Excess neonatal mortality among private facility births in north India

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Abstract

Background

India is home to one-sixth of the world's population, but to one-fourth of neonatal deaths. Within India, the northern states of Uttar Pradesh, Bihar, and Chhattisgarh ("focus states") account for more than half of neonatal deaths. Despite a recent increase in facility birth, the region's neonatal mortality rate (NMR) remains among the highest in the world. We undertake demographic analysis to document and study the large gap in NMR between births in public and private facilities.

Methods

We conduct demographic analysis of mother-reported birth histories from the NFHS 2015. We summarize population-representative NMR by facility type and use reweighting techniques to standardize births in private and public facilities to a common distribution of observable socioeconomic and demographic characteristics.

Findings

The NMR, ${}_{28}q_0$, among private facility births in the focus states is 50.4 per 1000 (95% CI: 46.4-54.4), compared with 35.7 per 1000 for public facility births (95% CI: 33.3-38.0) and 44.0 per 1000 for home births (95%CI: 40.0 – 47.0). In the rest of India, ${}_{28}q_0$ for private is 17.5 per 1000 (95% CI: 15.7-19.3), compared to 22.9 per 1000 (95% CI: 21.5-24.3) for public. After adjusting for the socioeconomic and demographic profile of births, the gap between private and public in the focus states increases from 14.7 per 1000 to 22.1 per 1000, and from -5.4 per 1000 to 0.1 per 1000 in the rest of India.

Interpretation

Increasing facility birth is thought to accelerate the decline in NMR. Yet, in the focus states, births in private facilities experience stunningly high NMR. Our further analysis suggests that only a small portion of the mortality disadvantage among private facility births is explained by observables indicating selection of higher-risk births into private facilities. Further research to understand what happens to mothers and newborns in private facilities in this region is sorely needed.

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Introduction

The third Sustainable Development Goal (SDG) aims to end preventable neonatal death by 2030, and to achieve a global neonatal mortality rate (NMR) of 12 per 1,000 live births. Whether this goal will be achieved depends critically on India, which is home approximately to one-sixth of persons, to one-fifth of births, and to one-fourth of neonatal deaths. Neonatal death in India is not merely disproportionately common relative to its population size; it is also greater than would be predicted given its level of economic development, its later-childhood mortality rates, and international trends (Coffey and Hathi, 2016; Hug, et al. 2019). Early-life mortality, like other human development outcomes, is worse in India than in many other poorer countries (Drèze and Sen, 2013; Deaton, 2013).

The literature has considered evidence for several explanations of India's poor early-life health outcomes, including poor maternal nutrition, poor sanitation and the persistence of open defecation, and ambient and indoor air pollution (Coffey, 2015; Geruso & Spears, 2018; Sinharoy et al., 2020). Here we document a puzzle of early-life mortality in India by investigating outcomes of births in public and private health facilities. Understanding birth in health facilities, rather than at home, is of increasing importance because, in part due to a large-scale government policy, the fraction of births in India taking place in a health facility has recently increased from about 20% in the 2005-6 National Family Health Survey (NFHS) to about 80% in 2015-16 NHFS.

We focus on three northern states with a combined population greater than that of the United States: Uttar Pradesh, Bihar, and Chhattisgarh. Six percent of worldwide births and 15% of worldwide neonatal deaths each year happen in these three states of India alone (authors' computations from Unicef, 2018 and NFHS-2015 data). Throughout the paper, we compare these "focus states" with the rest of India. We chose these as focus states because they are the states for which NMR among births in private hospitals exceeds NMR among births in public hospitals.

The low quality of health care in India, in both the public and private sectors, has been highlighted in prior research (Das, et al. 2008; Mohanan, et al. 2016). We advance this literature by comparing early-life mortality probabilities in public and private health facilities using demographic standardization methods to account for socioeconomic and other differences between mothers and children at each type of facility. Understanding the clinical settings in which Indian neonates are most likely to die is necessary for targeting policies to achieve the third SDG. Private hospitals and clinics in the focus states may require special policy attention. Thirty percent of births in a health facility in these states are in private settings. Beyond this policy-targeting purpose, the demographic analysis that we provide is a step towards understanding the systems, incentives, institutions, and environmental threats that generate India's high NMR.

Methods

We conduct demographic analysis of population-level survey data on mother-reported birth histories. In addition to summarizing population-representative statistics, we use reweighting techniques from population science to standardize births in private and public facilities to a common distribution of observable socioeconomic and demographic characteristics. In a secondary analysis, presented in the Supplementary Materials, we confirm that our main result is replicated using an alternative survey dataset commissioned by the Government of India. **[Supplementary Materials are not yet available, but will be prepared for the PAA conference.]**

Data Source

We analyse the birth recode of India's 2015-2016 National Family Health Survey (NFHS). The data are publicly available at measuredhs.com.

The NFHS is a stratified, clustered random sample of households. We use the retrospective birth history, in which information about each live birth is asked of every ever-married woman between the ages of 15 and 49 living in selected households.

Our dependent variable of interest is neonatal mortality. Specifically, we construct four binary indicators: for dying in the first 28 days of life (the NMR); in the first two days of life; in the next seven days conditional on surviving the first two days; and in the next 19 days conditional on surviving the first nine days. Sample means of these variables are estimates of conditional probabilities of death. Following the notation of formal demography, we express these quantities as ${}_{28}q_0$, ${}_{2}q_0$, ${}_{7}q_2$, and ${}_{19}q_9$, respectively.

Our independent variable of interest is whether a birth occurred in a private facility or in a public facility. We analyse the "focus states" – Bihar, Chhattisgarh, and Uttar Pradesh – separately from the other states of India.

Our reweighting analysis, which is described below, uses a set of socioeconomic and demographic variables that predict NMR. We reweight over the intersection of indicators for each of the DHS's asset quintiles; an indicator for rural residence; indicators for being first born, second born, or third and higher born; indicators for being from a siblingship size of one, two, or three or more; indicators for being born after an immediately prior sibling death, for being born after a sibling death that was not immediately prior, and for being born after no sibling death; and an indicator for having a mother whose first birth occurred in her adolescence (before the age of 20). In the Supplementary Materials, we show that each of these variables predicts NMR in a regression framework.

After documenting our main result, we explore explanations for the excess mortality in private facilities. In particular, we assess whether riskier births are more likely to occur in private facilities, and whether this can explain the NMR gap between private and public facilities in the focus states. We use survey-reported variables on mother's experience of prior neonatal death; complications during pregnancy (blurred daytime vision, convulsions not from fever, and swelling); whether the birth was vaginal or caesarean (CS); whether the birth was breech presentation; whether the mother experienced prolonged labour; whether she experienced excessive bleeding; and the child's birth order. In India, conditional on siblingship size, lower birth order child are more likely to die in neonatancy (Coffey & Spears, 2020). We also examine timing of initiation of breastfeeding in public and private facilities, which we interpret as a measure of quality of care.

Data Analysis

Standardization methods in demography use reweighting techniques to allow researchers to compare across populations net of confounding variables (Preston, et al, 2001; Kitagawa, 1955). We use a reweighting technique developed for the econometric literature by DiNardo, et al (1996) and extended to the demography literature by Geruso (2012).

Because births in private facilities tend to come from higher-socioeconomic status households than births in public facilities, and because socioeconomic status predicts neonatal survival, we produce reweighted mortality rates that standardize over a distribution of socioeconomic observables and other predictors of early-life mortality. Our reweighting analysis also accounts for demographic differences in births that are associated with NMR. These standardizations project what mortality rates would be if births in each setting (private or public facilities) counterfactually had the distribution of observables of all births in any facility. It assumes that the conditional probabilities of dying in each socioeconomic and demographic category do not change.

We bootstrap the reweighting procedure to produce standard errors that reflect both survey design and sampling error from the standardization process. For statistical significance tests reported in the text, we use logistic tests for differences in proportions and for difference-in-differences in proportions, with inference reflecting survey clustering, weighting, and stratification. Full details and equations are available in the Supplementary Material.

All computations are performed using Stata 16 on the statistics server of the Population Research Center of the University of Texas at Austin.

The institutional review board of the University of Texas at Austin determined that our study, using anonymized demographic data, is not human subjects research.

Supporting Analysis of an Additional Data Source

The Annual Health Survey (AHS) was conducted by the Government of India in nine high-mortality, high-fertility states of India. It is a state and district-representative panel study of four million households interviewed thrice between 2010 and 2013. In order to replicate our finding in an independent data source, we analyse AHS data from Round 3, when facility birth rates are closest to what they were in the NFHS 2015. We note that the AHS' measure of early life mortality does not allow us to compute age-specific probabilities of death. However, it does include stillbirth, which the NFHS' does not. This is an advantage of the AHS because stillbirth is a large fraction of early life mortality in this context. A large-scale intervention study conducted in Uttar Pradesh found that there were about two-thirds as many stillbirths in public facilities as neonatal deaths in the first week of life (Semaru, et al, 2017). Our analysis of the AHS data, presented in the Supplementary Material, finds a similar pattern to our main results: private facilities in the focus states have higher mortality rates than public facilities.

Role of the Funding Source

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Results

Table 1 presents summary statistics from the NFHS 2015. Neonatal mortality in the focus states of India is common. Death in early life is especially common in private facilities of the focus states (private vs public ${}_{28}q_0$: $p < 0.001$ for focus states), but is more common in public than private facilities in other states ($p < 0.001$ for other states; difference-in-differences interaction between state category and facility type $p < 0.001$).

Also visible in the summary statistics is the socioeconomic advantage of births in private hospitals. Mothers in private hospitals are more likely to live in an urban setting and more likely to come from the top quintile of the NFHS asset index. For some demographic variables, such as the percent who are firstborn and the percent who have a prior sibling death, private hospital births are disadvantaged. However, births in public hospitals tend to come from larger siblingship sizes. These differences motivate our standardization analysis.

Main result: Excess neonatal mortality in private facilities

Figure 1 presents our main result: unadjusted and standardized estimates of age-specific mortality probabilities. Standardized estimates project what mortality probabilities would be if all facility deliveries (public and private) happened at public or private facilities, based on the distribution of observables. Because births in private facilities are socioeconomically advantaged, on average, the standardization increases the already large gap between public and private facilities. After adjusting for the socioeconomic and demographic profile of births, the gap between private and public in the focus states increases from 14.7 per 1000 to 22.1 per 1000.

This pattern is different outside of the focus states. Early life mortality at every age is lower outside the focus states. The unadjusted difference between private and public is -5.4 per 1000. After standardization, the difference is less than 0.1 per 1000.

Although the pattern of higher mortality in private facilities in the focus states is also evident for ${}_{7}q_{2}$, the difference is most pronounced for ${}_{2}q_{0}$, mortality in the first two days of life. There is no statistically significant difference in ${}_{19}q_{9}$ between births in public and private facilities in the focus states.

Because there were about 5.3 million facility births in the focus states in 2015 (authors' computations from Unicef, 2018 and NFHS 2015), this would suggest that the excess mortality in private facilities, compared with public facilities, accounts for about 35,250 neonatal deaths annually in the focus states (1,594,848 births in private facilities × 22.1 ÷ 1000 standardized excess mortality = 35,250). For comparison, there were about 15,700 neonatal deaths in the United States in 2015 (Ely & Driscoll, 2020). Of course, this mechanical quantification should not be understood as an estimate of a causal effect.

Supporting analysis of the AHS

We use the AHS to replicate the pattern of our main result in an independent data source. Mothers report where the birth took place and whether births resulted in a stillbirth or an early-life death. As in the DHS, we find in the AHS that early-life death is more common in the focus states among private-facility than public-facility births; that early-life death is less common outside of the focus states; and that there is a smaller gap in early-life mortality across public and private births. Full details and results are in the Supplementary Material.

Suggestive evidence of mechanisms

It is beyond the scope of this demographic analysis to establish the causes of the excess mortality that we document. However, NFHS survey questions provide suggestive evidence about the extent to which selection of high-risk births into private facilities can explain the difference we document.

Why might high-risk births select into private facilities in the focus states? In principle, government policy dictates that risky pregnancies at small, rural public clinics get referred to hospitals in towns and cities. In practice, women receiving a referral or facing a risky delivery may decide not to pay the costs and difficulties of travelling to a physically and socially distant urban public facility (Babiarz, et al. 2016). Pregnant women and their families may be concerned about suffering from the verbal or physical abuse that is especially common in large, public maternity hospitals (Sharma et al. 2019). In such cases, the choice of a private provider may be motivated by proximity or customer-oriented treatment, such as services for accompanying family members, rather than by an understanding of the quality of medical care. If this is true, our results may reflect an interaction between the public and private systems of obstetric care.

Yet, there is little evidence that transfer of risky cases from the public to the private sector could explain the large mortality gap that we document. Table 1 shows that some types of higher-risk births (first borns, births with prior sibling deaths, and births in which there has been a pregnancy complication) are over-represented in private facilities. However, the magnitude of the differences is small, and in the case of pregnancy complication, very small. Table 1 also shows that other types of higher-risk births, such as those from large families, and births to rural women, are over-represented in public hospitals.

One important difference between births at private and public facilities, summarized in Table 1, is that births at private facilities are more likely than those at public facilities to be caesarean rather than vaginal. As the prior literature has noted, this may in part be because surgeries are less likely to be available at public facilities, so births for which surgery is medically necessary may be disproportionately sorted into private facilities. It is also in part because of an effect of provider economic incentives at private facilities to recommend caesarean birth even when it is not medically necessary.

These facts raise the possibility that high-risk caesarean births could perhaps explain excess NMR in private facilities. However, caesarean births are only about 12% of births in the focus states. More importantly, neonatal death is particularly likely among vaginal births at private facilities. Figure 2 shows that, within the focus states, neonatal death is most likely for private vaginal births, followed by public caesarean births, then by private caesarean births, then by public vaginal deliveries, which have the lowest probability of death. Outside of the focus states, this pattern is reversed: neonatal mortality is more common for public rather than private vaginal deliveries (focus/other state by private/public interaction on sample restricted to vaginal deliveries: difference-in-differences $p < 0.001$). Therefore, because the excess mortality in private facilities in the focus states is concentrated among vaginal births, our results cannot be explained by disproportionate sorting to private providers among high-risk cases that require surgery.

Table 2 documents differences between NMR in public and private facilities for subsamples of births with different risk profiles. These data show that a mortality gap between private and public exists for nearly every type of birth in the focus states. The results in Table 2 use survey weights, but not reweighting standardization. The first panel separates births by demographic factors. It finds differences in NMR between private and public facilities in the focus states that are large in magnitude and statistically significant even for lower-risk births, such as those that are not first born, and those who have had no prior sibling death.

The second panel of Table 2 report NMR by type of birth and whether the mother reports any of the birth or pregnancy complications summarized in Table 1. With the exception of caesarean birth, discussed above, births in private facilities have higher NMR than births in public facilities. This provides further evidence that selection of riskier births into private facilities in focus states does not explain excess NMR.

Unfortunately, the DHS contains little information about the quality of care during and after birth, which might be able to explain the excess mortality in private facilities. It does, however, collect data on the timing of initiation of breastfeeding. Table 1 shows that last births in private facilities are 12 percentage points less likely to initiate breastfeeding in the first hour, and 18 percentage points less likely to initiate breastfeeding on the first day, than births in public facilities. Early initiation of breastfeeding is known to promote neonatal survival (Smith et al. 2017). In the Discussion, we present a hypothesis to explain this difference.

Conclusion

The excess mortality in private facilities that we document in Uttar Pradesh, Bihar, and Chhattisgarh occur in a population where maternal nutrition, infectious disease, and other environmental and socioeconomic factors create a background of frailty. Yet, it is worth noting because the excess mortality is quantitatively large and these states are responsible for about half of neonatal mortality in India. If the percent of births in private facilities in the focus states has remained constant since 2015, that would imply that there were more births in private facilities in the three focus states of north India than the total number of births in each of 167 countries in 2019 (World Bank, 2020). No country in the world currently has a national neonatal mortality rate as high as the unadjusted rate for private facility births in focus states. According to World Bank (2020) data, this last happened in 2008 when Pakistan and Afghanistan both had a neonatal mortality rate just above 50 per 1,000.

Although the analysis presented here suggests that selection of higher-risk births into private facilities cannot explain the difference between public and private facilities, the data available in the NFHS cannot settle the question of why neonatal mortality is so high in private facilities in the focus states. It appears that the quality of care in private hospitals in these states is extremely low. Yet, the puzzle is sharpened by the extensive documentation in the literature of the poor quality of care in public obstetric facilities in the focus states (Coffey, 2014; Delaney, et al. 2019; Semaru et al. 2017). We recommend that qualitative research in clinical settings be included among further investigation to understand this problem.

What sorts of quality issues might such research investigate? More information is needed on differences in the initiation of breastfeeding, which the NFHS data allow us to partially document. We hypothesize that, in the focus states, newborns are more likely to be in the care of their mothers in public facilities relative to in private facilities, where newborns may be more likely to be separated from their mothers. Although newborns in public hospitals may be less likely to receive treatment in the minority of cases when such care is medically necessary, they may be more likely to establish breastfeeding and skin-to-skin thermal regulation, both of which are especially important where birthweights are low. If so, this difference in treatment could reflect the financial incentives of private care providers, who can charge for such conspicuous activity. Private providers may also be more likely to recommend or to respond to consumer demand for labour induction or augmentation, including by intramuscular injections of oxytocin (Brhlikova, et al 2009; Shyken, et al 1995). Health economists have long warned about the market failures caused by asymmetric information in health care (Arrow, 1963).

We do not have the evidence here to establish any of these conjectures, let alone to decompose the large excess mortality in the private facilities of the focus states among these candidate explanations. Because our results represent over 35,000 excess neonatal deaths annually – and a significant barrier to reaching the neonatal mortality SDG – this pattern of mortality should motivate further attention and research.

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Table 1, Panel A. Summary Statistics

	focus states			other states			all India		
	private	public	home	private	public	home	private	public	home
% of all births in India	6.6	15.3	11.0	20.3	36.9	9.9	26.9	52.2	20.9
% of neonatal deaths	11.5	19.0	16.6	12.3	29.3	11.3	23.8	48.3	27.9
mortality outcomes									
$_{28}q_0$ (NNMR)	50	36	44	17	23	33	25	27	38
	(46-54)	(33-38)	(40-47)	(16-19)	(21-24)	(30-36)	(24-27)	(25-28)	(36-41)
$_2q_0$	33	21	25	10	13	20	16	15	23
	(30-37)	(19-23)	(23-28)	(9-11)	(12-14)	(17-22)	(14-17)	(14-16)	(21-24)
$_7q_2$	12	10	13	6	7	9	8	8	11
	(10-14)	(9-11)	(11-14)	(5-7)	(7-8)	(7-10)	(7-8)	(8-9)	(10-12)
$_{19}q_9$	5	5	6	2	3	5	3	3	6
	(4-6)	(4-6)	(5-8)	(1-2)	(2-3)	(4-6)	(2-3)	(3-4)	(5-7)
deomographic correlates of birth outcomes									
mother's age at birth	24.6	24.7	25.8	24.4	23.6	24.4	24.4	23.9	25.1
	(24.5-24.7)	(24.6-24.7)	(25.7-25.9)	(24.3-24.5)	(23.5-23.7)	(24.3-24.5)	(24.3-24.5)	(23.9-24.0)	(25.1-25.2)
first born to mother	0.44	0.32	0.20	0.51	0.43	0.24	0.49	0.40	0.22
	(0.43-0.45)	(0.32-0.33)	(0.20-0.21)	(0.50-0.52)	(0.43-0.44)	(0.23-0.25)	(0.49-0.50)	(0.40-0.40)	(0.22-0.23)
birth order	2.1	2.5	3.1	1.7	1.9	2.7	1.8	2.1	2.9
	(2.1-2.1)	(2.5-2.6)	(3.1-3.1)	(1.7-1.7)	(1.9-1.9)	(2.7-2.7)	(1.8-1.8)	(2.1-2.1)	(2.9-2.9)
sibsize at time of survey	2.4	2.8	3.4	1.9	2.2	3.0	2.0	2.4	3.2
	(2.3-2.4)	(2.8-2.8)	(3.4-3.4)	(1.9-1.9)	(2.2-2.2)	(2.9-3.0)	(2.0-2.0)	(2.3-2.4)	(3.2-3.2)
male	0.55	0.52	0.51	0.54	0.52	0.50	0.54	0.52	0.51
	(0.54-0.56)	(0.51-0.52)	(0.50-0.52)	(0.53-0.54)	(0.52-0.52)	(0.50-0.51)	(0.53-0.55)	(0.52-0.52)	(0.50-0.51)
prior sibling neonatal	0.15	0.12	0.13	0.07	0.07	0.10	0.09	0.09	0.11
death	(0.14-0.16)	(0.12-0.13)	(0.12-0.14)	(0.06-0.08)	(0.07-0.07)	(0.09-0.10)	(0.09-0.10)	(0.08-0.09)	(0.11-0.12)
immediately prior sibling	0.08	0.05	0.05	0.04	0.03	0.04	0.05	0.04	0.04
neonatal death	(0.07-0.08)	(0.05-0.05)	(0.04-0.05)	(0.04-0.04)	(0.03-0.04)	(0.03-0.04)	(0.05-0.05)	(0.04-0.04)	(0.04-0.04)

Table 1, Panel B. Summary Statistics

	focus states			other states			all India		
	private	public	home	private	public	home	private	public	home
socioeconomic correlates of birth outcomes									
poorest quintile	0.18	0.43	0.54	0.04	0.17	0.41	0.07	0.25	0.48
	(0.17-0.19)	(0.42-0.44)	(0.53-0.56)	(0.04-0.04)	(0.16-0.17)	(0.40-0.42)	(0.07-0.08)	(0.24-0.25)	(0.47-0.49)
richest quintile	0.22	0.04	0.02	0.32	0.09	0.03	0.30	0.08	0.03
	(0.21-0.23)	(0.04-0.05)	(0.02-0.03)	(0.31-0.33)	(0.09-0.10)	(0.02-0.03)	(0.29-0.31)	(0.07-0.08)	(0.02-0.03)
rural	0.68	0.87	0.87	0.51	0.70	0.83	0.56	0.75	0.85
	(0.66-0.70)	(0.86-0.88)	(0.86-0.88)	(0.50-0.53)	(0.69-0.71)	(0.81-0.85)	(0.54-0.57)	(0.74-0.76)	(0.84-0.86)
type of birth, birth complications, and pregnancy complications									
caesarean birth	0.32	0.04	0.00	0.44	0.15	0.00	0.41	0.12	0.00
	(0.31-0.33)	(0.04-0.04)	(0.00-0.00)	(0.43-0.45)	(0.15-0.16)	(0.00-0.00)	(0.40-0.42)	(0.12-0.12)	(0.00-0.00)
vaginal birth	0.68	0.96	1.00	0.56	0.85	1.00	0.59	0.88	1.00
	(0.67-0.69)	(0.96-0.96)	(1.00-1.00)	(0.55-0.57)	(0.84-0.85)	(1.00-1.00)	(0.58-0.60)	(0.88-0.88)	(1.00-1.00)
breech presentation*	0.07	0.06	0.06	0.16	0.17	0.10	0.14	0.14	0.08
	(0.06-0.07)	(0.06-0.07)	(0.05-0.06)	(0.15-0.16)	(0.16-0.17)	(0.09-0.11)	(0.13-0.14)	(0.14-0.14)	(0.07-0.08)
prolonged labor*	0.44	0.43	0.38	0.41	0.45	0.36	0.42	0.44	0.37
	(0.43-0.45)	(0.42-0.44)	(0.37-0.39)	(0.40-0.42)	(0.44-0.46)	(0.35-0.38)	(0.41-0.42)	(0.44-0.45)	(0.36-0.38)
excessive bleeding*	0.29	0.32	0.30	0.33	0.37	0.32	0.32	0.36	0.31
	(0.28-0.30)	(0.31-0.33)	(0.29-0.31)	(0.32-0.34)	(0.37-0.38)	(0.31-0.33)	(0.31-0.33)	(0.35-0.37)	(0.30-0.32)
swelling in pregnancy*	0.36	0.32	0.31	0.34	0.31	0.27	0.35	0.31	0.29
	(0.35-0.37)	(0.31-0.33)	(0.30-0.32)	(0.33-0.35)	(0.31-0.32)	(0.26-0.28)	(0.34-0.35)	(0.31-0.32)	(0.28-0.29)
vision problem in	0.13	0.15	0.16	0.07	0.10	0.11	0.08	0.11	0.13
pregnancy*	(0.12-0.14)	(0.14-0.15)	(0.15-0.17)	(0.07-0.08)	(0.10-0.10)	(0.10-0.11)	(0.08-0.09)	(0.11-0.12)	(0.13-0.14)
convulsion in pregnancy*	0.26	0.26	0.26	0.11	0.13	0.12	0.14	0.17	0.19
	(0.25-0.27)	(0.26-0.27)	(0.25-0.28)	(0.10-0.11)	(0.13-0.13)	(0.11-0.13)	(0.14-0.15)	(0.16-0.17)	(0.19-0.20)
any complication in	0.50	0.48	0.46	0.41	0.40	0.35	0.43	0.42	0.41
pregnancy*	(0.49-0.51)	(0.47-0.48)	(0.45-0.47)	(0.40-0.42)	(0.40-0.41)	(0.34-0.36)	(0.42-0.44)	(0.42-0.43)	(0.40-0.42)
quality of neonatal care									
breastfeeding within	0.26	0.38	0.29	0.46	0.52	0.45	0.41	0.48	0.37
one hour*	(0.25-0.27)	(0.37-0.39)	(0.28-0.30)	(0.44-0.47)	(0.51-0.53)	(0.44-0.47)	(0.40-0.42)	(0.47-0.49)	(0.36-0.38)
breastfeeding within	0.69	0.87	0.72	0.84	0.93	0.88	0.80	0.91	0.80
24 hours*	(0.68-0.70)	(0.86-0.87)	(0.71-0.73)	(0.83-0.85)	(0.93-0.93)	(0.87-0.89)	(0.80-0.81)	(0.91-0.91)	(0.79-0.81)

Table 1 Note: 95% confidence intervals are given in parentheses. All estimates use the NFHS' sample weights. For starred (*) variables, data are only available for the last birth occurring in the five years prior to the survey. For other variables, data are available for all births occurring in the five years before the survey.

Figure 1. Reweighting standardization of age-specific neonatal mortality in public and private facilities

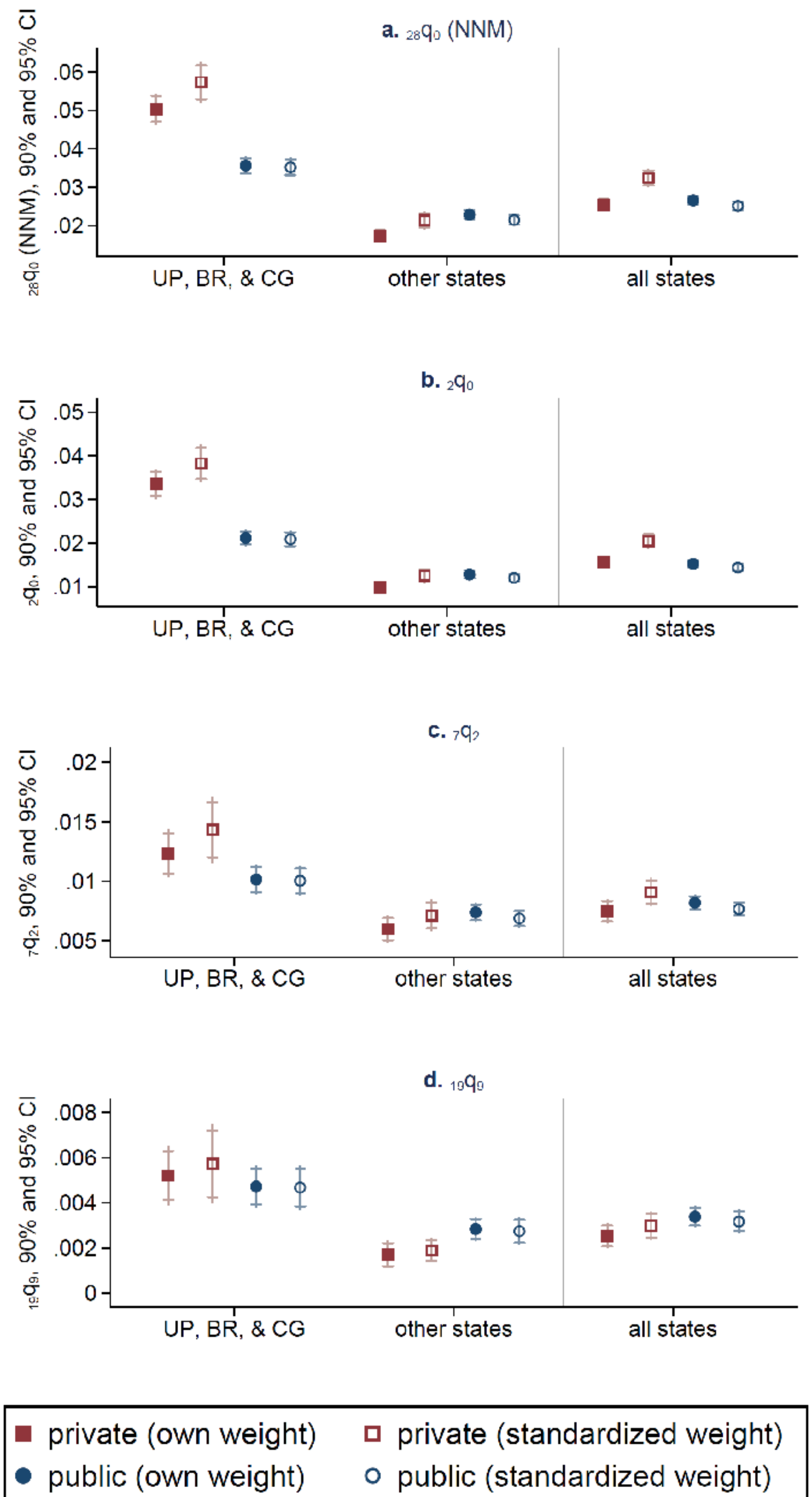

Figure 1 note: "Own weight estimates" use NFHS sample weights. Standardized weights are described in the text and Supplementary Materials.

Figure 2. Means and CIs for NMR by type of birth in public and private facilities

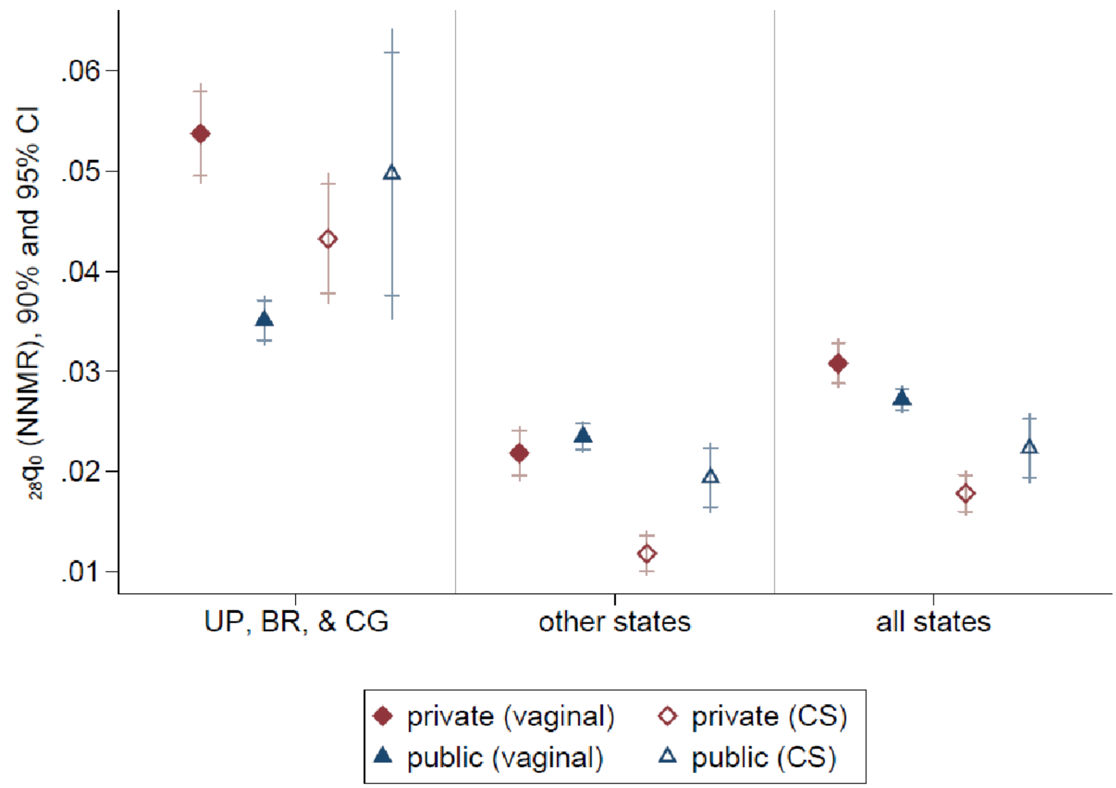

Figure 2 note: Estimates use sample weights but not standardized weights.

Table 2. Neonatal mortality rates, ${}_{28}q_0$, for subsamples of births in public and private facilities

	focus states		other states		all India	
	private	public	private	public	private	public
all facility births (full sample from Figure 1)	50	36	17	23	25	27
	(46-54)	(33-38)	(16-19)	(21-24)	(24-27)	(25-28)
demographic correlates of birth outcomes						
first-born to mother	47	45	18	27	24	31
	(42-53)	(40-49)	(15-20)	(24-29)	(22-27)	(29-33)
not first-born to mother	53	31	17	20	27	24
	(47-58)	(29-34)	(15-20)	(18-22)	(24-29)	(22-25)
mother had prior death (not first-born)	121	73	57	64	86	68
	(101-142)	(61-85)	(41-74)	(55-74)	(72-99)	(61-76)
mother did not have prior death (not first-born)	41	26	14	17	21	19
	(36-46)	(23-28)	(12-16)	(15-18)	(19-23)	(18-21)
type of birth, birth complications, and pregnancy complications						
vaginal birth	54	35	22	23	31	27
	(49-59)	(33-37)	(19-25)	(22-25)	(28-33)	(26-28)
vaginal birth, no birth complications*	24	21	11	12	15	15
	(19-29)	(18-24)	(8-14)	(10-14)	(12-15)	(13-16)
caesarean birth	43	50	12	19	18	22
	(37-50)	(35-64)	(10-14)	(16-23)	(16-20)	(19-26)
no pregnancy complications*	36	22	10	13	15	15
	(31-41)	(19-25)	(8-12)	(12-15)	(14-17)	(14-17)
no pregnancy complications, vaginal birth*	34	21	13	13	18	16
	(28-41)	(19-24)	(10-15)	(12-15)	(15-20)	(14-17)
any pregnancy complication(s)*	36	28	11	15	17	19
	(30-41)	(24-31)	(9-13)	(13-16)	(15-19)	(17-20)

Table 2 note: Estimates use sample weights but not standardized weights. For starred (*) variables, data are only available for the last birth occurring in the five years prior to the survey.