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## Working Paper COVID-19 Lockdowns and Childbirth Delivery Care in India

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## **COVID-19 Lockdowns and Childbirth Delivery Care in India**

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## Abstract

**Background:** Government-imposed lockdowns during the COVID-19 pandemic disrupted essential healthcare services in low- and middle-income countries (LMICs), including childbirth delivery care. While a few studies have documented a decline in institutional deliveries, little is known about the effects on skilled birth attendance, facility-type differences, and underlying mechanisms of disruption.

**Methods:** We examine the impact of lockdowns in India on institutional deliveries, skilled birth attendance, and delivery care across public and private facilities. We compare pre-, during, and post-lockdown periods using logistic regression to isolate the specific effects of lockdowns from broader pandemic-related disruptions. We also analyze potential mechanisms, including transportation barriers, facility closures, treatment costs, perceived quality of care and other reasons.

**Findings:** Our findings suggest that institutional deliveries and skilled birth attendance declined during and after the lockdown compared to the pre-pandemic period. Births in private facilities also decreased during the lockdown but showed no significant change post-lockdown relative to pre-lockdown levels. Out-of-pocket expenditures increased in private facilities during the lockdown, potentially limiting access. No significant differences were observed in reported barriers to institutional delivery, such as transportation unavailability, facility closures, distrust in health services, or cultural factors. However, fewer women cited economic constraints as a reason for non-institutional delivery during the lockdown, while reports of "other reasons" increased during and after the lockdown.

**Interpretation:** Our results show that lockdowns exacerbated barriers to skilled delivery care in India, worsening healthcare inequalities. The rising costs in private facilities added another challenge, pushing care out of reach for many. Ensuring affordable maternal healthcare is crucial highlighting the need for policies that sustain maternal health services during crises and safeguard vulnerable populations.

Keywords: COVID-19, lockdown, delivery care

**JEL Codes:** I12, I18, J13

## Strengths and limitations of this study

- The study analyzes multiple aspects of delivery care, such as institutional deliveries, differentiating between public and private health facilities, and examines whether deliveries were attended by trained professionals.
- It isolates the specific impact of lockdowns in India from broader pandemic effects, allowing us to understand the consequences of the lockdown policy.
- It investigates key mechanisms influencing delivery care access, such as transportation barriers, facility closures, out-of-pocket costs and distrust of health services.
- This study is based on 11 states in India, so it is not nationally representative.
- Reliance on self-reported outcomes, especially cost-related variables, may introduce measurement errors.

## **1. Introduction**

Government-imposed lockdowns and stay-at-home orders during the COVID-19 pandemic profoundly disrupted lives and livelihood, particularly in low- and middle-income countries (LMICs).<sup>1,2</sup> These regulations significantly reduced essential healthcare access and utilization such as regular outpatient visits, family planning services, management of non-communicable diseases, childhood vaccination, and others.<sup>3–8</sup> Childbirth delivery care is one such essential service that is critical in preventing maternal and neonatal deaths.<sup>9,10</sup> Maternal mortality rates increased in some LMICs during the pandemic, underscoring the vulnerability of maternal and child health services during such crises.<sup>11</sup> According to the most recent figures, there were over 2 million neonatal deaths in 2022 and more than 250,000 maternal deaths in 2020 in LMICs, which suggests that access to quality care during childbirth remains critical for improving health outcomes.<sup>12–14</sup> Reductions in maternal and neonatal mortality are also integral to achieving Sustainable Development Goal 3. However, progress towards these goals have stalled or worsened in many LMICs since 2015, and lockdown disruptions may have further worsened progress toward these goals.<sup>15</sup>

Despite its importance, the impact of pandemic-related lockdowns on delivery care in LMICs remains poorly understood. While most studies examine the pandemic's overall effects, it is crucial to isolate the specific impact of lockdowns on delivery care. The effects of the pandemic and lockdowns are distinct. Lockdowns were acute, time-bound policy interventions with immediate impacts on mobility and healthcare access. In contrast, the pandemic was prolonged and caused disruptions, such as heightened health risks, fears of infection, overcrowded facilities and rising costs of essentials.

Existing studies on the impact of lockdowns primarily focused on the place of delivery and found declines in institutional deliveries and increases in home births.<sup>5,16–18</sup> However, there is no study on the availability of trained professionals, despite evidence that skilled birth attendance reduces mortality by managing complications like sepsis, hemorrhage, and obstructed labor.<sup>19–21</sup> Further, little attention has been given to facility-level differences such as access to public versus private healthcare facilities. In LMICs, private facilities are often perceived to provide higher quality healthcare services compared to public facilities, albeit accompanied by high out of pocket costs.<sup>22</sup> There has also been little exploration of the mechanisms through which lockdowns impacted service utilization. Some mechanisms through which lockdown could have affected access to services include restricted mobility, reduced transportation availability, forced facilities to operate at limited capacity due to staffing shortages or repurposing for COVID-19 care, or led to widespread income losses, potentially rendering healthcare unaffordable.

This study addresses that gap by analyzing the effects of lockdowns on delivery care in India, a large middle-income country that implemented the world's largest lockdown in terms of population affected.<sup>23</sup> Despite the wide-scale lockdown, by May 2023, India reported over 44 million confirmed COVID-19 cases and more than 500,000 deaths.<sup>24</sup> Understanding how these restrictions influenced delivery care access is critical, particularly in a country where disparities in care quality and accessibility persist.<sup>25–27</sup>

To our knowledge, this is the first study to comprehensively examine the effects of lockdown measures on delivery care and the mechanisms of disruption in LMICs. Since high-quality delivery care has been found to be most effective in preventing maternal deaths,<sup>9</sup> we focus on institutional deliveries, their distribution across facility types, and deliveries by trained professionals as the

main outcome variables. Our secondary outcomes include out-of-pocket expenditure at private and public facilities to understand the reason for any differential effect of the lockdown across facility types. We also examine whether factors such as transportation barriers, facility closures, treatment costs, perceived quality of care, and sociocultural factors were the reasons due to which lockdowns could have impacted delivery care. By focusing on the national lockdown, we examine the differential effect of lockdown compared to pre- and post- lockdown periods. Such comparison method allows us to isolate the specific impact of the lockdown, as opposed to the effects of the broader pandemic.

## 2. Background

The healthcare system in India is characterized by a dynamic interplay between the public and private sectors. The public health system is designed to provide accessible and affordable healthcare, especially in rural areas, and plays a crucial role in delivery care through a three-tiered structure.<sup>25</sup> The public-sector exists alongside the private sector that includes a diverse range of private healthcare facilities, including internationally accredited super-specialty hospitals, large corporate hospitals, and small private clinics. The private sector is often perceived to offer higher-quality services, advanced technology, and shorter waiting times, making it an attractive option for many patients, particularly in urban areas.<sup>25</sup>

The Government of India and many state governments have introduced several programs encouraging antenatal care, institutional delivery, and post-natal care to curb the high MMR in the country, including the Janani Suraksha Yojana (JSY), Janani Shishu Suraksha Karyakaram (JSSK), the Pradhan Mantri Surakshit Matritva Abhiyaan (PMSMA), and others.<sup>28</sup> Although there has been progress in the utilization of maternal healthcare services in India over the last decade, significant challenges remain, including problems of poor quality of care, health system being underfunded, and high out-of-pocket costs.<sup>25–27</sup>

In response to the COVID-19 pandemic, the government of India imposed a nationwide lockdown starting on March 25, 2020. Initially set for 21 days, the lockdown was extended in phases due to the increasing number of cases. During Phase 1 (March 25 to April 14, 2020), strict measures were enforced, including a complete ban on movement, closure of non-essential businesses, and the suspension of public transport.<sup>29</sup> Phase 2 (April 15 to May 3, 2020) saw a 19-day extension with a gradual easing of certain rules.<sup>29</sup> In Phase 3 (May 4 to May 17, 2020), further restrictions were lifted, allowing for increased economic activities and movement, although some controls remained in place.<sup>29</sup> Finally, Phase 4 (May 18 to May 31, 2020) continued this trend, permitting even more economic activities while still implementing essential public health measures to curb the spread of the virus.<sup>29</sup> National lockdowns were eased from June 2020 onwards, with the responsibility for lockdown rules shifted to state governments if they felt it was appropriate, which were allowed to create their own regulations based on local conditions. The lockdown measures essentially strained resources, limited access to both public and private facilities, and disrupted critical services, particularly for maternal and child health.

Our analysis focuses on the impact of these nationwide lockdown implemented from March 25 to May 31, 2020, on delivery care.

## 3. Data

## 3.1 Health Related Measures

To examine the impact of COVID-19 lockdowns on access to maternal delivery care, we utilized data from the National Family Health Survey (NFHS-5), conducted between 2019 and 2021. NFHS, representative at district, state, and national level, surveyed women aged 15–49 collecting detailed information on maternal health services, fertility, reproductive health, and family planning. For this study, we focused on maternal delivery care. The survey asked married or cohabiting women about their most recent live births in the last five years, covering details such as the place of delivery, who provided delivery assistance, costs associated with delivery, and reasons why some women did not deliver at health facilities.

The NFHS-5 was conducted in two phases. Phase 1 was conducted in certain regions from June 17, 2019, to January 30, 2020. Phase 2, focusing on the other regions, started on January 2, 2020. However, because of the pandemic, data collection was suspended on March 21, 2020, and was resumed in November, and all interviews were completed by April 30, 2021.

As Phase 1 focused only on pre-lockdown period, our analysis focuses on regions that were surveyed during Phase 2, which includes interviews conducted before and after the nationwide lockdown. This phase allows us to examine both pre- and post-lockdown birth data. As NFHS collected five years of birth history from respondents, we have data for births in 2019 for individuals interviewed in 2020 or 2021. Phase 2 collected information across 11 states and 3 union territories in India. Our analyses focus on all births in the Phase 2 regions from January 1, 2019 to April 30, 2021, allowing sufficient comparison birth history both before and after the national lockdown. For comparisons across pre-, during-, and post-lockdown periods, we restrict the sample to post-lockdown interviews to maintain consistency and avoid biases arising from variations in sample composition.

We use three sets of outcome variables in our analysis. First, we created a variable to identify births given at a health institution as opposed to home. Second, for women with institutional deliveries, we categorized them between deliveries at public and private facilities. Public health facilities included government hospitals, dispensaries, community health centers, urban health centers, rural hospitals, block primary health centers, sub-centers, and other public-sector institutions. Private health facilities included private hospitals, maternity homes, clinics, and NGO or trust hospitals. Third, for all women giving birth, the type of delivery assistance received was categorized into two groups: deliveries attended by skilled professionals, including doctors, auxiliary nurse midwives (ANMs), nurses, midwives, or other trained personnel versus deliveries where no skilled professionals were present.

To understand the mechanisms through which lockdowns affected access to delivery care, we utilized NFHS questions on the reasons for not delivering in a health facility for their most recent birth. These reasons were categorized as follows: (1) cost, (2) facility not open, (3) facility too far or transportation unavailable, (4) distrust of health services or perceived poor quality of care, (5) cultural reasons such as no female providers, husband or family will not allow, not necessary, and not customary, and (6) other unspecified reasons. We created dummy variables for each of these categories.

We also examine the total cost of delivery. During interviews, respondents reported either the total out-of-pocket expenditure incurred during childbirth or a detailed breakdown of individual cost components which include expenses for hospital stays, tests, medications, transportation costs encompassing the expenses incurred for traveling to healthcare facilities, and other related costs. For the cost analysis, we use the total reported cost. If the total cost was missing but individual cost components were provided, we sum these components to compute the total expenditure. We log-transformed this medical cost variable.

#### 3.2 Lockdown Measures

We analyze care during birth across three periods: (i) pre-lockdown (January 1, 2019, to March 24, 2020), (ii) during the national lockdown (March 25, 2020, to May 31, 2020), and (iii) post-lockdown (June 1, 2020, to April 30, 2021). To capture the effects of these periods, we define two indicator variables. The first compares births during the lockdown period to those in the pre-lockdown period, allowing us to isolate the impact of the lockdown itself. The second compares the births in the post-lockdown period to those in the pre-lockdown period, enabling us to assess how the pandemic influenced care in the longer term relative to pre-pandemic conditions.

We supplement our analysis by doing robustness check using district-level information from the Google Community Mobility Reports (GCMR) to capture spatial and temporal variations in lockdown intensity across India. We use GCMR's Residential Mobility Index, which measures the percentage change in time spent at home compared to a baseline period before the pandemic. Daily district-level mobility data were matched with NFHS birth records by district and birth dates, enabling us to link lockdown intensity with maternal delivery care. Increased time at home served as a proxy for movement restrictions. By comparing residential mobility during the lockdown to baseline levels before the lockdowns, we examine the impact of lockdown on access to healthcare services.<sup>30</sup> Further details on how we used GCMR can be found in Appendix A1.

#### 4. Methodology

Our main specification regresses the likelihood of delivery care outcomes,  $Y_i$ , using a logistic regression model using the following specification:

$$ln\left(\frac{P(Y_{ist}=1)}{1-P(Y_{ist}=1)}\right) = \alpha + \beta_1 L_1 + \beta_2 L_2 + \beta_3 X_{ist} + \lambda_s + \delta_t + \varepsilon_{ist}$$

where  $P(Y_{ist} = 1)$  denotes the probability that individual i receives the delivery care outcome, and s denotes the states, and t is the year of child's birth. The main independent variables of interest are  $L_1$ , which represents the lockdown period, and  $L_2$ , which represents the post-lockdown period. X is the vector of control variables that can affect birth-related outcomes often used in the literature<sup>3,8,17</sup> - mother's age, mother's education, marriage status, religion, place of residence, ethnicity, and wealth index.<sup>1</sup> In addition to the lockdown, individuals may modify their healthseeking behaviors if they perceive a high risk of contracting COVID-19. To capture the severity

<sup>&</sup>lt;sup>1</sup> In NFHS surveys, the wealth index indicates the relative wealth of the household in which the woman resides. This index in the survey is created using principal components analysis, which ranks households on a continuous wealth scale, which is then divided into five groups, ranging from the poorest to the richest. For our analysis, we further combine these categories into three groups: rich, middle, and poor.

of the pandemic, we include the variable *Cases*, which measures the number of new COVID-19 cases per 100,000 persons in the 30 days preceding the date of delivery.<sup>2</sup> Since the outcomes related to delivery care are binary, we use a logit model to estimate equation (1).

 $\lambda_s$  represents the state fixed effects that control for unobserved state-level characteristics, and  $\delta_t$  represents year fixed effects that control for the year of childbirth, and  $\varepsilon_{idt}$  is the unobserved characteristics. Estimates are weighted using sampling weights provided by the NFHS, and the standard errors are robust and clustered at the state level. All analyses were conducted using STATA-18.

We use the same control variables, along with Ordinary Least Squares (OLS) model, to examine the impact of the lockdown on medical costs. Due to fewer observation with data on the reason for not delivering at a healthcare facility, we use t-tests to compare whether there were significant differences across the three periods in the share of women citing the various reasons.

## 5. Results

## 5.1 Summary Statistics

Table 1 presents the means of the outcome variables for the pre-lockdown, lockdown, and post-lockdown periods. 90·3 percent (SD 0.297) of births occurred in a health facility before the lockdown, but they decreased slightly to 89.5 (SD 0.307) and 88.7 percent (SD 0.317) for the lockdown and post-lockdown periods, respectively. Most institutional deliveries occurred in public health facilities, irrespective of the period. 68.6 percent (SD 0.464) of births occurred in public facilities before the lockdown. They increased to 70.9 percent (SD 0.454) during the lockdown but declined to 66.6 percent (SD 0.472) after the lockdown. In contrast, there was a decline of births in private facilities from 21.6 percent (SD 0.412) before the lockdown to 18.6 percent (SD 0.389) during the lockdown. However, they bounce back up to 22.1 percent (SD 0.415) post-lockdown.

We provide summary statistics of the control variables in Appendix Table A1. We find that a great majority (80%, SD 0.400) of women were from rural areas and their average age was 26 years. About half of the women (49.6 percent, SD 0.500) were from poor households according to the wealth index.

<sup>&</sup>lt;sup>2</sup> Data obtained from ourworldindata.org

	Pre-Loc	kdown	Lockd	lown	Pos Locka	st- lown
	N = 17	7,531	N = 2	,312	N = 10	),865
	Mean	SD	Mean	SD	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)
Place of Delivery:						
Institutional deliveries	90.25%	0.297	89.48%	0.307	88.70%	0.317
Private deliveries	21.64%	0.412	18.57%	0.389	22.07%	0.415
Public deliveries	68.61%	0.464	70.91%	0.454	66.62%	0.472
Type of Assistance:						
Skilled assistance	91.42%	0.280	91.25%	0.283	89.63%	0.305
Private Delivery Medical Costs (in log):	9.619	1.730	9.843	1.343	9.710	1.568
Public Delivery Medical Costs (in log):	5.151	3.514	5.312	3.562	5.298	3.477

#### **Table 1: Summary Statistics**

## 5.2 Impact on Institutional Delivery and Assisted by Skilled Professionals

Table 2 presents the average marginal effects from the logit estimation assessing the impact of the national lockdown on institutional deliveries. Column (1) shows that, relative to the prelockdown period, the lockdown led to a statistically significant  $3 \cdot 2$ -percentage-point (CI - $0 \cdot 054$ ,- $0 \cdot 010$ ) decrease in institutional deliveries. Given 89% (SD  $0 \cdot 307$ ) of births were institutional, this represents a decrease of  $3 \cdot 6$  percent. Furthermore, institutional deliveries remained  $2 \cdot 9$  percentage points (CI - $0 \cdot 048$ ,- $0 \cdot 010$ ) lower in the post-lockdown period compared to the pre-lockdown period, a decrease of  $3 \cdot 3$  percent.

Table 2: ImpactProfessionals	of Lockdown and Post-Lockdo	own Period on Institutional De	livery and Assisted by Skilled
	Institutional deliveries	Private deliveries	Skilled assistance
		Sample restricted to	

	Institutional deliv	veries	Private deliver	ries	Skilled assistar	nce
	Full sample		Sample restricte institutional deliv	ed to veries	Full sample	
	Marginal effects (95% CI)	p- values	Marginal effects (95% CI)	p- values	Marginal effects (95% CI)	p- values
	(1)	(2)	(3)	(4)	(5)	(6)
Lockdown	-0.032 (-0.054,-0.010)	0.004	-0.047 (-0.060,-0.035)	0.000	-0.022 (-0.032,-0.012)	0.000
Post- lockdown	-0·029 (-0·048,-0·010)	0.003	0.006 (-0.011,0.022)	0.485	-0.023 (-0.033,-0.012)	0.000
State Fixed Effect	Yes		Yes		Yes	
Year Fixed Effect	Yes		Yes		Yes	
Ν	30525		27487		30627	

Notes: Logistic regression model. All regressions control for maternal age, education, marital status, religion, residence, ethnicity, wealth index, and COVID-19 cases per 100,000 in the 30 days before delivery. Estimates are weighted using NFHS sampling weights.

In column (2), we find that for women delivering at healthcare facilities, births in private facility decreased significantly by 4.7 percentage points (CI -0.060, -0.035) during the lockdown relative to the pre-lockdown period. As 21.5 percent (SD 0.412) of births in the sample were in private facilities, this is a decrease of 22 percent in private facility births. In contrast, no significant change in private facility births was observed during the post-lockdown period compared to the pre-lockdown baseline.

Column (3) examines the presence of skilled health professionals at birth. During the lockdown, there was a significant  $2 \cdot 2$  percentage point (CI -0.032,-0.012) decline in deliveries attended by skilled health professionals compared to the pre-lockdown period. With about 91.4 percent (SD 0.280) births having skilled professionals present, this amounts to a decrease of  $2 \cdot 4$  percent. Similarly, the post-lockdown period also saw a  $2 \cdot 3$  percentage point (CI -0.033,-0.012) decline in skilled attendance relative to the pre-lockdown baseline, which represents a decrease of  $2 \cdot 5$  percent.

#### 5.2 Causes for the Changes in Delivery Care

Table 3 evaluates the role of medical costs in the shift from public to private facilities during the lockdown. There were no significant changes in medical costs at public facilities during the lockdown or in the post-lockdown period, relative to the pre-lockdown period. However, private facility costs significantly increased during the lockdown period by 19 percent (CI 0.007, 0.371). No such changes were observed for the post-lockdown period.

	Private Deliveries Total	Cost	Public Deliveries Total	Cost
	OLS Estimates (95% CI)	p-values	OLS Estimates (95% CI)	p-values
	(1)	(2)	(3)	(4)
Lokcdown	0.189 (0.007,0.371)	0.043	0.047 (-0.145,0.240)	0.605
Post-lockdown	-0.111 (-0.540,0.318)	0.587	-0.005 (-0.258,0.248)	0.966
State Fixed Effect	Yes		Yes	
Year Fixed Effect	Yes		Yes	
Ν	5459		18720	

Table 3: Impact of Lockdown and Post-Lockdown Period on Delivery Care Costs by Type of Institution

Notes: OLS model. All regressions control for maternal age, education, marital status, religion, residence, ethnicity, wealth index, and COVID-19 cases per 100,000 in the 30 days before delivery. Estimates are weighted using NFHS sampling weights.

Table 4 presents the percentage of women who report a particular reason for not delivering at a health facility before, during, and after the lockdown. There were no significant changes in reporting of most reasons between pre-lockdown and lockdown period, such as facility being too far or transportation being unavailable, facility not being open, distrust of health services or perceived poor quality of care, and cultural reasons such as the absence of female providers, restrictions imposed by husbands or family, perceptions of necessity, and customary practices. However, there was a statistically significant decrease in the share of women citing costs as a reason during the lockdown period, relative to before the lockdown. There was also a significant increase of 11.6 percent (CI -0.169,-0.064) in reporting of "other reasons" during the lockdown and of 3.5 percent (CI -0.065,-0.006) during the post-lockdown.

				Sa	mple restr	icted to w	vomen who did not deliver	in a health fac	ility	
	Pre-loc	kdown	Lockd	lown	Post-loc	kdown	Pre-lockdown VS L	ockdown	Pre-lockdown VS Pos	st-lockdown
	Mean	SD	Mean	SD	Mean	SD	Difference (95% CI)	$\Pr( T  >  t )$	Difference (95% CI)	$\Pr( T  >  t )$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Too far / No transport	19.91%	0.399	15.70%	0.365	18.27%	0.387	-4.21% (-0.011,0.096)	0.123	-1.64% (-0.013,0.046)	0.276
Facility not open	9.76%	0.297	11.16%	0.315	11.03%	0.313	1.39% (-0.054,0.027)	0.501	1.26% (-0.035,0.010)	0.277
Costs	13.08%	0.337	6.61%	0.249	14.57%	0.353	-6.47% (0.020,0.109)	0.004	1.49% (-0.041,0.011)	0.259
Don't trust / Poor service	4.40%	0.205	2.89%	0.168	3.95%	0.195	-1.51% (-0.012,0.042)	0.276	-0.45% (-0.011,0.020)	0.555
No female provider, Husband/family won't allow, Not necessary, Not customary	51.18%	0.500	47.93%	0.501	48.72%	0.500	-3.25% (-0.035,0.100)	0.347	-2.46% (-0.013,0.062)	0.199
Other	17.29%	0.378	28.93%	0.454	20.82%	0.406	11.60% (-0.169,-0.064)	0.000	3.53% (-0.065,-0.006)	0.018

Table 4: Reasons for not delivering in a health facility

## 5.3 Sensitivity Analysis

As our lockdown indicator variable does not capture the intensity and spatial variation of lockdown measures across India, we conduct sensitivity analysis using Google Mobility data. We replace the lockdown and post-lockdown indicator variables with the Residential Mobility Index (RMI), which measures the time spent at home, with higher values indicating increased time at home. We use the RMI calculated as the average time spent at home by people in the district in the four days leading up to each birth. As shown in Table 5, we observe that an increase in RMI is associated with a statistically significant decline in institutional deliveries and a shift from private to public facility births among institutional deliveries. However, the negative coefficient for skilled attendants is not statistically significant. Overall, these results suggest that our main findings related to location of delivery remain robust when using this alternative measure.

	Institutional deliv	veries	Private deliver	ries	Skilled assista	nce
	Full sample	2	Sample restrictorinstitutional deliv	ed to veries	Full sample	9
	Marginal effects (95% CI)	p- value s	Marginal effects (95% CI)	p- value s	Marginal effects (95% CI)	p- value s
	(1)	(2)	(3)	(4)	(5)	(6)
Residential Mobility Index	-0.002 (-0.004,-0.000)	0.038	-0.002 (-0.004,0.000)	0.093	-0.001 (-0.002,0.000)	0.202
State Fixed Effect	Yes		Yes		Yes	
Year Fixed Effect	Yes		Yes		Yes	
Ν	13320		11916		12441	

#### Table 5: Sensitivity Analysis Using Residential Mobility Index

Notes: Logistic regression model. All regressions control for maternal age, education, marital status, religion, residence, ethnicity, wealth index, and COVID-19 cases per 100,000 in the 30 days before delivery. Estimates are weighted using NFHS sampling weights.

## 6. Discussion

Our findings highlight significant shifts in delivery care utilization in India due to the COVID-19 lockdown measures. Institutional deliveries declined during the lockdowns compared to the pre-pandemic period and continued to remain at lower levels after the lockdowns. Similarly, we also observed a decline in deliveries assisted by skilled professionals during both the lockdowns and the post-lockdown period. These results highlight the significant challenge of maintaining access to skilled care during crises, which is crucial for reducing maternal and neonatal mortality. The disruption of skilled care during the pandemic, likely due to redirection of services towards care for COVID-19 patients,<sup>11</sup> may have exacerbated risks that mothers were exposed to, emphasizing the need for more resilient health systems in future emergencies. Overall, our findings are consistent with existing studies that found a significant decline in maternal and child health services, such as antenatal care, facility-based deliveries, child immunization provision, and family planning services.<sup>8,16</sup>

The reduction in institutional deliveries was accompanied by a notable decrease in births at private facilities, while deliveries in public facilities increased. Interestingly, the share of private facility births returned to pre-lockdown levels after restrictions were lifted, indicating that the lockdown itself was a key driver of this shift. When investigating whether medical costs contributed to shifts in delivery care patterns, we found that while medical costs for those delivering at private facilities increased during the lockdown, they returned to pre-pandemic levels afterward, mirroring the trend observed in private facility births. This is consistent with reports suggesting that some private healthcare providers in India engaged in price gouging during the pandemic.<sup>31,32</sup> Pregnant women with preferences for private facilities either chose to deliver at home or at public facilities when faced with economic and other barriers during the lockdowns.

During the lockdown period, there was a notable increase in the reporting of "other reasons" for not delivering at health facilities. Possible examples of these factors might include logistical barriers and misinformation about the risks associated with institutional delivery. This suggests

that the unique challenges posed by the lockdowns may have created additional barriers for women, beyond the usual difficulties faced under normal circumstances.

Overall, these findings suggest that policymakers need to be careful about the unintended consequences of lockdown measures, which may have been successful in keeping the pandemic in check, but the adverse effects may continue even after the end of the containment measures, as suggested by our post-lockdown results. Strategies for maintaining essential maternal care services and ensuring the availability of skilled health professionals should be prioritized in pandemic preparedness plans.

This study also underscores the importance of ensuring affordable and equitable access to healthcare during public health emergencies. The observed cost escalation in private facilities, which are often considered as having higher quality of service,<sup>22</sup> during lockdowns exacerbates existing inequities in LMICs, where financial barriers already limit healthcare access for many. Implementing price controls in private facilities or cash transfer programs during such emergencies could mitigate such disparities in future pandemics.

There are several limitations to our analysis that future research can focus on. Our analysis is based on 11 states in India and 3 Union Territories, and therefore, it is likely not representative of the entire country. All outcome variables are self-reported, which may lead to measurement errors, especially for variables related to cost. Moreover, due to data limitations in the NFHS-5, we are unable to directly examine whether facilities had COVID-19 testing capacities, which could also have affected women's choices during the pandemic. Despite these shortcomings, our study highlights the importance of ensuring resilience in maternal healthcare systems during pandemics can safeguard the health of women and children.

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## Appendix

## A1. Google Mobility Data

We use Google Community Mobility Reports data to conduct robustness check for our analysis. These reports track mobility trends by comparing visits and duration of stay at various locations including retail stores, grocery stores, transit stations, workplaces, and residential areas relative to a baseline period from January 3 to February 6, 2020, before the pandemic. This baseline period of comparison was chosen by Google. The anonymized data, derived from users who opted into location history on their Google accounts, offer a representative snapshot of mobility trends across regions.

Given that lockdown measures, also known as stay-at-home orders, encouraged individuals to remain at home, our analysis focused on residential mobility, which measures the percentage change in time spent at home compared with the baseline period. The strength of this measure lies in its ability to quantify the intensity of lockdowns and capture potential effects of state-level restrictions implemented later. However, its limitations include the lack of mobility data prior to January 2020, offering minimal pre-pandemic baseline information, and a high proportion of missing values, particularly in districts with limited mobile phone coverage.<sup>3</sup> Consequently, this measure is used as a robustness check rather than the primary analytic tool.

<sup>&</sup>lt;sup>3</sup> More than half of the dataset is missing for the variable residential mobility (56.87%), with the average districtlevel missing rate at 57.36%, 72.36% of districts having at least 50% of data missing, and 10.18% of districts having at least 90% missing.

	Full Sa	ample
	Mean	SD
	(1)	(2)
Religion		
Hindu	0.809	0.393
Muslim	0.109	0.312
Other	0.082	0.274
Residence Type		
Urban	0.200	0.400
Rural	0.800	0.400
Ethnicity		
Scheduled Caste	0.841	0.366
Scheduled Tribe	0.148	0.355
No caste/No Tribe	0.011	0.106
Women Age	26.064	4.637
Women Education Level		
Primary	0.112	0.315
Seconadry	0.513	0.500
Higher	0.175	0.380
No Education	0.201	0.400
<u>Marriage</u>		
Married	0.996	0.067
Widowed/Divorced	0.004	0.067
Wealth Index		
Poor	0.496	0.500
Middle	0.176	0.381
Rich	0.329	0.470
COVID Cases (/100,000)	4.781	7.987

Table A1: Summary Statistics of the ControlVariables

	Institutional deli	veries	Private delive	ries	Skilled assista	nce
	Full sample	e	Sample restrict institutional deli	ted to iveries	Full sample	e
	Odds ratio (95% CI)	p- values	Odds ratio (95% CI)	p- values	Odds ratio (95% CI)	p- values
	(1)	(2)	(3)	(4)	(5)	(6)
Lockdown	0.661 ( $0.512, 0.854$ )	0.002	0.748 (0.691,0.811)	0.000	0.737 (0.650,0.836)	0.000
Post-lockdown	0.685 ( $0.539, 0.872$ )	0.002	1.034 (0.941,1.137)	0.484	0.731 (0.634,0.843)	0.000
Religion: Hindu	$1 \cdot 171$ (0.800,1.713)	0.418	0.836 (0.642,1.089)	0.184	1.199 (0.912,1.578)	0.194
Religion: Muslim	0.754 (0.503,1.129)	0.170	$1 \cdot 298$ (1 \cdot 025, 1 \cdot 643)	0.030	0.829 (0.615,1.117)	0.217
Residence Type: Rural	$1 \cdot 229$ (0.978,1.544)	0.076	0.737 (0.668,0.813)	0.000	1.006 (0.864,1.171)	0.937
Ethnicity: Scheduled Caste	0.537 (0.304,0.949)	0.032	0.734 (0.535,1.008)	0.056	(0.508) (0.193, 1.339)	0.171
Ethnicity: Scheduled Tribe	0.288 (0.166,0.498)	0.000	0.481 (0.312,0.742)	0.001	(0.339) (0.137, 0.842)	0.020
Women Age	0.986 ( $0.978, 0.994$ )	0.001	1.033 (1.006,1.061)	0.017	(0.988) (0.983, 0.993)	0.000
Education: Primary	1.406 (1.140,1.733)	0.001	1.093 (0.956,1.248)	0.193	1.390 (1.171,1.649)	0.000
Education: Secondary	2.363 (1.911,2.922)	0.000	1.434 (1.188,1.732)	0.000	1.986 (1.569,2.514)	0.000
Education: Higher	4.922 (3.541,6.842)	0.000	(1.677, 4.633)	0.000	3.019 (2.254,4.043)	0.000
Married	(0.189, 2.455)	0.557	(0.767, 1.437)	0.763	(0.511) (0.174, 1.507)	0.224
Wealth Index: Middle	(0.931, 1.828)	0.122	$(1 \cdot 245, 1 \cdot 668)$	0.000	(1.220, 1.938)	0.000
Wealth Index: Rich	(1.454, 3.074)	0.000	(2.689, 3.193)	0.000	(1.645, 2.739)	0.000
Covid Cases	1.006 (0.987,1.025)	0.552	1.002 (0.998,1.005)	0.363	1.005 (0.993,1.018)	0.409
State Fixed Effect	Yes		Yes		Yes	
Year Fixed Effect	Yes		Yes		Yes	
Ν	30525		27487		30627	

Table A2: Impact on Institutional Delivery and Assisted by Skilled Professionals, Logit Estimations

Notes: Estimates are weighted using NFHS sampling weights.

	Private Deliveries Tot	al Cost	Public Deliveries Tota	al Cost
	OLS Estimates (95%	p-	OLS Estimates (95%	p-
	CI)	values	CI)	values
	(1)	(2)	(3)	(4)
Lokcdown	0.189 (0.007,0.371)	0.043	0.047 (-0.145,0.240)	0.605
Post-lockdown	-0.111 (-0.540,0.318)	0.587	-0.005 (-0.258,0.248)	0.966
Religion: Hindu	-0.061 (-0.268,0.147)	0.539	0.047 (-0.481,0.576)	0.850
Religion: Muslim	-0.179 (-0.429,0.070)	0.145	0.182 (-0.707,1.071)	0.666
Residence Type: Rural	0.072 (-0.033,0.178)	0.163	-0.080 (-0.381,0.220)	0.573
Ethnicity: Scheduled Caste	0.129 (-0.417,0.674)	0.619	0.517 (-0.522,1.556)	0.302
Ethnicity: Scheduled Tribe	0.118 (-0.392,0.628)	0.625	0.091 (-1.081,1.262)	0.870
Women Age	0.012 (-0.001,0.025)	0.069	-0.010 (-0.022,0.001)	0.071
Education: Primary	0.324 (0.165,0.483)	0.001	0.217 (-0.031,0.465)	0.082
Education: Secondary	0.272 (0.167,0.377)	0.000	0.062 (-0.143, 0.267)	0.524
Education: Higher	0.197 (0.099,0.294)	0.001	0.318 (-0.019,0.656)	0.063
Married	0.132 (-0.179,0.442)	0.377	-0.239 (-1.021,0.543)	0.521
Wealth Index: Middle	0.168 (0.072,0.265)	0.002	-0.026 (-0.195,0.142)	0.743
Wealth Index: Rich	0.416 (0.259,0.573)	0.000	0.021 (-0.208,0.251)	0.844
Covid Cases	0.010 (-0.001,0.021)	0.083	0.008 (0.002,0.013)	0.009
State Fixed Effect	Yes		Yes	
Year Fixed Effect	Yes		Yes	
Ν	5459		18720	

Table A3: OLS Estimates of Delivery Care Costs by Delivery Type

Notes: Estimates are weighted using NFHS sampling weights.

	Institutional del	iveries	Private delive	eries	Skilled assista	nce
	Full samp	e	Sample restrict institutional deli	ted to iveries	Full sample	e
	Odds ratio (95% CI)	p- values	Odds ratio (95% CI)	p- values	Odds ratio (95% CI)	p- values
	(1)	(2)	(3)	(4)	(5)	(6)
Residential Mobility Index	0·977 (0·957,0·998)	0.036	0.990 (0.979,1.002)	0.103	0·990 (0·974,1·006)	0.200
Religion: Hindu	1.046 (0.543,2.013)	0.894	0.981 (0.626,1.535)	0.932	1·142 (0·833,1·566)	0.409
Religion: Muslim	0.688 (0.342,1.383)	0.293	1.678 (1.066,2.643)	0.025	0.782 (0.528,1.159)	0.220
Residence Type: Rural	1·377 (1·106,1·716)	0.004	0.794 (0.641,0.983)	0.035	1.180 (0.992,1.403)	0.061
Ethnicity: Scheduled Caste	0.577 (0.276,1.206)	0.143	0.747 (0.494,1.130)	0.167	0.768 (0.297,1.987)	0.586
Ethnicity: Scheduled Tribe	0.287 (0.134,0.612)	0.001	0.571 (0.323,1.010)	0.054	0.490 (0.221,1.088)	0.080
Women Age	0·983 (0·976,0·990)	0.000	1.035 (0.995,1.078)	0.089	0.978 ( $0.972, 0.983$ )	0.000
Education: Primary	1.215 (0.968,1.524)	0.093	1.002 (0.886,1.133)	0.976	$1 \cdot 258$ (0.952,1.663)	0.106
Education: Secondary	$2 \cdot 362$ (1.951,2.860)	0.000	1.354 (1.106,1.657)	0.003	1.888 (1.503,2.372)	0.000
Education: Higher	4·947 (3·321,7·369)	0.000	2.573 (1.550,4.271)	0.000	2·965 (2·121,4·147)	0.000
Married	0.341 (0.049,2.356)	0.275	1.417 (0.528,3.804)	0.489	0.408 (0.063,2.617)	0.344
Wealth Index: Middle	1·346 (0·948,1·911)	0.096	1.478 (1.281,1.705)	0.000	1.527 (1.234,1.891)	0.000
Wealth Index: Rich	$2 \cdot 266$ (1 · 540,3 · 335)	0.000	3.040 (2.662,3.473)	0.000	2·442 (2·135,2·792)	0.000
Covid Cases	1.000 (0.986,1.014)	0.996	1.006 (1.001,1.010)	0.015	1.001 (0.990,1.012)	0.848
State Fixed Effect	Yes		Yes		Yes	
Year Fixed Effect	Yes		Yes		Yes	
Ν	13320		11916		12441	

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Notes: Estimates are weighted using NFHS sampling weights.