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# Risk factors for cesarean section in women of urban Puducherry, India: A matched case–control study

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## Abstract

Cesarean section (CS) is generally performed either to ensure maternal and child safety when vaginal delivery is not possible. The WHO has indicated that CS rates of more than 10% are considered overutilization. Increased CS rates can cause an increase in postpartum antibiotic treatment and longer hospital stay. In this research, we conducted a matched case–control study, including all women who gave birth through CS and resided in the study area over a 3-year period before the survey as cases and similar age- and year-matched women who had normal vaginal delivery during the same period as controls. The data were collected using a semi-structured pro forma through personal interviews and verified with discharge cards. We obtained a sample of 140 women (70 matched cases and controls) as study participants. Our results show that unadjusted analysis revealed socioeconomic status, history of gestational diabetes mellitus, previous lower segment CS (LSCS), and malpresentation emerged as risk factors, whereas in the adjusted analysis, we observed that previous LSCS (aOR 45.4 [4.3 – 483.6]), malpresentation (aOR 11.0 [1.6 – 73.8]), and belonging to middle (aOR 3.3 [1.0 – 10.8]) and upper class (aOR 23.55 [CI: 1.2 – 463.8]) remained as independent risk factors. Our study identified independent risk factors for CS that needs to be tackled for bringing down the CS rates.

***Keywords:*** Antenatal care; Cesarean section; India; Matched case–control design; National Family Health Survey; Risk factors

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## 1. Introduction

Cesarean section (CS or C-section) is a surgical procedure performed either to ensure maternal and child safety when vaginal delivery is not possible (emergency CS) or as an elective procedure (planned CS). With advancement in anesthetic procedures and improved surgical techniques, the morbidity and mortality of CSs have reduced. The WHO considers the proportion of CS to the total births as one of the vital indicators of emergency obstetric care (Arjun, 2008). A CS rate higher than 10% is regarded as over utilization, that is, for other than life-saving reasons (Wehberg *et al.*, 2018). Both developed and developing countries have reported about 27% CS in 2013 (Betran *et al.*, 2021). Many developing countries such as China and Bangladesh have reported a tremendous increase in CS birth rates in the past two decades (Ahmmed *et al.*, 2021; Li

*et al*., 2020), thereby making it a serious public health issue (Lauer *et al*., 2010). Several studies conducted in different parts of the world have shouldered the above statement (Betran *et al*., 2007; Betran *et al*., 2016; Betran *et al*., 2021).

A WHO global survey has revealed that CS is associated with an increase in postpartum antibiotic treatment, greater complications in subsequent pregnancies, longer hospital stay, and severe maternal-neonatal morbidity and mortality (Villar *et al*., 2006). Especially in neonates, this has led to increased risk of neonatal complications such as pulmonary hypertension, respiratory distress syndrome, and iatrogenic prematurity (Betran *et al*., 2021; Wehberg *et al*., 2018).

In India, there is no national guideline for decision-making among the clinicians in choosing CS. National Family Health Survey-4 states that the proportion of births delivered by CS in India is 17.2%, which is higher than the WHO recommendations (Panda *et al*., 2018). It is disquieting to note that these rates have doubled in the past decade (Srivastava *et al*., 2020). A study done among 30 teaching hospitals/medical colleges in South India, comparing the rates between 1993 – 1994 and 1998 – 1999, has shown that the overall CS rates have increased from 21.8% in 1993 – 1994 to 25.4% during 1998 – 1999. Alarmingly among them, primigravida constituted around 42.4%, and 31% were hailing from rural areas, which has right now reached 21% at the national level, with a considerable increase specifically in the private sectors (Kambo *et al*., 2002; Roy *et al*., 2021). One such important reason for peaking of these CS rates is the rise in primary CS followed by proportionate rise in repeat CS as well. Studies done in South India have also shown similar findings (Bhasker, 1994; Roy *et al*., 2021).

A cesarean without any indications could result in more harm than good, in fact a low-risk uncomplicated CS has an 8 times higher risk of mortality and 8 – 12-fold more risk of morbidity than spontaneous vaginal delivery (Boehm & Graves, 1994). Studies have proven that non-medical indications make up about 1/3$^{rd}$ of the global total 18.5 million CS cases performed annually (Begum *et al*., 2017; Festin *et al*., 2009).

Unnecessary cesareans may also result in catastrophic health expenditure at the family level and overburden the existing health finances at the national level (Lauer *et al*., 2010). Dismally, taking India's economic and human resource constraints into consideration, our health system is hardly equipped to handle such an unprecedented increase in CSs.

This drastic escalation of CS rates has warranted further research to monitor the indications and evaluate the factors influencing them. There is a paucity of research on clinical indications and factors influencing cesarean deliveries in India, which is essential for deeper understanding of various strategies to halt this epidemic of CSs. Prior attempts to determine the risk factors for CS were mostly cross-sectional in nature and were widely done across western settings. Thus, our study aimed to determine the various sociodemographic risk factors and antenatal complications that influenced cesarean deliveries among the mothers who delivered during the past 3 years in the selected wards of urban Puducherry, India.

## 2. Data and methods

### 2.1. Study design and study setting

Our study was conducted as a matched case control study in Jipmer Institute Urban Health Centre (JIUHC) service area, health center of a tertiary care institute in Puducherry, India. We adopted this novel study design as matched case–control studies, as this study design helps us not only to eliminate confounding but also to gain potential benefit in gaining efficiency when compared to conventional case–control studies. The health center caters a population of about 8000 comprising four wards, namely, Kurusukkupam, Vazhaikullam, Chinnayapuram, and Vaithikuppam, with around 2000 population each. The JIUHC (nearest health facility to all four wards ~ 1.2 km) provides comprehensive primary care services to the people, apart from being an urban health center for undergraduate and postgraduate teaching under JIPMER (Rajaa *et al*., 2019). All four wards share similar sociodemographic and cultural factors. The study was conducted during January and February 2018. A preliminary record review showed that on an average, around 80 – 90 deliveries are registered in the service area every year. For our study, we included all women who gave birth through CS and reside in our service area, during the past 3 years (January 2015 – December 2017) as cases and for controls, we enrolled age- and year-matched (for risk factor comparability) women who had normal vaginal delivery during January 2015 – December 2017.

### 2.2. Sample size

Sample size was calculated to be 45 matched pairs based on a study done by Wehberg *et al*. (2018) in Denmark taking the percentage of exposed (previous lower segment CS (LSCS) in cases as 36% and controls as 8% (normal delivery), power of 80%, alpha error of 5%, and 95% CI using nMaster 2.0 software). However, we included 70 matched pairs (140 in total, i.e., 70 women who delivered through CS and another 70 who delivered vaginally) as we considered all women who delivered through CS during the past 3 years of the study.

### 2.3. Data collection procedure

Three trained doctors were assigned to collect list of mothers who delivered in the past 3 years from the birth register (giving a total of 241 deliveries) and the total CS deliveries were jotted down. After a preliminarily data analysis, we could get a total of 83 CS deliveries. We tried approaching all 83 women who delivered through CS, out of which we could reach 70 mothers. Out of the 83 women who had CS, three of them moved out of the service area and 10 were not reachable even through mobile. Thus, finally, we finally arrived at 70 cases, and we went on choosing eligible age- and year-matched controls in the ratio of 1:1. Thus, the study progressed with 70 matched pairs (cases and controls). The controls were then age matched for the cases by selecting them with a within an age difference range of ±2 years. The controls were also month-matched by choosing them of the same month of delivery as that of the cases.

After obtaining the list of cases and eligible controls, four trained doctors were chosen to do data collection. The data collectors were enrolled after familiarizing them regarding the questionnaire and objectives of the study. Data collection was done through regular house to house visits on a daily basis, data collection process was supervised and reviewed by the principal investigator posted in health center to ensure completion of data and to address the issues faced by the data collectors. If the households remained closed even after making two home visits, we tried contacting them through phone and if they were: Not traceable through phone, moved out of service area, and houses remaining locked after two visits were excluded from the study. The same excluding criteria were applicable for the controls too.

The importance of the study was explained to the women before administration of the questionnaire. They were enrolled only after obtaining informed consent and assured confidentiality. Interview had three sections: Sociodemographic characteristics; indications for cesarean; and last section had delivery details. Since delivery being a significant life event, the recall period of 3 years was chosen as the chances of remembering the details are highly possible. The indications for CS were asked from the mother and cross-verified with the discharge slip for all cases. The delivery details were obtained from the delivery card.

### 2.4. Data analysis

Data were entered into Microsoft Excel 2013 and analyzed using STATA 14 (Stata Corp., 2012). Continuous variables were summarized as mean (SD) or median (IQR) depending on their distribution. The sociodemographic risk factors were summarized as proportions. Association between CS and various risk factors and sociodemographic factors was analyzed using Chi-square test with 95% confidence intervals. $P < 0.05$ was taken to be statistically significant. Bivariable logistic regression was carried out for each variable and those variables whose odds ratios (OR) were significant at $P < 0.2$ were taken into the model for calculating adjusted odds ratio.

### 2.5. Ethical statement

The study was done as a component of MCH care services delivered in the urban health center toward obstetric care. Any queries arising from the participants were clarified after obtaining written consent. The study was reviewed and approved by the department review committee.

## 3. Results

There were totally 140 mothers included into the study (70 case and 70 age and period matched controls). Table 1 shows the sociodemographic characteristics of the study participants. The mean age ± standard deviation (SD) of the cases and controls were 29.4 ± 4.9 and 29.2 ± 4.5 years, respectively. Among 140 mothers interviewed, almost 50% of the cases and controls had education up to 10$^{th}$ standard. Majority 61 (87.1%) and 62 (88.5%) of the cases and controls were Hindu by religion. About 56 (80%) of the cases and controls 60 (85%) were housewives by occupation. More than 2/3$^{rd}$ of the study population in each group belonged to middle or upper class according to Modified BG Prasad classification (cases 78% and controls 66%) (Majhi & Bhatnagar, 2021). Both the groups had almost equal proportion of low birth weight (cases 48% and controls 52%). A higher proportion of the cases (31.4%; $n = 22$) had delivered in a private institution compared with controls (18.5%; $n = 13$).

Among sociodemographic factors, only socioeconomic status ($P = 0.04$) emerged as a significant risk factor for CS. Other factors such as education, occupation, and religion and birth weight of the baby of the baby did not show significant association.

The association of cases and controls with the various antenatal complications assessed in the study is represented in Table 2. In unadjusted analysis [Table 2], history of gestational diabetes (OR = 3.7; CI: 1.1 – 14.2), previous LSCS (OR = 29.5; CI: 3.8 – 227.4), and malpresentation during delivery (OR = 5; CI: 10 – 24.1) emerged as the three significant risk factors for CS in this study.

Table 3 shows the final multivariable analysis which includes variables whose OR had a significance level $P < 0.2$ in unadjusted bivariable analysis. In multivariable analysis, previous LSCS (aOR of 45.4, CI: 4.3 – 483.6), malpresentation during delivery with (aOR of 11.02, CI: 1.6 – 73.8), and belonging to middle and upper class emerged as independent risk predictors with an aOR of 3.3 (CI: 1.0 – 10.8) and 23.55 (CI: 1.2 – 463.8), respectively,

**Table 1. Sociodemographic characteristics of cases and controls among selected wards in urban Puducherry, *n*=140.**

| Study characteristic | Cases frequency, *n* (%) | Controls frequency, *n* (%) | *P*-value* |
|---|---|---|---|
| Years of education (in years) | | | |
| <10 | 36 (51.4) | 35 (50) | 0.97 |
| 11–12 | 11 (15.7) | 12 (17.1) | |
| >12 | 23 (32.8) | 23 (32.9) | |
| Religion | | | |
| Hindu | 61 (87.1) | 62 (88.5) | 0.79 |
| Others | 9 (12.9) | 8 (11.4) | |
| Occupation of mother | | | |
| Housewife | 56 (80.0) | 60 (85.7) | 0.37 |
| Working | 14 (20.0) | 10 (14.3) | |
| Occupation of father | | | |
| Unskilled | 9 (12.9) | 4 (5.7) | 0.33 |
| Semiskilled | 42 (60.0) | 47 (67.1) | |
| Skilled | 19 (27.1) | 19 (27.1) | |
| Socioeconomic status (Modified BG Prasad Scale) (Majhi *et al.*, 2021) | | | |
| Lower class | 1 (1.4) | 5 (7.1) | 0.04† |
| Lower-middle class | 14 (20.0) | 19 (27.1) | |
| Middle class | 15 (21.4) | 21 (30.0) | |
| Upper-middle class | 15 (21.4) | 14 (20.0) | |
| Upper class | 25 (35.7) | 11 (15.7) | |
| Parity | | | |
| 1 | 32 (45.7) | 28 (40.0) | 0.37 |
| 2 | 35 (50.0) | 37 (52.9) | |
| 3 | 3 (4.3) | 5 (7.1) | |
| Institution of delivery | | | |
| Private | 22 (31.4) | 13 (18.5) | 0.07 |
| Government | 48 (68.6) | 57 (81.4) | |
| Birth weight | | | |
| Low birth weight (<2.5 kg) | 10 (47.6) | 11 (52.4) | 0.81 |
| Normal birth weight (>2.5 kg) | 60 (50.4) | 59 (49.6) | |

*Chi-square test, †statistically significant

even after adjusting for all other factors which turned significant during unadjusted analysis.

## 4. Discussion

This was a community-based matched case–control study conducted among selected urban wards of Puducherry to assess the risk factors for CS and compared to vaginal delivery. The proportion of CS deliveries among all deliveries during the past 3 years was found to be 34.4%. This found to be in accordance with the CS rates in Puducherry according to NFHS-4 but almost twice that of the national average (Matkar, 2017; Srivastava *et al.*, 2020). In our study, four factors, namely, middle and upper socioeconomic class, antenatal complications such as previous history of LSCS, and malpresentation during delivery were found to be the independent predictors of CS.

Our study showed that the socioeconomic status and delivery in a private institution had higher proportions of CS. A wide range of literature from different parts of the world has well established the relationship between the place of delivery and the risk of CS (Gibbons *et al.*, 2010; Witt *et al.*, 2015). The proportion of CS in a private sector was found to be almost 1.5 times more than the rate of vaginal deliveries (18.5% and 31.4%, respectively), though not statistically significant. This proportion was lesser than Puducherry data according to NFHS but quite similar to the national level figures (Matkar, 2017; Srivastava *et al.*, 2020). We also found that higher socioeconomic status was a risk factor. Various studies done in Latin America, China, and South India have also emphasized the above findings (Ming *et al.*, 2019; Mohan *et al.*, 2019). This reinforces the hypothesis that CS rates are highly influenced by income and health-seeking behavior of the wealthy people.

Our study described that gestational diabetes mellitus was a significant risk factor for CS, in unadjusted analysis. Similar study done in Indian context to understand the risk factors for CS have also established the same (Poobalan *et al.*, 2009). Our study established that mothers who delivered through CS had 5 times more odds of having Malpresentation (breech/transverse lie, etc.,) as a risk factor. We also found that among the mothers who underwent CS had 30 times, more odds of having undergone a LSCS in their previous pregnancy. Similar findings were reported in a cohort study conducted in Denmark which reported serious and explosive risk associated with these risk factors and the type of delivery (Wehberg *et al.*, 2018). These figures question the practice of trial of labor after CS (TOLAC) or vaginal birth after cesarean (VBAC) after previous LSCS. There is enough evidence around the world supporting trial of labor as a safe option for women following previous LSCS. Studies have showed that the success rates of TOLAC to be around 60-80% provided the candidates are appropriately selected (favorable bishop score and spontaneous onset of labor) (Soni *et al.*, 2015). Thus, encouraging VBAC or TOLAC among women with favorable factors would enable the health systems to combat this epidemic of rising CS rates. However, an individualized approach is necessary assessing every woman taking the existing circumstances and facilities into consideration.

Our study in multivariable logistic regression analysis showed that previous LSCS, malpresentation, and belonging

**Table 2. Antenatal complications and its association with cases and controls among selected wards in urban Puducherry, *n*=140.**

| Complications | Total, *n* (%) | Cases, *n* (%) | Controls, *n* (%) | Unadjusted odds ratio (95% CI) | *P*-value* |
|---|---|---|---|---|---|
| Gestational diabetes mellitus | | | | | |
| Yes | 13 (9.3) | 10 (14.3) | 3 (4.3) | 3.7 (1.1–14.2) | 0.04† |
| No | 127 (90.7) | 60 (85.7) | 67 (95.7) | 1 | |
| Gestational hypertension | | | | | |
| Yes | 13 (9.3) | 9 (12.9) | 4 (5.7) | 2.4 (0.7–8.3) | 0.14 |
| No | 127 (90.7) | 61 (87.1) | 66 (94.3) | 1 | |
| Cardiovascular diseases | | | | | |
| Yes | 3 (2.1) | 2 (2.9) | 1 (1.4) | 2 (0.2–22.9) | 1 |
| No | 137 (97.9) | 68 (97.1) | 69 (98.6) | 1 | |
| Previous LSCS‡ | | | | | |
| Yes | 22 (15.7) | 21 (30) | 1 (1.4) | 29.5 (3.8–227.2) | <0.001† |
| No | 118 (84.3) | 49 (70) | 69 (98.6) | 1 | |
| Elderly gravida | | | | | |
| Yes | 6 (4.3) | 5 (7.1) | 1 (1.4) | 5.3 (0.6–46.6) | 0.2 |
| No | 134 (95.7) | 65 (92.9) | 69 (98.6) | 1 | |
| Anemia | | | | | |
| Yes | 24 (17.1) | 13 (18.6) | 11 (5.7) | 1.2 (0.5–2.9) | 0.8 |
| No | 116 (82.1) | 57 (81.4) | 59 (84.3) | 1 | |
| Malpresentation | | | | | |
| Yes | 11 (7.9) | 9 (12.9) | 2 (2.9) | 5 (1.0–24.1) | 0.02† |
| No | 129 (92.1) | 61 (87.1) | 68 (97.1) | 1 | |

*Binary logistic regression, †statistically significant, ‡lower segment cesarean section

**Table 3. Multivariable logistic regression analysis for factors associated with the cases and controls among selected wards in urban Puducherry, *n*=140.**

| Characteristics | Adjusted odds ratio (95% CI) | *P*-value |
|---|---|---|
| Gestational diabetes mellitus | 3.3 (0.7–15.3) | 0.16 |
| Gestational hypertension | 1.98 (0.4–9.3) | 0.38 |
| Previous LSCS | 45.42 (4.3–483.6) | 0.002* |
| Malpresentation | 11.02 (1.6–73.8) | 0.01* |
| Elderly gravida | 6.3 (0.5–75.7) | 0.15 |
| Lower-middle class | 1.36 (0.4–4.3) | 0.59 |
| Middle class | 3.3 (1.0–10.8) | 0.05* |
| Upper-middle class | 2.2 (0.7–7.1) | 0.18 |
| Upper class | 23.55 (1.2–463.8) | 0.03* |
| Delivery in private hospital | 1.81 (0.7–4.7) | 0.22 |

*Statistically significant, †lower segment cesarean section

to middle and upper socioeconomic class emerged as independent risk factors for CS even after adjusting for all other variables in the model. This shows the importance of clinician's decision-making in determining the indication of CS among the pregnant women. It is very difficult to follow a protocol with a set of indications in determining CS as mostly these decisions are taken in an individualized approach, inside the labor room based on the intrapartum condition of the mother and the fetus.

Our study had several strengths. We employed a case–control design to find the risk factors associated with increased CS in an urban setting. We age and period matched the cases and controls to match the characteristics and risk factor profile of the study participants. Although we picked only 70 matched pairs, matching for age and period increased the power of the study. We collected the information through personal interviews from the mothers themselves. We verified the information obtained, through the discharge slips available with the mothers. Our study also adds to the existing literature for evidence-based decision-making in choosing CS as a mode of delivery. We used the same reference period for both cases and controls to reduce misclassification bias. To reduce interviewer bias, identical probes were used and effort was made to ensure approximately similar interview time for both cases and controls.

Our study also had certain limitations. Although we had a recall period of 3 years to reduce the recall bias, it

was unavoidable. The assessment of risk factors could have been subjected to recall bias when the discharge slips were not available with the participants. Furthermore, we got a limited sample size of 70 matched cases and controls, the results are less likely robust, especially for some very large odds ratios, making our study lacked sufficient power to detect an association for known risk factors such as gestational hypertension, cardiovascular diseases, and elderly gravida. In addition, we have only utilized the variables that were readily available in the ANC cards, thus, we could have missed other significant associates of CS. Studies with larger sample size are clearly warranted to establish more reliable findings.

## 5. Conclusions

Our study showed that socioeconomic class, previous LSCS, and malpresentation were found to be independent risk factors for CS in urban Puducherry. We recommend a further review of the health-care delivery system, to halt the rise in CS rates in the nation. We also call for policymakers to formulate and set up national guidelines reviewing various indications for CS, thereby minimizing the rates of unnecessary CS.

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## Conflict of interest

None declared.

## Author contributions

*Conceptualization:* Sathish Rajaa and Akkilangunta Sujiv
*Data curation:* Sathish Rajaa, Akkilangunta Sujiv, and Sitanshu Sekar Kar
*Formal analysis:* Sathish Rajaa and Akkilangunta Sujiv
*Writing – original draft:* Sathish Rajaa and Akkilangunta Sujiv
*Writing – review and editing:* Sathish Rajaa, Akkilangunta Sujiv, and Sitanshu Sekar Kar.

## Ethics approval and consent to participate

The study was done as a component of MCH care services delivered in the urban health center toward obstetric care. Any queries arising from the participants were clarified after obtaining written consent. The study was reviewed and approved by the department research and ethics committee (approved ID batch: JIP/2018).

## Consent for publication

Not applicable.

## Availability of data

The authors confirm that the data supporting the findings of this study are available within the article, and if necessary, will be shared on reasonable request.

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