*Janasamkhya: A Journal of Demography: Published by the Department of Demography, University of Kerala: Vol. XLI, 2023* ISSN 0971-698X

# Exploring Regulatory Factors of Caesarean Delivery in Public and Private Health Institutions of India: Evidence from NFHS-5

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## Abstract

This paper examines the increasing rates of c-section deliveries in India over the past years using evidence from NFHS-5, highlighting their importance as indicators of emergency obstetric care. Our findings indicate a higher prevalence of c-sections among urban women, those with higher education, and affluent households, with access to comprehensive antenatal care and mass media exposure also playing significant roles. The analysis reveals stark differences between public and private healthcare facilities, where women in rural areas face barriers to timely access due to the uneven distribution of public resources. Socioeconomic factors, such as wealth, caste, and religion, influence c-section access in public settings but are statistically insignificant in private facilities, which cater to a more homogeneous clientele. Additionally, perceptions of care quality drive women's preferences for private facilities, often associated with better amenities. This study underscores the need for equitable healthcare policies that address disparities in access to safe childbirth options, ensuring that c-sections are performed based on medical necessity rather than socioeconomic status, ultimately promoting better maternal health outcomes across diverse populations.

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## Introduction

A Caesarean section, commonly known as c-section, is a surgical procedure used to deliver a baby through an incision in the mother's abdomen and uterus. It is typically performed when vaginal delivery would pose a risk to the mother or baby, or when complications arise during labour. Such an obstetric procedure involves making an incision in the abdomen and uterus, usually horizontally along the lower abdomen (a low transverse incision) or vertically from just below the navel to the pubic bone (a vertical incision). The baby is carefully delivered through the incisions, followed by the placenta. The incisions are then closed, typically in layers, with dissolvable sutures or staples. Overall, while c-section deliveries are generally safe when performed for appropriate medical reasons, it is essential for healthcare providers to carefully weigh the risks and benefits and follow evidence-based guidelines to optimize outcomes for both the mother and baby. When medically justified, c-sections can effectively prevent maternal and perinatal mortality and morbidity. However, there is no evidence showing the benefits of caesarean delivery for women or infants who do not require the procedure. Although c-section has become a very safe procedure in many parts of the world, it is not without risk. (Wiklund, 2012). As with any surgery, c-section is associated with short- and long-term risks with potential implications in future pregnancies. These risks are higher in women with limited access to comprehensive obstetric care and in settings that lack the facilities and the capacity to properly conduct safe surgery and appropriately manage its complications (Essendi, 2011).

According to the World Health Organization (WHO), the ideal rate for c-sections is between 10-15%. Global c-section rates have significantly increased from around 7% in 1990 to 21% today, and is

projected to 29% by 2030 (WHO news, 2021). This is due to many reasons, which may be country- and culture-specific. Some of the most omnipresent reasons behind this rise are: the fear of pain during birth including the pain of uterine contractions (Kaya, 2024); the convenience to schedule the birth when it is most suitable for families or health care professionals; and because caesarean section can be perceived as being less traumatic for the baby (Puramban, 2024) (Muhandule, 2024). In some cultures, c-section allows people to choose the date or day of the birth due to beliefs around luck or that a certain date or day is more auspicious for the child's future. In a number of countries, there is societal pressure for a perfect birth outcome, and health professionals may be sued when the results of a vaginal delivery are not as expected, which fuels their fear of litigation. In addition, in some societies, delivery by c-section is perceived to better preserve the pelvic floor, resulting in less urinary incontinence, in addition to a more satisfactory return to sexual life (Hoffmann, 2024).

The WHO has also published recommendations for non-clinical interventions to reduce unnecessary c-sections. The Robson Classification system, also known as the 10 groups classification system, is a tool designed to categorize women into mutually exclusive groups based on specific obstetric characteristics (WHO publication, 2017). This classification system helps healthcare providers to understand and analyse patterns of childbirth within healthcare facilities, allowing for better monitoring and management of labour and delivery. By identifying groups of women who are at higher risk for c-section, the Robson classification system can potentially prevent unnecessary c-sections through targeted interventions and improved management of labour.

In both public and private hospitals, c-section deliveries are common practices, albeit with some differences in accessibility, quality of care, and adherence to guidelines. Public hospitals often cater to a larger population and may face constraints in terms of resources and infrastructure, leading to potential delays in scheduling elective c-sections and longer waiting times for emergency cases. While public hospitals strive to provide adequate care, overcrowding and understaffing can sometimes compromise the quality of services. Additionally, variations in the expertise of healthcare professionals may affect the outcomes of c-section deliveries. On the other hand, private hospitals often offer more flexibility in scheduling c-section deliveries, catering to the preferences of the mother and healthcare provider. However, the cost of services in private hospitals may limit access for lower-income individuals. Also, private hospitals may vary in their adherence to WHO guidelines for c-section deliveries. Some facilities prioritize patient preferences and may be more inclined to perform elective c-sections without clear medical indications, potentially contributing to the rising rates of unnecessary c-sections globally.

In India, the prevalence of c-section deliveries has been steadily increasing, raising concerns about over-medicalization and potential risks to maternal and neonatal health. While c-sections can be life-saving in certain circumstances, the high rates of elective c-sections, particularly in private healthcare settings, have prompted calls for stricter adherence to evidence-based guidelines. Challenges such as limited access to quality maternal healthcare in rural areas, socioeconomic disparities, and cultural preferences for c-sections contribute to the complex landscape of childbirth in India. Efforts to improve access to skilled birth attendants, promote vaginal birth, and regulate the use of c-sections are underway to address these

challenges and ensure safer childbirth practices across both public and private healthcare sectors.

In this paper we have studied the various factors that might decide whether a caesarean delivery takes place in a public or a private health institute in India using evidence from National Family Health Survey (NFHS)-5 report. The approach of this paper would be to explore possible variables that might affect c-section delivery in a given health institute (which is the study variable), to study their association and statistical significance using univariate and multivariate analysis.

## Literature Review

A comprehensive search was done in databases like PubMed and Google Scholar to identify and understand factors influencing institutional deliveries and c-sections in general, and a combination of the two (c-section delivery in specific types of health institutions) in particular. The common determinants affecting c-sections in public and private health institutes in the country can be broadly grouped into socio-economic and demographic categories and healthcare or pregnancy related factors. Factors may vary for different countries based on their regional and cultural context.

There has been an increasing trend of c-section deliveries in India across public and private health facilities according to data from NFHS-4 (Das, 2019). It has been found that the rate of c-section deliveries has been increasing in India, particularly in private health facilities. Factors influencing c-section delivery include socioeconomic status, education level, place of residence, age, BMI, and exposure to media. The need for holistic programs including public-private partnerships, to reduce medically unnecessary c-section cases and improve women's health have been emphasized.

A study on clinical ethics by Movsas et al determine whether differences in medical risk factors account for the apparent caesarean rate discrepancy between Medicaid and privately insured patients. The key takeaway from the paper is that there is no significant disparity in the odds of caesarean delivery between privately insured and Medicaid patients in Michigan after adjusting for other caesarean risk factors. This suggests that financial incentives associated with insurance status do not play a significant role in physician decision-making regarding caesarean delivery (Movsas, 2012).

It is crucial to formulate a mandate and implement it in the states where c-sections are too high through community health workers and primary care providers (Roy, 2021). Studies have also been conducted focusing on regional variations and prevalence of caesarean delivery. The prevalence of c-section deliveries in India has increased over time, with higher rates in Tamil Nadu compared to Chhattisgarh (Mohan, 2023). The paper examines the factors associated with this trend, including geographical location, religion, caste, education level, exposure to media, number of ANC visits, age at marriage, woman's age, size of child at birth, average number of children, and the impact of private and public-sector hospitals (Mohan, 2023).

Factors affecting institutional delivery in India has been studied by Bikash Barman et al based on NFHS-4 survey data. It showed that middle-aged women were more likely to deliver at a medical institution than the younger women. This study also includes women's autonomy as a variable that might affect institutional delivery (Barman, 2020). A paper by Kesterton et al (2010) has studied the relative importance of accessibility and economic status in rural India regarding ID using data from NFHS I and II surveys

(Kesterton, 2010). Trends in percentage of rural women opting for ID showed an increase through the years 1989-1998. It was suggested that financial constraints needed to be addressed and provision for side financing made in order to increase the number of IDs in rural India.

A variable named partner human capital index (PHI) has been studied as a factor for caesarean delivery and showed that women with high PHI are more likely to undergo caesarean delivery (Pandey, 2023).

If I do 10–15 normal deliveries in a month I hardly ever sleep at home.' A qualitative study of health providers' reasons for high rates of caesarean deliveries in private sector maternity care in Delhi, India" is a research article by Peel et al (2018) that discusses the high rates of caesarean deliveries in private sector maternity care in Delhi, India, and the reasons behind them. The paper discusses provider-related, system-related and patient-related factors that may motivate a c-section delivery. While financial incentives were mentioned as a factor, the focus was more on the need to maintain high patient loads to run commercially successful practices. Additionally, there is no government requirement for reporting on maternity care in the private sector, which may contribute to high caesarean rates (Peel, 2018). After a careful examination of the literature, I have come across some shortcomings in each of these papers which I will list under research gap. This project will attempt to tackle some of these issues.

## Research Gap

The following points highlight the research gaps:

- The studies that have been done based on past surveys provide outdated information and may not be applicable to the present

- scenario of caesarean delivery in public and private institutions in India. They only give us an insight into the development made so far.
- Researches that focus on either specific targeted state (e.g., low performing states) or rural areas fail to provide an inclusive picture of the entire country. Studies that are based on the entire country overlook prevailing regional variations. While it is equally important to study and understand where each of the regions stand in terms of participation rate in public/private caesarean delivery, it is not always feasible to focus on all the areas of the country in particular research. This might lead to inconveniences in comparative analysis.
- Sufficient data on women's occupation, spousal occupation, distance to the health facility and spousal education is not available in NFHS-4, which might have been crucial to the study. As a result, it has been hard to determine how woman's autonomy and partner's support might affect institutional delivery rate. Distance to the health facility is also linked with out-of-pocket expenses required to reach the place of delivery and may provide important insight for the study.
- The previously mentioned 2010 paper by Kesterton et al that aimed to study the relative importance of accessibility and economic status was unable to measure community access in urban areas.
- Variables that study pregnancy complications are less rigorous and include only response to questions such as whether the woman experienced any swelling of the body, vision difficulty, convulsions that are not from fever, etc.

## Objective of the Study

Following are the objectives of the study:

1. To explore the factors responsible for c-section deliveries in India
2. To analyse the distribution of c-section deliveries into public and private institutes based on various background characteristics/factors
3. To study the association between each of these factors and place of delivery
4. To get an in-depth understanding of the independent variables and the significance or insignificance of their impact in the study
5. Using multivariate logistic regression to compute odds ratios and compare the likelihood of a c-section delivery in a public or private healthcare facility

## Methodology

1. Sample Selection:

This study is based on secondary source of data, which is the fifth National Family Health Survey data (NFHS-5). NFHS-5 followed two-stage stratified sampling technique to select sample households from both rural and urban areas respectively. In rural areas, villages were selected as the Primary Sampling Units (PSUs) in the first stage and a random selection of 22 households in each PSU was made at the second stage. In urban areas, Census Enumeration Blocks (CEBs) were selected in the first stage and then a random selection of 22 households from each CEB was made in the second stage.

For the purpose of current research, only those women of age group 15 to 49 years who are in union and had given at least 1 birth

in last 5 years were selected at first. Out of these women, we are interested in studying the behavior pattern of women whose last birth was a caesarean delivery.

2. Variable Selection:

After literature review, those variables which were found to be recurrent in previous studies as well as some new variables that can potentially affect c-section deliveries in public and private hospitals have been considered. These independent variables can be grouped into two main categories namely 'Characteristic Variables' that measure socio-economic and demographic characteristics and 'Pregnancy and Healthcare Related' variables that include possible factors for caesarean delivery and/or delivery in a public/private medical institute.

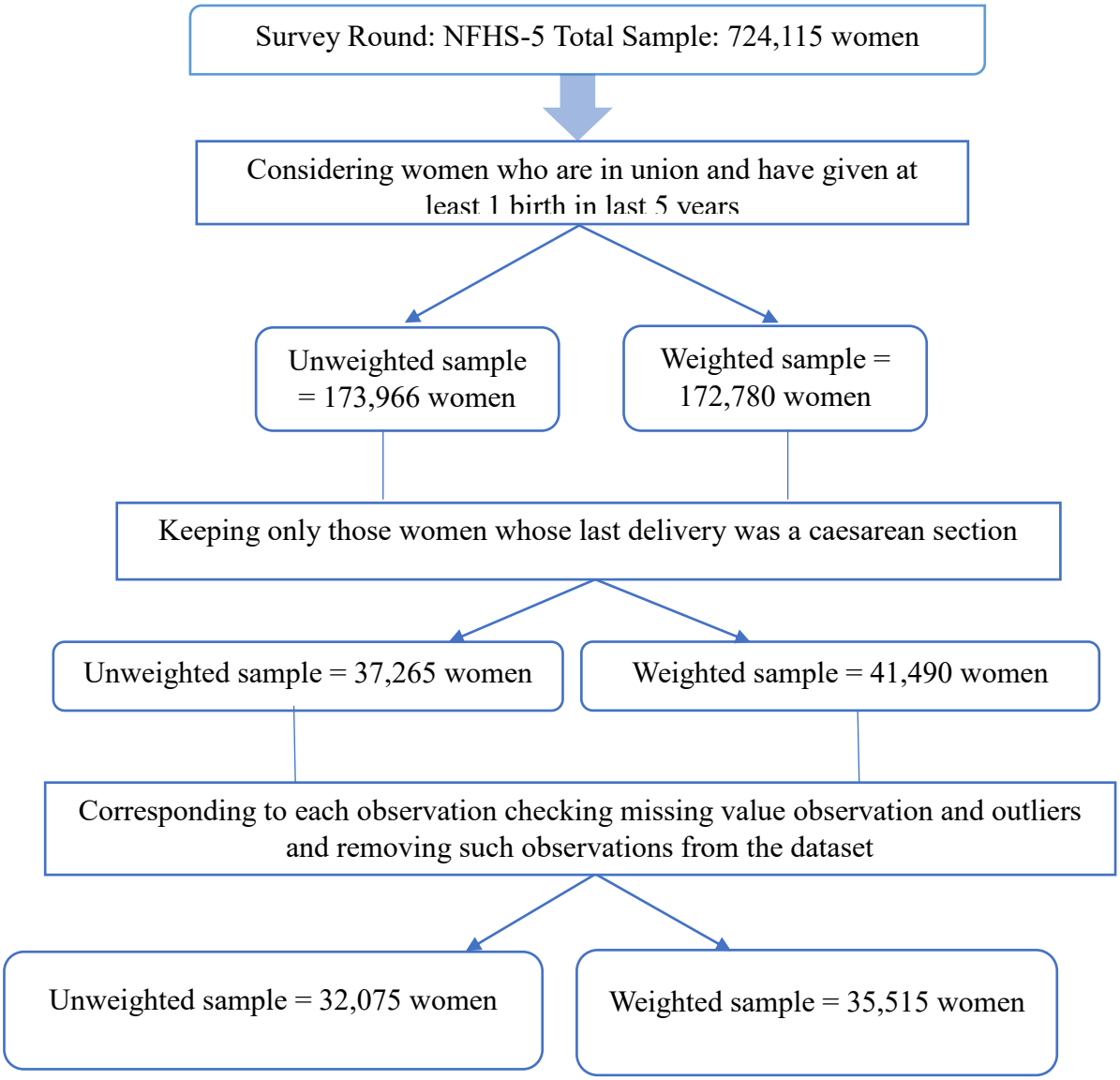
Our study variable is dichotomous—whether a caesarean delivery takes place in a public or a private medical institute of India.

3. Statistical Analysis:

Association between place of c-section delivery and various social, economic and pregnancy-related factors is studied using Chi-square test of association (univariate analysis). Those variables which are not significantly associated with the study variable are dropped. To compare the set of factors which significantly affect a caesarean delivery in public and private healthcare institute respectively, multivariate logistic regression analysis is performed. The study variable is dichotomous (categorical), where a c-section delivery is coded as 1 and a normal delivery is coded as 0. The independent variables have been selected based on their statistical association with the study variable. Adjusted odds ratio has been calculated to show the difference in likelihood of a c-section delivery happening

in a public versus a private medical institute according to different explanatory variables.

**Fig 1. Respondent selection in each round of the survey**



**Statistical Techniques Used**

1. Chi-square test of Association:

The chi-square test of association is a statistical method used to determine whether there is a significant association between two categorical variables.

The assumptions of this test are as follows:

(a) Independence: Observations should be independent of each other. Each subject should only contribute to one cell of the contingency table.

(b) Expected Cell Frequencies: The expected frequency count for each cell should be at least 5. If any cell has an expected frequency less than 5, the chi-square test might not be appropriate, and alternative methods like Fisher's exact test could be considered.

The data is arranged into a contingency table format, with one variable defining the rows and the other defining the columns.

The chi-square statistic is computed using the formula:

$$\chi^2 = \frac{\sum(O_i - E_i)^2}{E_i}$$

Where $O_i$ is the observed frequency in the $i^{th}$ cell

$E_i$ is the expected frequency in the $i^{th}$ cell

The degrees of freedom for the statistic are calculated as $(r-1)(c-1)$ where $r$ is the number of rows in the contingency table and $c$ is the number of columns.

Based on the calculated chi-square statistic and degrees of freedom, the critical value is found from the chi-square distribution table or the p-value is computed.

The calculated chi-square statistic is then compared to the critical value or p-value. If the calculated chi-square value exceeds the critical value or if the p-value is less than the chosen significance level (commonly 0.05), then we reject the null hypothesis and conclude that there is a significant association between the two categorical variables.

2. Logistic Regression:

Multivariate logistic regression is a statistical technique used to model the relationship between multiple independent variables (predictors) and a binary outcome variable. It extends simple logistic regression, which models the relationship between one independent variable and a binary outcome. Multivariate logistic regression allows for the inclusion of multiple predictors, enabling the examination of the simultaneous effect of these predictors on the probability of the outcome.

Following are the assumptions of multivariate logistic regression model:

(a) The outcome variable should be binary, meaning it has only two possible outcomes (e.g., yes/no, success/failure).
(b) Each observation in the dataset should be independent of each other.
(c) There should be no multicollinearity among the independent variables, meaning they should not be highly correlated with each other.
(d) Linearity of the Logit: The relationship between the independent variables and the logit of the outcome should be linear.
(e) There are no extreme outliers.
(f) The sample size is sufficiently large.

The logistic regression model uses the logit function to model the relationship between the independent variables and the log-odds of the outcome. The logit function is defined as:

$$logit(p) = \log\left(\frac{p}{1-p}\right)$$

Where $p$ is the probability of the outcome.

The logistic regression equation can be expressed as:

$$logit(p) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p$$

Where $\beta_0$ is the intercept

$\beta_1, \beta_2, \ldots, \beta_p$ are the coefficients associated with the independent variables $x_1, x_2, \ldots, x_p$ respectively.

The odds ratio is used to quantify the effect of each independent variable on the odds of the outcome. It is calculated as:

Odds ratio $= e^{\beta_i}$ where $\beta_i$ is the coefficient associated with the independent variable $x_i$.

The parameters of the logistic regression model are estimated using maximum likelihood estimation, which involves finding the values of the coefficients that maximize the likelihood of observing the given data. This is typically done using optimization algorithms.

All the statistical analyses have been performed using Stata version 16.1.

**Variables**

1. Outcome Variable:

The main outcome of interest is caesarean delivery. It is a binary variable with code 0 for normal delivery and 1 for caesarean delivery, using data from National Family Health Survey (2019-21).

2. Explanatory Variables:

Studies have shown that a number of factors play a significant role in deciding the type of place of caesarean delivery, whether public or private. Maternal ages, residential status, body mass index of females, pregnancy complications and other socio-economic factors are considered possible factors leading to a caesarean delivery. Table 1 shows the set of independent variables, along with their types and ranges, that are included in our study.

A variable was created to assess women's autonomy as a composite measure of woman's independence in household decision making. Questions in NFHS that related to women's ability to make decisions on their healthcare, large household purchases, visit to family or relatives and on money earned by the husband were combined to create a score. The autonomy level was divided into three categories based on the scores—women who ranked in the top 25% were labelled as fully autonomous, the ones between 25-50% were moderately autonomous and those below the top 50% were considered to have no autonomy. The Cronbach's alpha value for the variable was calculated to be 0.81, which can be considered good.

**Table 1: Summary of Key Variables for analysis**

| Variable | Type | Codes/Range |
|---|---|---|
| Residence | Categorical | Rural* Urban |
| Age | Categorical | 15-19*/20-24/25-29/30-34 35-39/40-44/45-49 |
| Religion | Categorical | Hindu/Muslim/Others* |

| | | |
|---|---|---|
| Caste | Categorical | SC/ST*/OBC/Others |
| Education | Categorical | No Education*/Primary Secondary /Higher |
| Wealth Quintile | Categorical | Poor*/Middle/Rich |
| Mass-Media Exposure | Categorical | Very Rare*/Less Frequently Very Frequently/(newspaper + radio + television) |
| Region | Categorical | North*/Central/East Northeast/West/South |
| Birth Order | Categorical | 1*/2/>=3 |
| Received Full ANC | Categorical | No<br>Yes*<br>(Yes, if the following occurs: 4 or more visits + at least one tetanus injection + iron supplements taken) |
| Pregnancy Complications | Categorical | No<br>Yes*<br>(Yes, if any one of the following problems occur during pregnancy: baby breech, prolonged labour, excessive bleeding) |
| Wanted pregnancy when became pregnant | Categorical | Then*/Later/No more |

| | | |
|---|---|---|
| Woman belongs to overweight/obesity-2 category | Categorical | Yes (BMI > 25.0)/No* |
| ertility Gap | Categorical | Yes<br>No*<br>(Yes, if difference between ideal number of children and number of living children exists) |
| Perceived distance to health facility | Categorical | Non-problematic<br>Problematic* |
| Multiple Birth | Categorical | Single*<br>Multiple<br>(Multiple, if mother gives birth to twins or more) |

*Reference category

This variable, however, could not be included in the present study due to the following reasons:

(i) Data in NFHS-5 regarding this variable is available only at the state level, therefore, the number of observations is quite less as compared to the other variables in the study.

(ii) Women autonomy is a multi-faceted concept comprising of rights to decision making and the ability of a woman to make choices about her body and reproductive functions without coercion or violence. As such it affects women's equality, personal life and family life. Specific targeted questions of interest are either not available in the survey or have poor responses.

(iii) There is no way to separate emergency c-section deliveries from pre-planned ones. If, during an emergency, the doctors decide to perform a c-section delivery, woman's autonomy does not play any role. Therefore, there is no use in including

(iv) women's autonomy as an independent variable affecting c-section delivery in public and private medical institutions.

## Results and Discussion

**Table 2: Different Characteristics of Population in Consideration for the Analysis**

| Background Characteristics | Number of females undergoing c-section delivery (N = 35515) | Percentage |
|---|---|---|
| **Type of institutional delivery** | | |
| Public | 14634 | 15.11 |
| Private | 20881 | 47.75 |
| **Residence** | | |
| Urban | 14665 | 35.53 |
| Rural | 20849 | 20.99 |
| **Age** | | |
| 15-19 | 787 | 18.90 |
| 20-24 | 9252 | 22.20 |
| 25-29 | 14089 | 25.52 |
| 30-34 | 7870 | 28.76 |
| 35-39 | 2861 | 29.37 |
| 40-44 | 564 | 28.12 |
| 45-49 | 88 | 20.52 |
| **Religion** | | |
| Hindu | 29126 | 25.00 |
| Muslim | 4403 | 24.29 |
| Others | 1984 | 33.27 |

| | | |
|---|---|---|
| **Caste** | | |
| SC/ST | 9448 | 20.23 |
| OBC | 16792 | 25.93 |
| Others | 9274 | 31.83 |
| **Education** | | |
| No education | 2696 | 11.20 |
| Primary | 2434 | 15.55 |
| Secondary | 19328 | 26.07 |
| Higher | 11055 | 41.37 |
| **Wealth Quintile** | | |
| Poor | 7769 | 13.84 |
| Middle | 7615 | 26.54 |
| Rich | 20130 | 36.10 |
| **Mass Media Exposure** | | |
| Very Rare | 4188 | 12.64 |
| Less Frequently | 6221 | 21.30 |
| Very Frequently | 25105 | 32.08 |
| **Region** | | |
| North | 4260 | 20.75 |
| Central | 6485 | 16.88 |
| East | 6980 | 21.62 |
| Northeast | 965 | 26.04 |
| West | 4908 | 25.97 |
| South | 11913 | 44.58 |

| | | |
|---|---|---|
| **Birth Order** | | |
| 1 | 15996 | 31.86 |
| 2 | 14703 | 28.08 |
| >=3 | 4815 | 12.66 |
| **Received Full ANC** | | |
| No | 12057 | 19.29 |
| Yes | 23457 | 30.04 |
| **Pregnancy Complications** | | |
| No | 16681 | 25.36 |
| Yes | 18833 | 25.18 |
| **Wanted Pregnancy when became pregnant** | | |
| Then | 33381 | 25.63 |
| Later | 1241 | 22.66 |
| No more | 891 | 18.40 |
| **Woman belongs to Obesity-2 category** | | |
| Yes | 13378 | 39.77 |
| No | 22136 | 20.70 |
| **Fertility Gap** | | |
| Yes | 19845 | 23.95 |
| No | 15670 | 27.15 |
| **Perceived distance to health facility** | | |
| Non-problematic | 28539 | 26.38 |
| Problematic | 6975 | 21.53 |

| **Multiple Birth** | | |
|---|---|---|
| Single | 34886 | 25.06 |
| Multiple | 628 | 46.04 |

Table 2 explains the distribution of women in our study according to various socio-economic, demographic and pregnancy experience-related background characteristics. Out of the total number of women (35,515) who had their most recent birth a caesarean delivery, 41.21% had the surgery done in a public healthcare institution while 58.79% delivered in a private healthcare institution. Across all regions 35.53% of the deliveries in urban areas are c-sections and 20.99% of total deliveries are c-sections in rural areas. When categorized into 5-year age groups from 15 to 49 years, it is seen that c-section delivery is more prevalent among women in the age groups 25-29 years (25.52%), 30-34 years (28.76%), 35-39 years (29.37%) and 40-44 years (28.12%) with the highest percentage of c-section deliveries among women in 35-39 years age group. All the states and UTs of the country have been grouped according to their geographical location into 6 major regions, i.e., North (Jammu and Kashmir, Himachal Pradesh, Punjab, Uttarakhand, Haryana, Chandigarh, Delhi, Rajasthan), Central (Chhattisgarh, Madhya Pradesh, Uttar Pradesh), East (Bihar, Jharkhand, Orissa, West Bengal), Northeast (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura), West (Dadra and Nagar Haveli, Daman and Diu, Goa, Gujarat, Maharashtra) and South (Andaman and Nicobar Islands, Andhra Pradesh, Karnataka, Kerala, Lakshadweep, Puducherry, Tamil Nadu, Telangana (Das, 2019). It is seen that the share of caesarean delivery is 20.75% in the North, 16.88% in Central India, 21.62% in the East, 26.04% in the Northeast, 25.97% in the West and 44.58% in the South. This shows

that c-section delivery is highly prevalent in South India as compared to other regions of the country. Proportion of c-section deliveries is the least in Central Indian states, namely, Chhattisgarh, Madhya Pradesh and Uttar Pradesh.

The table also shows that the proportion of c-section deliveries is almost the same for Hindus and Muslims in NFHS-5, with a share of 25% and 24.29% respectively. OBC women have 25.93% caesarean deliveries. Proportion of c-section deliveries increase with an increase in women's highest education level, with those women who have achieved higher education having a share of 41.37% as compared to the mere 11.20% among uneducated women. It is seen that across all regions only around 13% of the respondents belong to a poor household, 26.54% to a middle-class household while 36.10% of them come from rich households. Most of these women (32.08%) have a frequent exposure to mass media, namely, radio, television and newspaper.

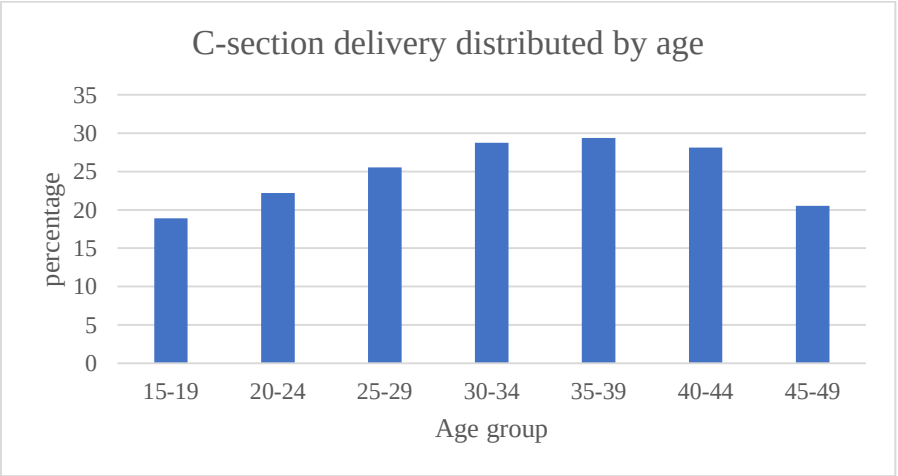
It is seen that c-section delivery is highly prevalent among women whose latest delivery was of birth order 1 (31.86%) and birth order 2 (28.08%). Caesarean delivery could be a popular choice among primiparous women (women of birth order 1) due to fear and heightened anxiety about the pain associated with labour and vaginal delivery, as they have not experienced childbirth before. Similarly, women who have had a previous vaginal delivery may remember the pain and discomfort and may opt for a c-section to avoid experiencing it again. Some women perceive c-section delivery as a safer and more controlled option compared to vaginal delivery, as it allows for scheduling and planning the birth process. They may feel more in control of the timing and circumstances surrounding the birth, which can alleviate anxiety and uncertainty. Women who have heard stories or had previous experiences of labour complications,

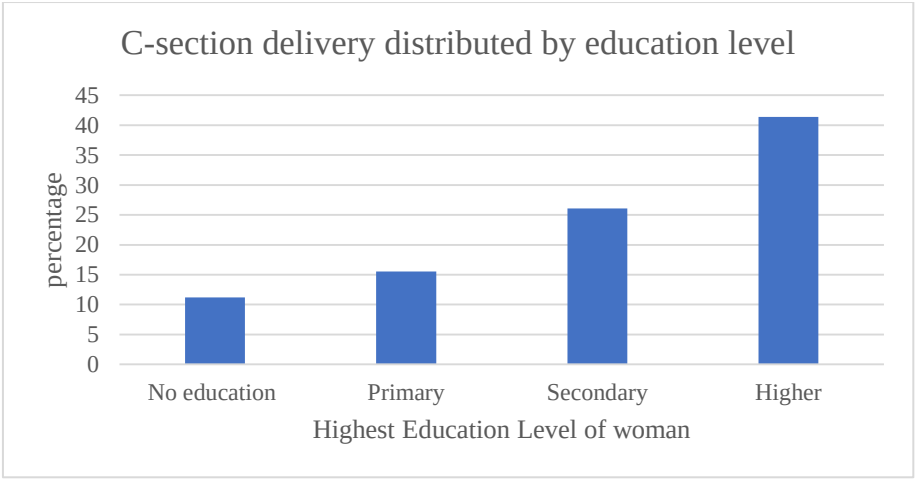
such as prolonged labour, foetal distress, or obstetric emergencies, may prefer c-section delivery to reduce the risk of such complications. There is a perception among some women that vaginal delivery can lead to pelvic floor damage, urinary incontinence, or other long-term health issues. They may opt for c-section delivery to minimize the risk of such complications, particularly if they prioritize preserving pelvic health. Another very significant factor is the influence of healthcare providers and cultural norms. Healthcare providers may tend to recommend c-section delivery due to greater financial incentives and less time associated with the surgical procedure as compared to a natural vaginal delivery. In some cultures, c-section delivery may be perceived as more prestigious or modern, leading women to choose it over vaginal delivery.

Among all the respondents, 25.18% had experienced medical complications during pregnancy such as baby breech, prolonged labour or excessive bleeding and underwent a c-section delivery. Out of all women who did not have any medical complications, 25.36% still underwent a c-section delivery. This could be indicative of the fact that those caesarean deliveries might have been preventable as they were not conducted out of emergency medical necessity. Among women who have received full antenatal care, which comprises of 4 or more visits to health centre for routine tests and screening, at least one tetanus injection received, and iron supplements taken during the course of pregnancy, 30.04% had caesarean delivery, while the prevalence of c-section delivery was 19.29% among women who did not receive full antenatal care. 25.63% of all wanted pregnancies resulted in c-sections. Among overweight women, 39.77% women had c-section deliveries compared to 20.70% c-section deliveries among women who are not overweight (obesity type-2). In most cases, c-section delivery

becomes a necessity for obese women due to several factors that increase the risks associated with vaginal delivery. 23.95% of the total deliveries were c-sections by women have fertility gap, i.e., there is a difference between ideal number of children and existing number of living children. The share of c-section delivery in case of multiple birth (46.04%) is higher than in case of single births (25.06%). Of all the women who perceived distance to health facility as problematic, 21.53% had caesarean deliveries.

**Fig 2. Bar graphs showing percentage distribution of c-section across variable categories (for factors with 4 or more categories)**





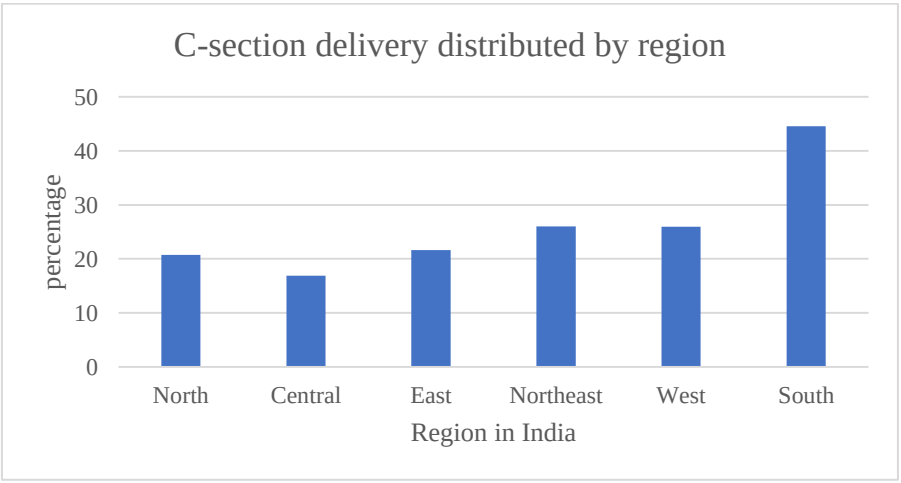




Table 3 gives the percentage distribution of c-section deliveries in the public and private healthcare facilities according to the above-mentioned background characteristics. The Chi-square test and *p*-value reveal that all other predictors have a significant association with the place of c-section delivery except for the following independent variables: whether woman received full antenatal care, wanted pregnancy when became pregnant and fertility gap.

**Table 3: Percent distribution of c-section delivery in public and private institutes according to background characteristics**

| Background Characteristics | Public Healthcare Facility | Private Healthcare Facility | *p*-value |
|---|---|---|---|
| **Residence** | | | |
| Urban | 37.01 | 62.99 | 0.000 |
| Rural | 44.16 | 55.84 | |
| **Age** | | | |
| 15-19 | 51.24 | 48.76 | 0.000 |
| 20-24 | 45.44 | 54.56 | |
| 25-29 | 41.15 | 58.85 | |
| 30-34 | 37.53 | 62.47 | |
| 35-39 | 35.46 | 64.54 | |
| 40-44 | 40.08 | 59.92 | |
| 45-49 | 37.88 | 62.12 | |
| **Religion** | | | |
| Hindu | 41.67 | 58.33 | 0.000 |
| Muslim | 39.05 | 60.95 | |
| Others | 39.13 | 60.87 | |
| **Caste** | | | |
| SC/ST | 53.57 | 46.43 | 0.000 |
| OBC | 38.21 | 61.79 | |
| Others | 34.04 | 65.96 | |

| | | | |
|---|---|---|---|
| **Education** | | | |
| No education | 49.14 | 50.86 | 0.000 |
| Primary | 54.33 | 45.67 | |
| Secondary | 47.09 | 52.91 | |
| Higher | 26.09 | 73.91 | |
| **Wealth Quintile** | | | |
| Poor | 55.16 | 44.84 | 0.000 |
| Middle | 50.98 | 49.02 | |
| Rich | 32.12 | 67.88 | |
| **Mass Media Exposure** | | | |
| Very Rare | 48.82 | 51.58 | 0.000 |
| Less Frequently | 42.11 | 57.89 | |
| Very Frequently | 39.78 | 60.22 | |
| **Region** | | | |
| North | 49.24 | 50.76 | 0.000 |
| Central | 32.85 | 67.15 | |
| East | 40.91 | 59.09 | |
| Northeast | 62.53 | 37.47 | |
| West | 34.81 | 65.19 | |
| South | 43.97 | 56.03 | |
| **Birth Order** | | | |
| 1 | 39.39 | 60.61 | 0.000 |
| 2 | 43.06 | 56.94 | |
| >=3 | 41.59 | 58.41 | |

| | | | |
|---|---|---|---|
| **Received Full ANC** | | | |
| No | 40.06 | 59.94 | 0.498 |
| Yes | 41.79 | 58.21 | |
| **Pregnancy Complications** | | | |
| No | 39.21 | 60.79 | 0.000 |
| Yes | 42.97 | 57.03 | |
| **Wanted Pregnancy when became pregnant** | | | |
| Then | 41.13 | 58.87 | 0.506 |
| Later | 41.66 | 58.34 | |
| No more | 43.55 | 56.45 | |
| **Woman belongs to Obesity-2 category** | | | |
| Yes | 35.91 | 64.09 | 0.000 |
| No | 44.41 | 55.59 | |
| **Fertility Gap** | | | |
| Yes | 40.71 | 59.29 | 0.532 |
| No | 41.84 | 58.16 | |
| **Perceived distance to health facility** | | | |
| Non-problematic | 39.88 | 60.12 | 0.000 |
| Problematic | 46.62 | 53.38 | |
| **Multiple Birth** | | | |
| Single | 41.48 | 58.52 | 0.000 |
| Multiple | 26.27 | 73.73 | |

Table 4 gives the results of logistic regression analysis where we test the association between the independent variables and c-section delivery in public and private healthcare institutions respectively. Odds ratios give the likelihood of a woman participant opting for a

c-section delivery under different circumstances (labelled by the independent variables) for both public and private healthcare systems. 95% confidence interval limits have been provided for each. In public healthcare facilities, women participants from urban areas were 1.170 times [OR 1.170, 95% C.I (1.117, 1.226)] more likely to undergo c-section delivery than normal delivery as compared to women from rural areas. Looking at the age distribution, we see that the likelihood of women experiencing c-section delivery as compared to normal delivery increased steadily with increase in age, from the age group 20-24 years to 40-44 years. Women of age group 40-44 years were 3.657 times [OR 3.657, 95% C.I (3.019, 4.429)] more likely to have c-section delivery than normal delivery as compared to women of 15-19 years' age group.

Muslim women were 1.487 times [OR 1.487, 95% C.I (1.364, 1.621)] more likely to undergo c-section delivery than normal delivery as compared to women of other religion. As compared to women participants from SC/ST category, women from other categories were 1.304 times [OR 1.304, 95% C.I (1.235, 1.378)] more likely to have c-section delivery than normal delivery. Women participants with higher education were 1.441 times [OR 1.441, 95% C.I (1.331, 1.560)] more likely to experience c-section delivery than normal delivery as compared to women participants with no formal education. Rich and middle-class women had higher likelihoods of having c-section delivery than normal delivery, with rich women being 1.378 times [OR 1.378, 95% C.I (1.304, 1.457)] more likely to undergo c-section than normal delivery as compared to poor women.

**Table 4: Adjusted Logistic Regression Analysis to assess the association between various factors and c-section delivery in Public and Private Healthcare institutes**

| Background Characteristics | Public Healthcare Facility | | | Private Healthcare Facility | | |
|---|---|---|---|---|---|---|
| | Odds Ratio | 95% CI | | Odds Ratio | 95% CI | |
| | | Lower | Upper | | Lower | Upper |
| **Residence** | | | | | | |
| Urban | 0.954* | 0.907 | 1.004 | 1.170**** | 1.117 | 1.226 |
| Rural | Ref | | | Ref | | |
| **Age** | | | | | | |
| 15-19 | Ref | | | Ref | | |
| 20-24 | 1.355**** | 1.195 | 1.537 | 1.343**** | 1.141 | 1.581 |
| 25-29 | 1.852**** | 1.632 | 2.102 | 1.664**** | 1.412 | 1.961 |
| 30-34 | 2.436**** | 2.135 | 2.780 | 1.924**** | 1.623 | 2.280 |
| 35-39 | 3.083**** | 2.672 | 3.557 | 2.393**** | 1.993 | 2.873 |
| 40-44 | 3.657**** | 3.019 | 4.429 | 2.620**** | 2.072 | 3.314 |
| 45-49 | 2.535**** | 1.775 | 3.621 | 3.448**** | 2.202 | 5.401 |
| **Religion** | | | | | | |
| Hindu | 1.042 | 0.973 | 1.116 | 1.086* | 0.993 | 1.187 |
| Muslim | 1.487**** | 1.364 | 1.621 | 0.856*** | 0.767 | 0.955 |
| Others | Ref | | | Ref | | |
| **Caste** | | | | | | |
| SC/ST | Ref | | | Ref | | |
| OBC | 1.006 | 0.962 | 1.053 | 0.950* | 0.897 | 1.006 |
| Others | 1.304**** | 1.235 | 1.378 | 1.116*** | 1.045 | 1.192 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Education** | | | | | | |
| No education | Ref | | | Ref | | |
| Primary | 1.091** | 1.006 | 1.183 | 1.138** | 1.016 | 1.275 |
| Secondary | 1.363**** | 1.279 | 1.454 | 1.226**** | 1.124 | 1.337 |
| Higher | 1.441**** | 1.331 | 1.560 | 1.218**** | 1.106 | 1.342 |
| **Wealth Quintile** | | | | | | |
| Poor | Ref | | | Ref | | |
| Middle | 1.285**** | 1.220 | 1.353 | 1.093** | 1.015 | 1.177 |
| Rich | 1.378**** | 1.304 | 1.457 | 1.103*** | 1.026 | 1.186 |
| **Mass Media Exposure** | | | | | | |
| Very Rare | Ref | | | Ref | | |
| Less Frequently | 1.193**** | 1.121 | 1.269 | 1.177**** | 1.085 | 1.277 |
| Very Frequently | 1.231**** | 1.162 | 1.304 | 1.193**** | 1.106 | 1.287 |
| **Region** | | | | | | |
| North | Ref | | | Ref | | |
| Central | 0.530**** | 0.497 | 0.564 | 1.433**** | 1.334 | 1.539 |
| East | 0.837**** | 0.784 | 0.894 | 2.175**** | 2.006 | 2.358 |
| Northeast | 1.218**** | 1.135 | 1.307 | 1.713**** | 1.532 | 1.916 |
| West | 1.013 | 0.938 | 1.093 | 0.841**** | 0.779 | 0.909 |
| South | 2.719**** | 2.564 | 2.885 | 2.719**** | 2.527 | 2.925 |
| **Birth Order** | | | | | | |
| 1 | Ref | | | Ref | | |
| 2 | 0.624**** | 0.591 | 0.658 | 0.692**** | 0.649 | 0.738 |
| >=3 | 0.299**** | 0.280 | 0.318 | 0.369**** | 0.342 | 0.397 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Received Full ANC** | | | | | | |
| No | 0.841**** | 0.809 | 0.875 | 0.888**** | 0.848 | 0.930 |
| Yes | Ref | | | Ref | | |
| **Pregnancy Complications** | | | | | | |
| No | Ref | | | Ref | | |
| Yes | 1.080**** | 1.040 | 1.121 | 0.974 | 0.932 | 1.018 |
| **Woman belongs to Obesity-2 category** | | | | | | |
| Yes | 1.761**** | 1.688 | 1.838 | 1.566**** | 1.492 | 1.643 |
| No | Ref | | | Ref | | |
| **Fertility Gap** | | | | | | |
| Yes | Ref | | | Ref | | |
| No | 1.251**** | 1.193 | 1.312 | 1.219**** | 1.152 | 1.290 |
| **Perceived distance to health facility** | | | | | | |
| Non-problematic | 0.869**** | 0.832 | 0.907 | 0.898**** | 0.848 | 0.950 |
| Problematic | Ref | | | Ref | | |
| **Multiple Birth** | | | | | | |
| Single | Ref | | | Ref | | |
| Multiple | 3.551**** | 2.968 | 4.249 | 3.052**** | 2.533 | 3.678 |

Level of Significance: *p < 0.1 **p < 0.05 ***p < 0.01 ****p < 0.001

Women participants who had very frequent media exposure were 1.231 times [OR 1.231, 95% C.I (1.162, 1.304)] more likely to deliver by c-section than normal delivery as compared to those who had very rare media exposure. Women participants who belonged to South Indian states were 2.719 times [OR 2.719, 95% C.I (2.564, 2.885)] more likely to opt for c-section delivery than normal delivery as compared to women from North Indian states. The likelihood of women opting for c-section than normal delivery reduced with

higher birth order. Women participants who had three or more children were 0.299 times [OR 0.299, 95% C.I (0.280, 0.318)] less likely to undergo c-section delivery than normal delivery as compared to women who had child of birth order 1. This can be attributed to the fact that as women gain greater experience of childbirth, they become better physically and psychologically equipped to handle pregnancy related issues and can decide when to opt for a c-section if need be (Mohan, 2023).

Women participants who did not fully utilize antenatal care were 0.841 times [OR 0.841, 95% C.I (0.809, 0.875)] less likely to undergo c-section delivery than normal delivery, compared to women who had received comprehensive antenatal care. Women who had pregnancy related complications were 1.080 times [OR 1.080, 95% C.I (1.688, 1.838)] more likely to undergo c-section delivery than normal delivery, compared to women participants who did not experience pregnancy related complications. Overweight women participants were 1.761 times [OR 1.761, 95% C.I (1.688, 1.838)] more likely to opt for c-section delivery than normal delivery as compared to women who were not overweight. Overweight and obese women are at higher risk of developing pregnancy complications such as gestational diabetes, preeclampsia, and foetal macrosomia (large birth weight). These complications can increase the likelihood of caesarean delivery to mitigate risks to both the mother and baby.

Absence of fertility gap made women participants 1.251 times [OR 1.251, 95% C.I (1.193, 1.312)] more likely to undergo c-section delivery than normal delivery as compared to women who had fertility gap. If distance to healthcare facility was considered problematic, women participants were 0.869 times [OR 0.869, 95% C.I (0.832, 0.907)] less likely to undergo c-section delivery than

normal delivery as compared to women who perceived distance to healthcare facility as non-problematic. Women who had multiple births were 3.551 times [OR 3.551, 95% C.I (2.968, 4.249)] more likely to have c-section delivery than normal delivery as compared to women who had delivered a single child.

In private healthcare facilities, the likelihood of women opting for c-section delivery than normal delivery increased steadily with increase in age. Women participants of age group 45-49 years were 3.448 times [OR 3.448, 95% C.I (2.202, 5.401)] more likely to have c-section delivery than normal delivery as compared to women of 15-19 years age group. Women participants with higher education were 1.218 times [OR 1.218, 95% C.I (1.106, 1.342)] more likely to experience c-section delivery than normal delivery as compared to women participants with no formal education. Women participants who had very frequent media exposure were 1.193 times [OR 1.193, 95% C.I (1.106, 1.287)] more likely to deliver by c-section than normal delivery as compared to those who had very rare media exposure.

Women participants who belonged to South Indian states were 2.719 times [OR 2.719, 95% C.I (2.527, 2.925)] more likely to opt for c-section delivery than normal delivery as compared to women from North Indian states. The likelihood of women opting for c-section than normal delivery reduced with higher birth order. Women participants who had three or more children were 0.369 times [OR 0.369, 95% C.I (0.342, 0.397)] less likely to undergo c-section delivery than normal delivery as compared to women who had child of birth order 1. Women participants who did not fully utilize antenatal care were 0.888 times [OR 0.888, 95% C.I (0.848, 0.930)] less likely to undergo c-section delivery than normal delivery, compared to women who had received comprehensive antenatal

care. Overweight women participants were 1.566 times [OR 1.566, 95% C.I (1.492, 1.643)] more likely to opt for c-section delivery than normal delivery as compared to women who were not overweight. Absence of fertility gap made women participants 1.219 times [OR 1.219, 95% C.I (1.152, 1.290)] more likely to undergo c-section delivery than normal delivery as compared to women who had fertility gap.

If distance to healthcare facility was considered problematic, women participants were 0.898 times [OR 0.898, 95% C.I (0.848, 0.950)] less likely to undergo c-section delivery than normal delivery as compared to women who perceived distance to healthcare facility as non-problematic. Women who had multiple births were 3.052 times [OR 3.052, 95% C.I (2.533, 3.678)] more likely to have c-section delivery than normal delivery as compared to women who had delivered a single child. In a private healthcare facility, we observe more or less similar characteristics of caesarean delivery among women belonging to different categories of socio-economic, demographic and pregnancy-related factors. The variables associated with place of residence, religion, caste, wealth quintile and medical complications turn out to be statistically insignificant or less significant in context of a private healthcare facility as compared to a public healthcare facility.

Such a behaviour can be explained by the following points stated below:

Private healthcare facilities are more prevalent in urban areas and women may have better access to obstetric care and a wider range of healthcare options. This improved access to healthcare services in urban settings may lead to similar rates of C-section delivery regardless of place of residence of the woman participant. Urban areas are more diverse in terms of socio-demographic groups based

on religion, caste, etc. and as such will have no significant impact on c-section in private healthcare facilities. While wealth quintile is a somewhat significant factor that determines the prevalence of c-sections in a private healthcare facility, its comparatively lower level of significance suggests that factors other than wealth quintile of the woman participant may be driving the decision to perform c-sections in these places. Perhaps, one opts for quality service regardless of their wealth because private medical institutes provide a wider range of obstetric care options. Unmet need of financial expenditure is then met by borrowing from various sources. Comparatively less statistical significance of pregnancy related medical complications in private healthcare facilities suggests that the presence or absence of complications is not a determining factor in the type of institute chosen for delivery. Or it may indicate that private healthcare facilities are better equipped to handle childbirths regardless of whether the woman faces any pregnancy related complications.

Differences can be noted in the countrywide odds of c-section deliveries across different regions in the private institutes. Unlike in public healthcare facilities, the women in states of Central and Eastern parts of the country are 1.43 and 2.17 times respectively more likely to opt for a c-section delivery than normal delivery in a private institute, compared to those in the Northen states. The chances of caesarean delivery in South Indian states remain significantly high for both public and private medical facilities. This phenomenon could be attributed to high literacy rates, improved health infrastructural facilities in South India. Factors such as maternal choices and roles of doctors could play relevant roles but specific conclusions cannot be drawn without an explicit study for the same.

## Conclusion

The percentage of c-section deliveries relative to the total births is regarded as one of the most crucial indicators of emergency obstetric care. Both the situations of unsatisfactory healthcare interventions leading to either an overwhelming or underwhelming percentage of c-section deliveries among women is a cause of concern. Performing a c-section delivery is appropriate only when the obstetric risks outweigh the surgical risks involved.

In the last two and a half decades, there has been an increasing trend of c-section births in India. It has been found that higher percentage of c-section deliveries is prevalent among women in urban areas, women having higher level of education and those belonging to rich households. Very frequent mass media exposure and access to full antenatal care are also associated with higher percentages of c-section deliveries among the participants. Higher birth order results in progressively lesser share of c-sections among the women, which can be attributed to women having greater experience in childbirth and pregnancy related issues.

There are certain marked differences in the odds of women undergoing c-section delivery than normal delivery in a public versus a private healthcare facility. Private healthcare facilities are more widely available and are situated in both rural and urban areas. In contrast, public healthcare facilities are unevenly distributed across different regions. As a result, women from rural or remote areas might face challenges in accessing these facilities, leading to delays or complications in receiving timely c-section deliveries. Moreover, public health facilities often have limited resources, including staff, equipment, and infrastructure. Therefore, they may prioritize certain patients or procedures based on perceived need or other criteria. Factors like place of residence, caste, religion, and

wealth quintile may influence these decisions, consciously or unconsciously, leading to disparities in access to c-section deliveries.

Public healthcare institutes serve a more socio-economic diverse clientele whereas private facilities may cater to a more homogenous clientele, potentially reducing the influence of cultural and religious factors on access to c-section deliveries. Private health facilities typically operate on a fee-for-service basis and may not be as influenced by factors like place of residence, caste, religion, or wealth quintile. However, access to private facilities is often limited by affordability, which can still create disparities based on socioeconomic status.

Perception of the quality of care provided at public health facilities compared to private facilities can also influence women's choices regarding where to give birth. Women from certain demographics may perceive public facilities as offering lower-quality care or experiencing overcrowding and prefer the perceived privacy and better amenities of private facilities for c-section deliveries.

In conclusion, we see that the variables associated with place of residence, religion, caste, wealth quintile and medical complications turn out to be statistically insignificant in context of a private healthcare facility as compared to a public healthcare facility. Other variables follow similar trends in terms of c-section births in both types of medical institutions.

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