma experienced during a previous birth and FP pressure on women (Bhattacharya *et al.*, 2006) are the main reasons for other states. These arguments also explain the finding that advanced

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Table 3. Logistic regression estimates of predicted probability (PP) of having sterilization in women with second or higher order delivery by type of last delivery and other covariates, India, 2015–16

Predictor variable	n^a	PP	95% CI		$p>z$
			Lower	Upper	
Type of delivery					
Non-C-section (Ref.)	174,173	0.188	0.188	0.189	
C-section	21,188	0.365	0.363	0.367	<0.001
Age (years)					
15–24 (Ref.)	48,146	0.179	0.178	0.180	
25–34	122,982	0.222	0.221	0.223	<0.001
35–49	24,233	0.190	0.188	0.191	<0.001
Religion					
Hindu (Ref.)	139,866	0.250	0.249	0.250	
Muslim	32,517	0.096	0.095	0.097	<0.001
Christian	16,063	0.087	0.086	0.087	<0.001
Other	6915	0.155	0.153	0.157	<0.001
Caste					
SC (Ref.)	37,932	0.243	0.242	0.244	
ST	39,984	0.166	0.165	0.167	0.009
OBC	77,265	0.231	0.230	0.231	<0.001
Other	33,160	0.181	0.180	0.182	<0.001
Not stated	7020	0.124	0.122	0.126	<0.001
Woman's education					
Illiterate (Ref.)	70,976	0.188	0.187	0.189	
Primary	31,027	0.215	0.214	0.217	<0.001
Secondary	80,726	0.223	0.222	0.224	0.052
Higher and above	12,632	0.195	0.193	0.197	<0.001
Partner's education					
Illiterate (Ref.)	6997	0.190	0.187	0.193	
Primary	5426	0.219	0.216	0.223	0.068
Secondary	17,990	0.229	0.227	0.231	0.568
Higher and above	3449	0.200	0.196	0.204	0.103
Missing	161,499	0.206	0.205	0.206	0.243
Work status					
Not working (Ref.)	27,747	0.204	0.202	0.205	
Working	6204	0.272	0.269	0.276	<0.001
Missing	161,410	0.206	0.205	0.206	0.162

(*Continued*)

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Table 3. (*Continued*)

Predictor variable	n^a	PP	95% CI		$p>z$
			Lower	Upper	
Sex of last child					
Girl (Ref.)	94,419	0.168	0.168	0.169	
Boy	100,942	0.244	0.243	0.245	<0.001
Place of residence					
Rural (Ref.)	152,359	0.205	0.205	0.206	
Urban	43,002	0.216	0.214	0.217	0.016
Wealth status					
Poorest (Ref.)	57,597	0.180	0.179	0.181	
Poorer	48,114	0.202	0.201	0.204	<0.001
Middle	38,201	0.236	0.235	0.237	<0.001
Richer	29,834	0.236	0.235	0.238	<0.001
Richest	21,615	0.202	0.200	0.203	<0.001
Region					
High-fertility region (Ref.)	125,868	0.162	0.162	0.163	
Low-fertility region	69,493	0.289	0.288	0.290	<0.001
Constant	195,361	0.207	0.207	0.208	<0.001
n			195,361		
LR χ^2 (27)			16,714.51		
Prob>χ^2			0.000		
Pseudo R^2			0.0838		
Log-likelihood			–91,398.49		

[a]Includes women whose last delivery was second order or more.
Ref.: reference category.

C-section births induce subsequent female sterilization, which has significantly contributed to an augmented fertility decline in India, even at lower levels of socioeconomic development and higher childhood mortality rates compared with the standards of developed countries during the peak of their fertility transition (James & Goli, 2016).

Furthermore, the results indicated that the predicted probability of sterilization was higher for a male child (PP = 0.24, $p<0.001$) compared with a female child at the last birth (PP = 0.17, $p<0.001$). This shows that sterilization works as an instrument of Meta preference for sons in India when the analysis is controlled for type of last delivery and other covariates. The predicted probability of sterilization for women with two or higher parity is substantially higher in the case of low-fertility regions (PP = 0.29, $p<0.001$) compared with high-fertility regions (PP = 0.16, $p<0.001$). This finding corroborates the hypothesis that a region with a lower level of fertility has considerably higher C-section births as well as female sterilizations. Working women (PP = 0.27, $p<0.001$) also have a significantly higher probability of undergoing sterilization under the controlled effects of type of birth, region and women's other socioeconomic characteristics.

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Future fertility intentions and C-section birth

It has been argued that women who have a C-section at their previous birth have a lesser chance of progression to higher parity births (Norberg & Pantano, 2016). This is because of the misconception prevailing in society that having a C-section birth means that subsequent births will have to be by C-section. However, an examination of this hypothesis was not possible using the available dataset as the NFHS does not list all births to a mother by corresponding modes of birth (i.e. C-section or vaginal delivery). Information on type of birth was available for the latest birth only. However, using available information, a significant transition in fertility behaviour was noted among women who had a C-section at their latest birth, especially second- and higher-order births (Table 4). Importantly, in the Indian context, where fertility level has reached replacement level, the role of C-section becomes critical to future fertility intentions, specifically around second-order births. In this context, a net association between C-section births and future fertility intentions was explored for unsterilized women. The results indicate a lower progression to higher-order births for women who had delivered any previous birth through abdomen incision (PP = 0.25, $p<0.001$). This means that unsterilized women with a previous C-section birth tended to have a lower intention to have an additional birth, but increased practice of FP. The practice of FP for birth spacing also increased notably for women (PP = 0.30, $p<0.001$) who desired more than two births under the influence of a C-section birth. These findings corroborate those of previous studies, which showed that C-section birth is associated with the birth spacing behaviour of women (Smith *et al.*, 2006; O'Neill *et al.*, 2014).

The desire for more births decreases substantially when the sex of the last child was male (PP = 0.21, $p<0.001$) rather than female (PP = 0.34, $p<0.001$). Socioeconomic indicators such as women's education and household wealth status considerably limit future fertility desire on moving vertically from the most vulnerable to the affluent category. Most importantly, the predicted probability for future intentions to have more than two children in the low-fertility region (PP = 0.24, $p<0.001$) was significantly lower than that of the high-fertility region (PP = 0.29, $p<0.001$). These findings indicate that future fertility intention in both the high- and low- fertility regions is guided by the controlled effect of type of births in India.

The important takeaway message from this is that the sex of the child at last birth and type of birth critically determine the fertility choices and behaviours of unsterilized women in India. Nevertheless, pathways by which C-section birth influence completed fertility are only partially explained in the previous analyses. To account for this, a correlation analysis between C-section births and total fertility rate (TFR) was performed (Figure 4). The correlation coefficient obtained from state-level analysis depicted a significant inverse linear relationship between C-section births and TFR. Conspicuously, the states with TFR below 2.1 had a high share of C-section births (Table 1). Similarly, a high rate of C-section births was also seen among the states and UTs that were on the verge of replacement level fertility. This implies that fertility levels and C-section births reciprocally affect each other. However, there was significant heterogeneity in the level of association at the state level. Spatial disparity in factors, such as availability of modern health technology, and access to and use of antenatal care services, especially in private health institutions, partly explains the increase in C-section births, as well as the pathways of fertility decline, at the sub-national level.

To understand the effect of type of birth on fertility, CEB was used as a proxy for completed fertility. The association of C-section births with fertility was exercised for two sets of samples: a 'sterilized women' sample and 'currently married women' sample. Table 5 shows the results of the net association between C-section births and CEB after controlling for contraception use and other socio-demographic factors. The results revealed that CEB was significantly lower in women with C-section birth (PP = 1.85, $p<0.001$) compared with non-C-section birth (PP = 2.69, $p<0.001$). Separate analyses for sterilized women also indicated that the CEB is significantly lower in women with C-section births (PP = 2.49, $p<0.001$) than those with non-C-section births

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Table 4. Logistic regression estimates of predicted probability (PP) of future fertility intentions of women with second-order delivery who were not sterilized and wanted to have an additional child by type of last delivery and other covariates, India, 2015–16

Predictor	n^a	PP	95% CI		$p>z$
			Lower	Upper	
Type of delivery					
Non-C-section (Ref.)	43,628	0.279	0.278	0.279	
C-section	111,196	0.251	0.249	0.253	<0.001
Currently using FP					
No (Ref.)	141,367	0.212	0.211	0.213	
Yes	13,457	0.302	0.301	0.302	<0.001
Age (years)					
15–24 (Ref.)	39,512	0.387	0.386	0.388	
25–34	95,682	0.260	0.259	0.260	<0.001
35–49	19,630	0.133	0.132	0.134	<0.001
Religion					
Hindu (Ref.)	104,917	0.260	0.260	0.261	
Muslim	29,392	0.291	0.290	0.292	<0.001
Christian	14,673	0.374	0.372	0.377	<0.001
Other	5842	0.241	0.238	0.244	0.262
Caste					
SC (Ref.)	28,706	0.271	0.270	0.273	
ST	33,360	0.341	0.340	0.343	<0.001
OBC	59,455	0.275	0.274	0.276	<0.001
Other	27,151	0.214	0.213	0.216	<0.001
Not stated	6152	0.234	0.231	0.237	<0.001
Woman's education					
Illiterate (Ref.)	57,617	0.277	0.276	0.278	
Primary	24,345	0.299	0.298	0.301	0.740
Secondary	62,693	0.277	0.276	0.277	0.020
Higher and above	10,169	0.213	0.211	0.215	0.007
Partner's education					
Illiterate (Ref.)	5667	0.286	0.282	0.289	
Primary	4236	0.301	0.297	0.304	0.334
Secondary	13,875	0.276	0.274	0.278	0.925
Higher and above	2760	0.232	0.228	0.236	0.972
Missing	128,286	0.276	0.275	0.277	0.729
Work status					
Not working (Ref.)	22,097	0.274	0.272	0.276	

(*Continued*)

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Table 4. (*Continued*)

Predictor	n^a	PP	95% CI		$p>z$
			Lower	Upper	
Working	4516	0.295	0.291	0.299	0.001
Missing	128,211	0.276	0.275	0.277	0.771
Sex of last child					
Girl (Ref.)	78,520	0.344	0.343	0.344	
Boy	76,304	0.207	0.206	0.208	<0.001
Place of residence					
Rural (Ref.)	121,090	0.284	0.284	0.285	
Urban	33,734	0.248	0.246	0.249	<0.001
Wealth status					
Poorest (Ref.)	47,229	0.296	0.295	0.297	
Poorer	38,372	0.288	0.287	0.290	<0.001
Middle	29,188	0.279	0.278	0.281	0.151
Richer	22,781	0.258	0.256	0.259	0.016
Richest	17,254	0.214	0.212	0.215	0.001
Region					
High-fertility region (Ref.)	105,417	0.293	0.293	0.294	
Low-fertility region	49,407	0.240	0.239	0.241	<0.001
Constant	154,824	0.276	0.276	0.277	<0.001
n			154,824		
LR χ^2 (27)			12,080.71		
Prob>χ^2			0.000		
Pseudo R^2			0.0662		
Log-likelihood			–85,206.28		

[a]Includes non-sterilized women whose last delivery was second-order or more.
Ref.: reference category.

(PP = 3.12, $p<0.001$). This indicates that the completed fertility rate for women under the effect of C-section births is relatively lower than that for their counterparts. A similar gap in completed fertility was observed between the low-fertility (PP = 2.64, $p<0.001$) and high-fertility regions (PP = 3.35, $p<0.001$) when the analysis was controlled for type of birth and other socioeconomic and demographic covariates. Furthermore, the completed fertility was lower among higher educated women, women belonging to urban areas and those with improving economic status compared with their counterparts.

C-section delivery, female sterilization and the violation of reproductive rights

Sterilization is a limiting method of FP and needs a surgical procedure for its implementation. Being an irreversible method of contraception, it mandates service providers to adequately inform women of the consequences of undergoing sterilization, especially when births occur in health

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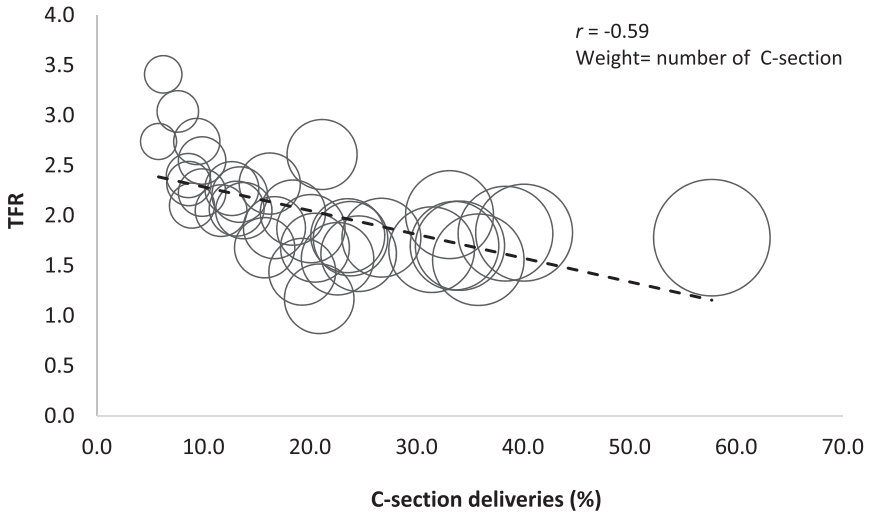

Figure 4. State-level association between level of C-section delivery and TFR.

facilities. However, the estimates from NFHS-4 manifest that three in every five currently married women who were sterilized 5 years preceding the survey were not informed about the side-effects and their management (IIPS & ICF, 2017). There is well-documented evidence of inadequate counselling and advice about other forms of contraceptives and about the side-effects of the sterilization process (Verma & Roy, 1999; Koenig, 2003; Jain, 2016). It is noteworthy to mention that sterilization regret has nearly doubled in India is last decade. A study by Bansal and Dwivedi (2020) substantiated this observation and noted that one in every five women regret sterilization in resource-poor settings. Importantly, quality-of-care factors such as provider competence, interpersonal relationship between service providers and women and availability of appropriate constellation of services are severely lacking in India (Gupta, 1993; Nataraj, 1994; Ganatra *et al.*, 1999; Singh *et al.*, 2012; Bansal & Dviwedi, 2020). When aligned with excess C-section deliveries and attributable risk of sterilization, these observations suggest a glaring violation of women's reproductive rights. The study analysis precisely explains how the rate of sterilization is enhanced in the presence of C-section deliveries (Figure 3). The gap between sterilization among C-section and non-C-section deliveries is high at all birth orders. It can be concluded that C-section deliveries instil an involuntary channel of adopting coercive measures of fertility regulation. This finding corroborates previous studies from other geographies (Sifris, 2010).

Another factor that is typical of patriarchal societies like India is the lack of involvement of women in decision-making regarding FP methods. Women usually have little autonomy and control over their fertility and contraceptive choices (Jeejebhoy, 1995; Raj *et al.*, 2009; Oliveira *et al.*, 2014) and therefore the decision to undergo sterilization is often not a personal choice. Conspicuously, Figure 5a shows higher sterilization regret among women who were not involved in decision-making on FP. It was observed that among women who were not primary decision-makers on FP method use, sterilization regret was 11.8% for those who had a C-section delivery previously compared with their counterparts who had a normal delivery (6.9%). It is intriguing to note that among women who were involved in the decision-making on FP method use, the share of sterilization regret was nearly the same irrespective of type of delivery. This indicates that C-section delivery positively correlates with ill-informed decisions to undergo sterilization and consequently to higher involuntary sterilization leading to regret of opting for sterilization (Figure 5b).

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Table 5. Poisson regression estimates showing the effect of type of delivery and other covariates on CEB to women, India

Background characteristic	Model I (All Currently married women)					Model II (Sterilized Women)				
			95% CI					95% CI		
	n	PP	Lower	Upper	*p*>*z*	Sample (*n*)	PP	Lower	Upper	*p*>*z*
Type of delivery										
Non-C-section (Ref.)	220,542	2.69	2.69	2.70		33,022	3.12	3.11	3.13	
C-section	35,184	1.85	1.84	1.86	<0.001	7813	2.49	2.48	2.51	<0.001
Ever use of contraception										
No (Ref.)	101,683	2.63	2.62	2.64		—	—	—	—	—
Yes	154,043	2.54	2.54	2.55	<0.001	—	—	—	—	—
Age (years)										
15–24 (Ref.)	83,685	1.76	1.76	1.76		8736	2.34	2.33	2.35	
25–34	146,287	2.71	2.71	2.71	<0.001	27,470	2.98	2.98	2.99	<0.001
35–49	25,754	4.47	4.46	4.48	<0.001	4629	4.34	4.31	4.36	<0.001
Religion										
Hindu (Ref.)	185,425	2.47	2.46	2.47		35,207	2.96	2.95	2.96	
Muslim	40,445	2.95	2.94	2.96	<0.001	3138	3.41	3.38	3.44	<0.001
Christian	19,898	3.01	2.99	3.02	<0.001	1402	3.30	3.26	3.34	<0.001
Other	9958	2.27	2.25	2.28	<0.001	1088	2.76	2.73	2.80	0.261
Caste										
SC (Ref.)	48,407	2.65	2.64	2.66		9291	3.12	3.10	3.13	
ST	50,616	2.82	2.81	2.83	<0.001	6668	3.30	3.28	3.32	<0.001
OBC	100,722	2.55	2.54	2.56	<0.001	17,934	2.91	2.89	2.92	<0.001
Other	46,201	2.34	2.33	2.35	<0.001	6067	2.77	2.76	2.79	<0.001
Not stated	9780	2.36	2.35	2.38	<0.001	875	2.88	2.83	2.93	<0.001
Woman's education										
Illiterate (Ref.)	79,963	3.39	3.39	3.40		13,444	3.66	3.65	3.68	
Primary	37,325	2.76	2.76	2.77	<0.001	6715	3.06	3.05	3.07	<0.001
Secondary	114,740	2.14	2.13	2.14	<0.001	18,173	2.59	2.58	2.59	<0.001
Higher and above	23,698	1.67	1.66	1.68	<0.001	2503	2.23	2.22	2.25	<0.001
Partner's education										
Illiterate (Ref.)	7996	3.41	3.39	3.44		1338	3.64	3.59	3.68	
Primary	6510	2.92	2.90	2.95	0.183	1194	3.18	3.14	3.23	0.438
Secondary	24,216	2.36	2.35	2.37	<0.001	4133	2.82	2.80	2.84	0.117
Higher and above	5736	1.88	1.86	1.89	<0.001	699	2.48	2.44	2.53	0.096
Don't know	211,268	2.58	2.57	2.58	0.006	33,471	3.00	2.99	3.01	0.503
Work status										
Not working (Ref.)	37,013	2.51	2.50	2.52		5678	2.95	2.93	2.97	

(*Continued*)

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Table 5. (*Continued*)

Background characteristic	Model I (All Currently married women)					Sample		Model II (Sterilized Women)		
			95% CI					95% CI		
	n	PP	Lower	Upper	*p*>*z*	(*n*)	PP	Lower	Upper	*p*>*z*
Working	7563	2.88	2.85	2.90	<0.001	1700	3.15	3.12	3.19	0.588
missing	211,150	2.58	2.57	2.58	0.029	33,457	3.00	2.99	3.01	0.608
Sex of last child										
Girl (Ref.)	122,631	2.62	2.61	2.62		15,987	3.07	3.05	3.08	
Boy	133,095	2.54	2.53	2.54	<0.001	24,848	2.95	2.95	2.96	<0.001
Place of residence										
Rural (Ref.)	195,440	2.67	2.67	2.67		31,477	3.07	3.06	3.08	
Urban	60,286	2.28	2.27	2.28	0.052	9358	2.75	2.74	2.77	0.533
Wealth status										
Poorest (Ref.)	67,630	3.18	3.17	3.19		10,425	3.60	3.58	3.61	
Poorer	60,556	2.73	2.72	2.74	<0.001	9794	3.11	3.10	3.13	<0.001
Middle	50,845	2.40	2.39	2.40	<0.001	9075	2.78	2.77	2.79	<0.001
Richer	42,325	2.16	2.16	2.17	<0.001	7118	2.59	2.58	2.60	<0.001
Richest	34,370	1.90	1.89	1.91	<0.001	4423	2.45	2.43	2.46	<0.001
Region										
High-fertility states (Ref.)	157,755	2.81	2.80	2.81		20,559	3.35	3.34	3.36	
Low-fertility states	97,971	2.21	2.20	2.21	<0.001	20,276	2.64	2.64	2.65	<0.001
Constant	255,726	2.58	2.57	2.58	<0.001	40,835	3.00	2.99	3.01	<0.001
n		255,726					40,835			
LR χ^2 (27)		90,182.42					7681.98			
Prob > χ^2		0.000					0.000			
Pseudo R^2		0.1005					0.0554			
Log-likelihood		−403,595					−65,525.033			

Ref.: reference category.

Robustness checks

Estimates for sub-samples among high- and low-fertility states were checked for consistency and robustness. The analyses suggest that robustness checks were in tune with findings that emerged based on the total sample (Table 6). The findings from both sub-samples suggest a significant negative relationship between C-section births and CEB, even after controlling for several other determinants of fertility. Women's education attainment and husband's education level were also significantly related to lower CEB, which indicates that educated couples plan their fertility even with a previous C-section birth. The results corroborate the findings from a range of other studies which have established that C-section birth reduces the likelihood of subsequent birth compared with spontaneous vaginal delivery (Collin *et al.*, 2006; Smith *et al.*, 2006; O'Neill *et al.*, 2014;

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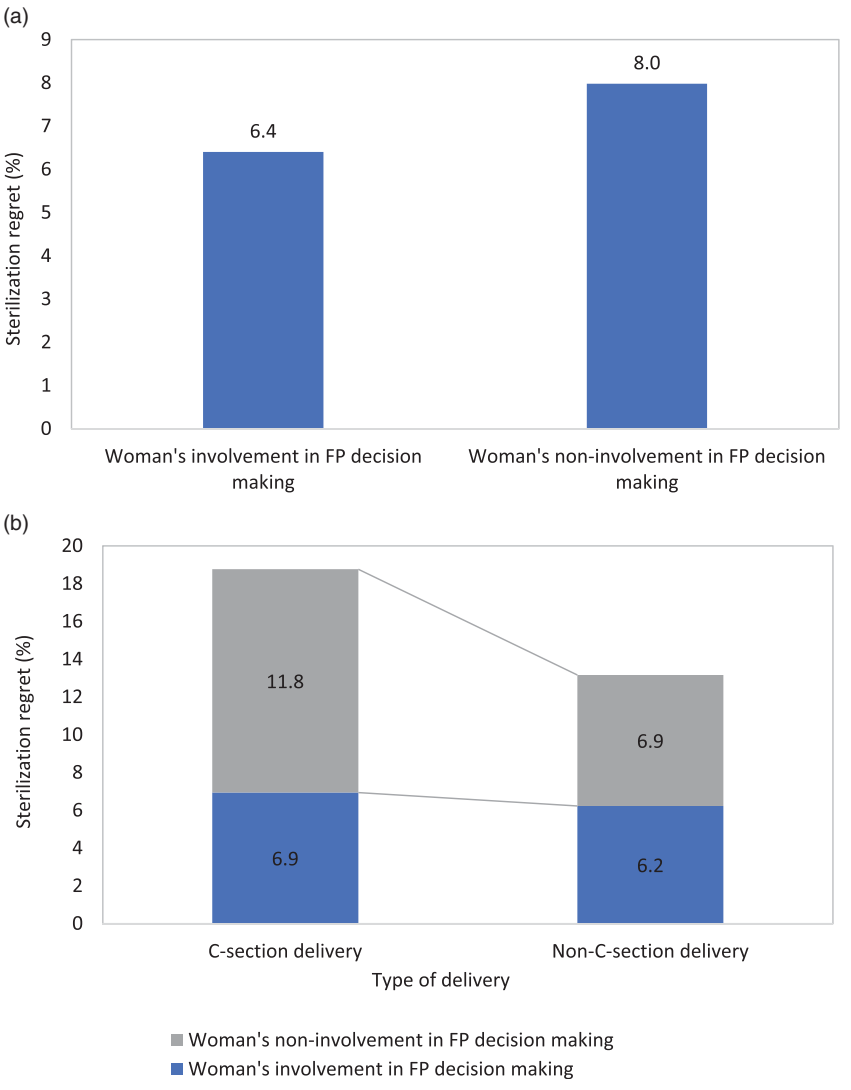

Figure 5. Female sterilization regret by a) women's involvement in decision-making on family planning (FP) and b) type of delivery.

Norberg & Pantano, 2016). However, the results are in contrast with findings from other studies that indicate no association between the occurrence of C-section births and fertility levels (Gurol-Urganci *et al.*, 2014). This might be due to different contextual factors involved with those studies, which might contrast with the Indian scenario.

Conclusion

This study attempted to understand and differentiate the nature of the relationship between type of birth and consequent fertility performance among females in India using robust empirical investigation through macro- and micro-level approaches. The macro-level evaluation indicated a positive association between C-section births and female sterilizations. In contrast, it also showed a reciprocal relationship between C-section births and TFR, meaning that an increase

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Table 6. Robustness checks: estimates based on sub-samples of high-fertility (TFR≥2.1) and low-fertility (TFR<2.1) states, India, 2015–16

	High-fertility states					Low-fertility states				
			95% CI					95% CI		
Predictor	PP	SE	Lower	Upper	$p>z$	PP	SE	Lower	Upper	$p>z$
Model 1[a]										
	$n = 125{,}868$					$n = 69{,}493$				
Type of delivery										
Non-C-section (Ref.)	0.154	0.0002	0.154	0.155		0.259	0.0004	0.258	0.259	
C-section	0.274	0.0014	0.272	0.277	<0.001	0.427	0.0012	0.424	0.429	<0.001
Model 2[b]										
	$n = 105{,}417$					$n = 49{,}417$				
Type of delivery										
Non-C-section (Ref.)	0.295	0.0004	0.294	0.296		0.240	0.001	0.239	0.241	
C-section	0.266	0.0016	0.262	0.269	<0.001	0.239	0.001	0.236	0.241	
Current use of family planning										
No (Ref.)	0.220	0.0006	0.219	0.221		0.199	0.001	0.197	0.200	
Yes	0.318	0.0005	0.317	0.319	<0.001	0.262	0.001	0.261	0.263	<0.001
Model 3[c]										
All married women										
	$n = 105{,}417$					$n = 49{,}417$				
Type of delivery										
Non-C-section (Ref.)	2.892	0.003	2.886	2.897		2.323	0.003	2.318	2.328	
C-section	1.941	0.006	1.929	1.952	<0.001	1.789	0.003	1.782	1.796	<0.001
Current use of family planning										
No (Ref.)	2.903	0.005	2.894	2.912		2.311	0.003	2.304	2.317	
Yes	2.755	0.003	2.748	2.761	<0.001	2.114	0.003	2.108	2.120	<0.001
Sterilized women										
	$n = 20{,}559$					$n = 20{,}276$				
Type of delivery										
Non-C-section (Ref.)	3.417	0.006	3.405	3.429		2.751	0.004	2.743	2.759	
C-section	2.811	0.015	2.782	2.840	<0.001	2.353	0.006	2.342	2.364	<0.001
Current use of family planning										
No (Ref.)	—	—	—	—		—	—	—	—	
Yes	—	—	—	—		—	—	—	—	

The analysis was controlled for demographic, socioeconomic and biomedical covariates included in the previous models. Ref.: reference category.

[a]Model 1: logistic regression estimates of predicted probability of having sterilization in women with second-order delivery by type of last delivery.

[b]Model 2: logistic regression estimates of predicted probability of future fertility intentions: women with second-order delivery but not sterilized and wanted to have an additional child by type of last delivery.

[c]Model 3: Poisson regression showing the effect of type of delivery and other covariates on CEB in women.

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in C-section births increases the chance of female sterilization as well as a reduction in overall fertility level. Equivalent findings were noted in the micro-level analyses, which implied lower completed family size among women who experienced C-section births compared with those with non-C-section births. Interestingly, C-section has led to a fertility decline among both sterilized and non-sterilized married women in India. It has contributed to significantly smaller family sizes among sterilized women, while among non-sterilized women it increased use of contraception and a higher intention to have another child was observed.

The study found that females with C-section births had a relatively higher probability of having sterilization, especially after the second birth. Thus, it can be concluded that number of children, progression to higher-order births and the adoption of sterilization are significantly affected by C-section births. In turn, C-section births are affected by the number and sex composition of children at the last birth. There could be two crucial pathways through which C-section affects subsequent fertility levels in India. The first takes the pattern of the more affluent section of society where sterilization followed by C-section is understood as an instrument of wilfully reaching desired fertility goals by bypassing successive physiological pain and the risk of unwanted births. In the second scenario, for poor and rural women, post-C-section sterilization is not always a deliberate decision of women, but an involuntary choice made out of compromises or lack of awareness of other FP methods.

C-section births are widely regarded as life-saving interventions for women with emergency obstetric complications. They are crucial to reducing maternal and infant mortality. However, an excessive prevalence of C-section births is a regressive indicator of public health and maternal health care in any country (WHO, 2015). The over-utilization of C-section shifts resources away from other important medical interventions such as improving maternal health outcomes, maternal and child undernutrition and poor BMI, and inadequate access to other basic health care facilities. The excessive utilization of interventions for medically non-required cases may be harmful to maternal and neonatal outcomes. In most cases, physicians may impose it on women to get higher remuneration or implement state directives (Jou *et al.*, 2015). Due to the unreasonable economic burden of C-section deliveries, women's postnatal care and child care might be affected (Goli *et al.*, 2018). At the same time, it disproportionately influences fertility desires and reproductive behaviour in a country at various disaggregated levels.

This study suggests that sterilization regret for post-C-section delivery is higher than for normal deliveries, especially when women are not involved in contraception decision-making. Other studies have also reported an overall rise in sterilization regret in India and associated it with quality-of-care issues in the health system (Singh, 2018; Bansal & Dwivedi, 2020). Thus, the C-section deliveries inflate fertility-limiting behaviour through the involuntary imposition of sterilizations as viable FP options among potential users, thereby violating reproductive rights (Sifris, 2010). In particular, the astonishing rise in C-section births pushing an increased rate of unwanted female sterilization is a matter of policy concern. Therefore, this study has broader policy implications in addressing high C-section rates by revisiting intervention strategies towards reducing its over-utilization and preventing involuntary, uninformed or coercive female sterilizations, especially in the demographically advanced states of India.

Although replacement level of fertility is a desired demographic goal for India, the way states are achieving this goal needs rethinking (Sharma, 2014; Goli, 2021). Attainment of lower fertility rates without making substantive progress in socioeconomic development, improvement in health and women status has received substantial criticism from the Bucharest and Cairo conferences on Population and Development (Cohen & Richards, 1994; McIntosh & Finkle, 1995; Goli, 2021). Similarly, female sterilization's involuntary and coercive nature has received strong criticism worldwide (Beckett, 2005; Del Aguila, 2006; Schoen, 2001; Goli, 2021). Thus, FP programmes in India need to advocate counselling sessions for women before providing postpartum sterilization, which must include providing comprehensive information on the surgical procedure and its associated risks, safety concerns, informed consent, quality of care and choice of modern

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reversible contraception. Fertility decline in a country should happen through informed choice on FP and must uphold women's reproductive rights.

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Conflicts of Interest. The authors have no conflicts of interest to declare.

Ethical Approval. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. NFHS data are available in the public domain, so ethical approval was not required for this study.

References

Alagarajan M (2003) An analysis of fertility differentials by religion in Kerala state: a test of the interaction hypothesis. *Population Research and Policy Review* **22**(5–6), 557–574.

Bansal A and Dwivedi LK (2020) Sterilization regret in India: is quality of care a matter of concern? *Contraception and Reproductive Medicine* **5**(1), 1–12.

Barros FCD, Victora CE, Vaughan JP and Huttly SRA (1991) Epidemic of caesarean sections in Brazil. *The Lancet* **338**(8760), 167–169.

Basu AM and Desai S (2016) Hopes, dreams and anxieties: India's one-child families. *Asian Population Studies* **12**, 1.

Baveja R, Buckshee K, Das K, Das SK, Hazra MN, Gopalan S *et al.* (2000) Evaluating contraceptive choice through the method-mix approach: an Indian Council of Medical Research (ICMR) Task Force study, *Contraception* **61**(2), 113–119.

Beckett K (2005) Choosing caesarean: feminism and the politics of childbirth in the United States. *Feminist Theory* **6**(3), 251–275.

Betran AP, Merialdi M, Lauer JA, Bing-Shun W, Thomas J *et al.* (2007) Rates of caesarean section: analysis of global, regional and national estimates. *Paediatric and Perinatal Epidemiology* **21**(2), 98–113.

Bhat PNM (2002) Returning a favor: reciprocity between female education and fertility in India. *World Development* **30**(10), 1791–1803.

Bhattacharya S, Porter M, Harrild K, Naji A, Mollison J, Teijlingen E *et al.* (2006) The absence of contraception after caesarean section: voluntary or involuntary? *BJOG* **113**(3), 268–275.

Bongaarts J (2009) Human population growth and the demographic transition. *Philosophical Transactions of the Royal Society B: Biological Sciences* **364**(1532), 2985–2990.

Chan LM and Westhoff CL (2010) Tubal sterilization trends in the United States. *Fertility and Sterility* **94**(1), 1–6.

Clark S (2000) Son preference and sex composition of children: evidence from India. *Demography* **37**(1), 95–108.

Cohen SA and Richards CL (1994) The Cairo consensus: population, development and women. *Family Planning Perspectives* **26**, 272–277.

Collin SM, Marshall T and Filippi V, (2006) Caesarean section and subsequent fertility in sub-Saharan Africa. *BJOG* **113**(3), 276–283.

De Oliveira IT, Dias JG and Padmadas SS, (2014) The dominance of sterilization and alternative choices of contraception in India: an appraisal of the socioeconomic impact. *PloS One* **9**, e86654.

Del Aguila EV (2006) Invisible women: forced sterilization, reproductive rights, and structural inequalities in Peru of Fujimori and Toledo. *Studies and Research in Psychology* **6**(1), 109–124.

Dharmalingam A, Rajan S and Morgan SP (2014) The determinants of low fertility in India. *Demography* **51**(4), 1451–1475.

Dommaraju P and Agadjanian V (2009) India's North–South divide and theories of fertility change. *Journal of Population Research* **26**(3), 249.

Drèze J and Murthi M (2001) Fertility, education, and development: evidence from India. *Population and Development Review* **27**(1), 33–63.

Dyson T and Moore M (1983) On kinship structure, female autonomy, and demographic behavior in India. *Population and Development Review* **9**(1), 35–60.

Ehrenberg HM, Dierker L, Milluzzi C and Mercer BM (2003) Low maternal weight, failure to thrive in pregnancy, and adverse pregnancy outcomes. *American Journal of Obstetrics and Gynaecology* **189**(6), 1726–1730.

Engelhardt H, Kohler HP and Prskawetz A (2009) Causal analysis in population studies. In *Causal Analysis in Population Studies*. Springer, The Netherlands, pp. 1–7.

Evans CL, Maine D, McCloskey L, Feeley FG and Sanghvi H (2009) Where there is no obstetrician-increasing capacity for emergency obstetric care in rural India: an evaluation of a pilot program to train general doctors. *International Journal of Gynaecology & Obstetrics* **107**(3), 277–282.

Evers EC, McDermott KC, Blomquist JL and Handa VL (2014) Mode of birth and subsequent fertility. *Human Reproduction* **29**(11), 2569–2574.

Faúndes A and Cecatti, JG (1993) Which policy for caesarian sections in Brazil? An analysis of trends and consequences. *Health Policy and Planning* **8**(1), 33–42.

Ganatra BR, Coyaji KJ and Rao VN (1998) Too far, too little, too late: a community-based case-control study of maternal mortality in rural west Maharashtra, India. *Bulletin of the World Health Organization* **76**(6), 591.

Ghosh S and Chattopadhyay A (2017) Religion, contraceptive method mix, and son preference among Bengali-speaking community of Indian subcontinent. *Population Research and Policy Review* **36**(6), 929–959.

Goli S, Rammohan A and Moradhvaj (2018) Out-of-pocket expenditure on maternity care for hospital births in Uttar Pradesh, India. *Health Econonomics Review* **8**(1), 1–16.

Goli S, James KS, Singh D, Srinivasan V, Mishra R, Rana MJ and Reddy US (2021) Economic returns of family planning and fertility decline in India, 1991–2061. *Journal of Demographic Economics*, doi.org/10.1017/dem.2021.3.

Goli S (2021) *Problems with Uttar Pradesh's Population Bill, East Asia Forum*. Published 14th August 2021. URL: https://www.eastasiaforum.org/2021/08/14/problems-with-uttar-pradeshs-population-bill/ (accessed 15th August 2021)

Guilmoto CZ and Dumont A (2019) Trends, regional variations, and socioeconomic disparities in cesarean births in India, 2010–2016. *JAMA Network Open* **2**(3), e190526–e190526.

Gupta JA (1993) 'People like you never agree to get it: an Indian family planning clinic. *Reproductive Health Matters* **1**(1), 39–43.

Gurol-Urganci I, Cromwell DA, Mahmood TA, Van Der Meulen JH and Templeton A (2014) A population-based cohort study of the effect of Caesarean section on subsequent fertility. *Human Reproduction* **29**(6), 1320–1326.

IIPS and ICF (2017*) India National Family Health Survey NFHS-4, 2015–16*. India International Institute for Population Sciences (IIPS) and ICF, Mumbai.

Jain AK (2016) Examining progress and equity in information received by women using a modern method in 25 developing countries. *International Perspectives on Sexual and Reproductive Health* **42**(3), 131–140.

James KS (1999) Fertility decline in Andhra Pradesh: a search for alternative hypotheses. *Economic & Political Weekly* **34**(8), 491–499.

James KS (2011) India's demographic change: opportunities and challenges. *Science* **333**(6042), 576–580.

James KS and Goli S (2016) Demographic changes in India. Is the country prepared for the challenge? *The Brown Journal of World Affairs* XXI, Fall–Winter.

Jayaraman A, Mishra V and Arnold F (2009) The relationship of family size and composition to fertility desires, contraceptive adoption and method choice in South Asia. *International Perspectives on Sexual and Reproductive Health* **35**(1), 29–38.

Jejeebhoy SJ (1995) *Women's Education, Autonomy, and Reproductive Behaviour: Experience from Developing Countries*. Oxford University Press. ISBN: 9780198290339.

Jou J, Kozhimannil KB, Johnson PJ and Sakala C (2015) Patient-perceived pressure from clinicians for labor induction and cesarean delivery: a population-based survey of US women. *Health Services Research* **50**(4), 961–981.

Koenig MA (2003) *The Impact of Quality of Care on Contraceptive Use: Evidence from Longitudinal Data from Rural Bangladesh. Frontiers Final Report*, Population Council, Washington DC.

León FR (2011) Does professed religion moderate the relationship between women's domestic power and contraceptive use in India. *Open Family Studies Journal* **4**(1), 1–8.

Ma KZM, Norton EC and Lee SYD (2010) Declining fertility and the use of cesarean delivery: evidence from a population-based study in Taiwan. *Health Services Research* **45**(5), 1360–1375.

McIntosh CA and Finkle JL (1995) The Cairo conference on population and development: a new paradigm? *Population and Development Review* **21**(2), 223–260.

McNay K, Arokiasamy P and Casses R (2003) Why are uneducated women in India using contraception? *A multilevel analysis, Population Studies* **57**(1), 1–40.

Mishra US and Ramanathan M (2002) Birth-related complications and determinants of caesarean section rates in India. *Health Policy and Planning* **17**(1), 90–98.

Mollison J, Porter M, Campbell D and Bhattacharya S (2005) Primary mode of birth and subsequent pregnancy. *BJOG: An International Journal of Obstetrics & Gynaecology* **112**(8), 1061–1065.

Moursand A and Kravdal Ø (2003) Individual and community effects of women's education and autonomy on contraceptive use in India. *Population Studies* **57**(3), 285–301.

Murphy DJ, Stirrat GM, Heron J and **ALSPAC Study Team** (2002) The relationship between Caesarean section and subfertility in a population-based sample of 14541 pregnancies. *Human Reproduction* **17**(7), 1914–1917.

Nataraj S (1994) The magnitude of neglect: women and sexually transmitted diseases in India. In *Private Decisions, Public Debate: Women, Reproduction and Population.* Panos Publication, London, pp. 7–20.

Norberg K and Pantano JJ (2016) Caesarean section and subsequent fertility. *Journal of Population Economics* **29**(1), 5–37.

Oliveira ITD, Dias JG and Padmadas SS (2014) Dominance of sterilization and alternative choices of contraception in India: an appraisal of the socioeconomic impact. *PLoS One* **9**(1), e86654.

O'Neill SM, Khashan AS, Henriksen TB, Kenny LC, Kearney PM, Mortensen PB *et al.* (2014) Does a Caesarean section increase the time to a second live birth? A register-based cohort study. *Human Reproduction* **29**(11), 2560–2568.

Oral E and Elter K (2007) The impact of cesarean birth on subsequent fertility. *Current Opinion in Obstetrics and Gynecology* **19**(3), 238–243.

Raj A, Saggurti N, Balaiah D and Silverman JG (2009) Prevalence of child marriage and its effect on fertility and fertility-control outcomes of young women in India: a cross-sectional, observational study. *The Lancet* **373**(9678), 1883–1889.

Rajaretnam T and Deshpande RV (1994) The effect of sex preference on contraceptive use and fertility in rural South India. *International Family Planning Perspectives* **20**(3), 88–95.

Saavala M (2013) *Fertility and Familial Power Relations: Procreation in South India*. Routledge.

Schoen J (2001) Between choice and coercion: women and the politics of sterilization in North Carolina, 1929–1975. *Journal of Women's History* **13**(1), 132–156.

Sebire NJ, Jolly M, Harris J, Regan L and Robinson S (2001) Is maternal underweight really a risk factor for adverse pregnancy outcome? *A population-based study in London'. British Journal of Obstetrics and Gynaecology* **108**(1), 61–66.

Sharma DC (2014) India's sterilization scandal. *The Lancet* **384**(9961), e68–e69.

Sifris R (2010) Conceptualising involuntary sterilization as 'severe pain or suffering'for the purposes of torture discourse. *Netherlands Quarterly of Human Rights* **28**(4), 523–547.

Singh A, Ogollah R, Ram F and Pallikadavath S (2012) Sterilization regret among married women in India: implications for the Indian national family planning program. *International Perspectives on Sexual and Reproductive Health* **38**(4) 187–195.

Singh A (2018) Sterilization regret among married women in India: trends, patterns and correlates. *International Perspectives on Sexual and Reproductive Health* **44**(4), 167–176.

Smith GCS, Wood AM, Pell JP and Dobbie R (2006) First caesarean birth and subsequent fertility. *Fertility and Sterility* **85**(1), 90–95.

Spoorenberg T and Dommaraju P (2012) Regional fertility transition in India: an analysis using synthetic parity progression ratios. *International Journal of Population Research* **2012**, 358409.

Srikanthan A and Reid RL (2008) Religious and cultural influences on contraception. *Journal of Obstetrics and Gynaecology Canada* **30**(2), 129–137.

Srinivasan K (2017) *Population Concerns in India: Shifting Trends, Policies, and Programs*. SAGE Publishing, India.

Stulp G, Verhulst S, Pollet TV, Nettle D and Buunk AP (2011) Parental height differences predict the need for an emergency caesarean section, *PLoS One* **6**(6), e20497.

Verma RK and Roy TK (1999) Assessing the quality of family planning service providers in four Indian states. In Koenig MA and Khan ME (eds) *Improving Quality of Care in India's Family Welfare Programme: The Challenge Ahead*. The Population Council, New York, pp. 169–182.

Vlassoff C, Rao S and Vishnu Lale S (2016) Can conditional cash transfers promote delayed childbearing? *Evidence from the 'Second Honeymoon Package' in rural Maharashtra, India. Asian Population Studies* **13**(1), 1–15.

WHO (2015) *WHO Statement on Caesarean Section Rates* (No. WHO/RHR/15.02). World Health Organization, Geneva.

Xiong C, Zhou A, Cao Z, Zhang Y, Qiu L, Yao C *et al.* (2016) Association of pre-pregnancy body mass index, gestational weight gain with caesarean section in term births of China. *Scientific Reports* **6**(37168), doi: 10.1038/srep3716

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