BMC Medicine

RESEARCH

Open Access

Private sector delivery of care for maternal and newborn health: trends over a decade in the Indian state of Bihar

G. Anil Kumar[1], Sibin George[1], Moutushi Majumder[1], S. Siva Prasad Dora[1], Md Akbar[1], Tanmay Mahapatra[2] and Rakhi Dandona[1,3*]

Abstract

Background We synthesised the current evidence in coverage and quality of delivery care, change in neonatal mortality (NMR), and causes of neonatal death in the private sector deliveries in the Indian state of Bihar from 2011 to 2021.

Methods Women aged 15–49 years with livebirths were interviewed in three household surveys involving state-representative samples in 2011, 2016 and 2020–2021 designed to document the coverage of maternal and newborn health services and change in NMR over time. Verbal autopsy interviews were used to assign the cause of neonatal death. The coverage of private sector facilities for livebirths in each survey and the percent change over time by 38 districts in the state and select socio-demographic characteristics, along with trends in NMR and causes of neonatal death across years are reported.

Results Private sector delivery coverage was 17.3% (95% CI = 16.6–17.9), 16.7% (95% CI = 16.2–17.2) and 26.1 (95% CI = 25.6–26.6) in 2011, 2016 and 2020–2021, respectively. A significant increase of 56.3% (95% CI = 49.3 to 63.3) in this coverage was documented between 2016 and 2020–2021 with the highest increase in the lowest wealth index quartile in urban areas. The district-wise coverage of private sector delivery ranged from 4.6% to 34.9%, 5.5% to 40.7%, and 5.9% to 62.0% in 2011, 2016 and 2020–2021, respectively. NMR was estimated at 41.3 (95% CI = 31.4–51.2), 36.6 (95% CI = 29.4–43.8), 38.6 (95% CI = 34.4–43.3) per 1000 livebirths in 2011, 2016 and 2020–2021, with no significant change over the years. Birth asphyxia was the leading cause of death in 2016 (37.8%) and 2020–2021 (33.9%) followed by preterm delivery and neonatal pneumonia; a statistically significant reduction was seen in meningitis/sepsis between 2016 and 2020–2021 (77.8%; 95% CI = −145.4 to −10.1).

Conclusions This analysis contributes to a nuanced understanding of the changes in the private sector delivery in a given population over time to facilitate appropriate actions and interventions to improve newborn survival and maternal services.

Keywords Bihar, India, Private sector, Maternal, Newborn, Services, Neonatal mortality, Quality, Cause of neonatal death

*Correspondence:
Rakhi Dandona
rakhi.dandona@phfi.org
Full list of author information is available at the end of the article

Background

Progress to reach the sustainable development goals for ending preventable maternal, newborn and child deaths requires investing in increasing coverage of interventions both in the public and private health service delivery systems to sustainably deliver quality care for mothers, newborns and children at scale [1]. Furthermore, there is increasing global evidence of poor quality of health care being a major driver of excess mortality across conditions, including neonatal mortality [2, 3]. The private sector contributes to a considerable proportion of institutional deliveries globally, and a little over one-third of maternal and newborn health (MNH) services in low- and middle-income countries (LMICs) [4, 5]. While the substantial role of private health sector delivery care in LMICs is documented, limited evidence is available on the quality of care in the private sector [3, 6, 7]. A recent secondary review of MNH quality in the private sector established a lack of consistency between private and public sector quality across the quality of care domains [8].

Better engagement with the private sector in improving and sustaining the quality of care for mothers and newborns is desired under the India Newborn Action Plan (INAP) [9]. Nearly 30% of all institutional deliveries were documented to be in a private facility in India as per the most recent round of the National Family Health Survey (NFHS-5), with this share at 43.2% in urban areas and 24.3% in rural areas [10]. A comparison of home, public sector and private sector deliveries in India from NFHS-5 has highlighted poor neonatal survival in private sector deliveries [11]. To analyse opportunities and challenges of private sector delivery of care for a meaningful engagement, a more granular understanding of the private health sector's role and extent in MNH delivery is imperative [1]. In this background, we synthesised the current evidence to address the knowledge gaps in the coverage and quality of delivery care, change in neonatal mortality rate (NMR), and causes of neonatal death among the private sector deliveries in the Indian state of Bihar from 2011 to 2021. Bihar state is among one of India's poorest and most densely populated states with systemic deficiencies for decades [12, 13], with a share of private sector deliveries at 42.4% in the NFHS-5 [10]. The NMR for Bihar state was estimated at 24.7 in 2016 [14], and the district-level NMR in Bihar ranged from 20.4 to 27.2 in 2017 [15]. With India accounting for the largest numbers of neonatal deaths globally and Bihar state being the second largest contributor to these deaths in India [16], this analysis contributes to a nuanced understanding of the changes in the private sector delivery in a given population over time to facilitate appropriate actions and interventions.

Methods

Design of surveys

A state-wide implementation of quality improvement initiative for reproductive, maternal, newborn and child health, and nutrition in the public sector was started in eight programmatically prioritised districts of Bihar in 2010 which was later expanded to cover the entire state [13]. As part of the monitoring and evaluation component of this quality initiative, three household surveys in a state-representative sample of births were undertaken over a decade designed to document the coverage of maternal and newborn health services and change in NMR over time [14, 17–19]. All the survey procedures and protocols were reviewed and approved by the Institutional Ethics Committee of the Public Health Foundation of India. All participants in each survey provided written informed consent, and the participant information sheets and consent form were explained (in a language well understood by the participants) by the trained interviewers and a thumb impression was obtained for those who could not read or write in presence of impartial witnesses.

Detailed survey design and methods have been previously reported for these surveys [14, 17–20]. Births among the eligible women were enumerated in the surveys of 2016 and 2020–2021 and only livebirths were enumerated in the survey of 2011. Details of the survey sample, data collection time period, and participation for each survey are shown in Additional file 1: Table 1. The current analysis is presented for livebirths and relevant details are summarised here. A multistage sampling design was utilised in all surveys to obtain a state-representative sample of live births in a given time period (Additional file 1: Table 1). The blocks were stratified into rural populations and those with both rural and urban populations, and a desired number of blocks were sampled. Within these sampled blocks, the secondary sampling units (SSUs) were villages in rural areas and urban frame survey blocks in urban areas as defined by the Census 2011 [21]. Each selected SSU was mapped and all the households (a household was defined as people eating from the same kitchen) were enumerated to list all livebirths during the period of interest among usual resident women aged 15–49 years. We also documented births in the period of interest for women who had died during or after giving birth to ensure a robust estimation of total births in this population in all three surveys.

Data collection

In the surveys of 2011 and 2016, all women with livebirths during the period of interest were considered eligible for a detailed interview. However, in the 2020–2021 survey, all women with neonatal deaths and 25%

of women with livebirth currently alive sampled using systematic random sampling were considered eligible for detailed interviews. Place of delivery, maternal history, details of pregnancy, labour, delivery, and postnatal care for the focal child of interest were documented in all surveys (Additional file 1: Table 2). In the survey of 2020–2021, further details were collected from the participants to sub-categorise private sector deliveries into those in private hospitals, nursing homes, or clinics. The survey questionnaire was developed in English and then translated into Hindi (the local language), after which it was back-translated into English to ensure the accurate and relevant meaning and intent of the questions in all three surveys. Pilot testing of the questionnaire was carried out and modifications were made as necessary. Verbal autopsy (VA) interviews were conducted for all neonatal deaths using the Population Health Metrics Research Consortium (PHMRC) shortened VA questionnaire, which includes close-ended questions and an open narrative to ascertain the cause of death in the surveys of 2016 and 2020–2021. The interviews were captured by trained interviewers using the Computer Assisted Personal Interview software on hand-held tablets in all the surveys. Data entered were scrutinised using the internal consistency checks built in to detect and correct errors using the procedures standardised in the baseline study to meet the data quality in all the surveys.

Data analysis

We estimated the coverage of private sector facilities for livebirth in the three surveys, and estimated the percent change in this coverage between 2011 to 2016 and 2016 to 2020–2021 by select socio-demographic characteristics and by 38 districts in the state. We report on the coverage of the delivery and post-delivery service provision in the private sector in the three surveys and estimate the percent change in these service coverages between 2011 to 2016 and 2016 to 2020–2021 by select socio-demographic characteristics.

The proportions of neonatal deaths among livebirths delivered in the private sector in each survey are reported, and NMR per 1000 livebirths is estimated (death of a livebirth within the first 28 days of birth). As the place of delivery was not documented for all enumerated livebirths in the 2011 and 2016 surveys (Additional file 1: Table 2), we applied the distribution of livebirths and neonatal deaths by place of delivery from the detailed interview in the survey to the enumeration sample to estimate the denominator and numerator for NMR estimation. We report on the overall private sector NMR and for three sub-categories based on age at death (0–2 days, 3–7 days, and 8–27 days), and present change in overall NMR over time. Private sector NMR was also estimated by sex of the baby and place of residence for the three surveys.

The cause of neonatal death was assigned using the validated SmartVA automated algorithm as per the PHMRC protocol [22–24]. The causes of neonatal death are presented for 0–27 days, and in the three age-at-death subcategories, by place of residence and by wealth index quartile from the surveys of 2016 and 2020–2021. The percent change in causes of death between the two surveys is also reported. Furthermore, causes of neonatal death are presented by the type of private sector from the survey of 2020–2021.

Women were categorised into household wealth index quartile using the standard methods used in the Indian National Family Health Survey, where the quartile 1 is the poorest, and quartile 4 is the richest wealth quartile [10, 25]. Sampling weights were used in the survey of 2020–2021 as only 25% of neonates currently alive were sampled for interview. Sampling weights were calculated based on the sampling probabilities separately for each sampling stage and the selection probabilities for a cluster from the sample and the birth outcomes to arrive at final sampling weights [18]. We report 95% confidence intervals (CI) for all estimates as relevant, and z test, chi-square test and design-based F test of significance. STATA V.13.1 version was used for all analyses.

Role of the funding source

The funder had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

Results

A total of 14,847, 23,602 and 8271 livebirths were sampled in surveys of 2011, 2016 and 2020–2021, respectively and the detailed interview was available for 13,069 (88.0% participation), 19,877 (84.2% participation) and 6,771 (81.9% participation) livebirths in each of the corresponding surveys.

Coverage of private sector delivery

Distribution of private sector utilisation for livebirth deliveries by select variables is shown in Additional file 1: Table 3 for the three surveys. The coverage of private sector delivery for livebirths was 17.3% (95% CI 16.6–17.9), 16.7% (95% CI 16.2–17.2) and 26.1 (95% CI 25.6–26.6) in the surveys of 2011, 2016 and 2020–2021, respectively (Table 1). A statistically significant increase of 56.3% (95% CI 49.3 to 63.3) in this coverage was documented between 2016 and 2020–2021, and also by all select variables (Table 1). Considering the coverage of private sector delivery by wealth index and place of delivery (Additional

Table 1 Coverage of private sector facility for livebirth delivery and percent change over time by select characteristics in the Indian state of Bihar in 2011, 2016 and 2020–2021. CI denotes confidence interval

Variable		Coverage of private facility utilisation for livebirth delivery (95% CI)			Percent change (95% CI)	Percent change (95% CI)
		Survey 2011	Survey 2016	Survey 2020–2021	2011 to 2016	2016 to 2020–2021
Overall		17.3 (16.6–17.9)	16.7 (16.2–17.2)	26.1 (25.6–26.6)	−3.5 (−8.3 to 1.3)	56.3 (49.3 to 63.3)
Sex of the baby[a]	Boy	19.1 (18.2–20.1)	17.2 (16.5–18.0)	29.0 (28.3–29.7)	−9.9 (−16.1 to −3.8)	68.6 (58.9 to 78.3)
	Girl	15.2 (14.3–16.1)	16.2 (15.5–16.9)	23.0 (22.3–23.6)	5.9 (−1.7 to 13.5)	42.9 (32.8 to 52.9)
Place of residence	Urban	32.3 (30.5–34.3)	31.5 (29.4–33.7)	52.2 (50.9–53.4)	−2.5 (−11.4 to 6.5)	65.7 (54.4 to 77.0)
	Rural	14.0 (13.4–14.7)	15.3 (14.7–15.8)	17.9 (17.5–18.3)	9.3 (3.3 to 15.3)	17.0 (9.6 to 24.4)
Wealth index quartile[b]	Q1	6.8 (5.9–7.7)	7.1 (6.4–7.9)	11.9 (11.3–12.6)	4.4 (−12.1 to 21.0)	67.6 (44.0 to 91.2)
	Q2	10.3 (9.3–11.4)	10.7 (9.8–11.6)	16.6 (15.9–17.4)	3.9 (−9.3 to 17.1)	55.1 (36.9 to 73.4)
	Q3	14.2 (13.0–15.4)	15.9 (14.9–16.9)	24.8 (24.0–25.7)	12.0 (0.9 to 23.0)	56.0 (41.5 to 70.4)
	Q4	37.3 (35.6–38.9)	32.9 (31.6–34.2)	50.9 (49.8–52.1)	−11.8 (−17.4 to −6.2)	54.7 (46.2 to 63.2)
First child[c]	No	13.7 (13.0–14.4)	13.5 (13.0–14.1)	22.4 (21.9–22.9)	−1.5 (−8.0 to 5.1)	65.9 (56.5 to 75.3)
	Yes	24.8 (23.5–26.2)	26.8 (25.5–28.1)	36.9 (35.9–38.0)	8.1 (0.7 to 15.4)	37.7 (27.9 to 47.4)
Age of the mother[d]	15–19 years	24.9 (21.0–29.3)	18.8 (16.4–21.4)	25.9 (23.9–28.1)	−24.5 (−44.0 to −5.0)	37.8 (12.3 to 63.2)
	20–24 years	20.1 (19.0–21.2)	19.5 (18.6–20.3)	26.4 (25.7–27.0)	−3.0 (−10.0 to 4.0)	35.4 (26.2 to 44.6)
	25–34 years	15.7 (14.9–16.6)	14.6 (13.9–15.3)	25.8 (25.1–26.6)	−7.0 (−14.1 to 0.1)	76.7 (64.9 to 88.5)
	35–49 years	10.2 (8.4–12.3)	11.4 (9.4–13.7)	26.0 (23.8–28.3)	11.8 (−16.6 to 40.2)	128.1 (85.4 to 170.7)

[a] Data missing for 3 cases in 2011

[b] Data missing for 48 and 5 cases in 2016 and 2020–2021, respectively

[c] Data missing for 1 case in 2020–2021

[d] Data missing for 3 cases in 2016

file 1: Table 4), the coverage in rural areas saw a statistically significant increase between 2016 and 2020–2021 in all wealth quartiles except in quartile 4 and in urban areas was seen in all wealth quartiles except in quartile 2. The highest increase in this coverage was documented in wealth index quartile 1 in urban areas (378.6; 95% CI 256.9 to 500.4).

Among the 1630 private sector deliveries in the survey of 2020–2021, 1206 (74.8%) were in a private hospital, 220 (13.9%) in a private nursing home, and 204 (11.3%) in a private clinic (Additional file 1: Table 5). The utilisation of private clinics was relatively low in wealth quartiles 3 and 4 as compared with quartiles 1 and 2 ($p=0.061$) but not statistically significant, whereas utilisation of nursing homes was significantly high in the wealth quartiles 3 and 4 as compared with quartiles 1 and 2 ($p=0.007$).

The district-wise coverage of private sector delivery ranged from 4.6% to 34.9%, 5.5% to 40.7%, and 5.9% to 62.0% in the surveys of 2011, 2016 and 2020–2021, respectively (Fig. 1 and Additional file Table 6). The coverage of private sector delivery in 10 (26.3%) districts increased by twofolds between 2011 and 2020–2021 with the highest increase documented in district Kishanganj (5.39), and on the other hand, a four-fold drop was documented in district Bhagalpur (4.27) over this period (Additional file 1: Table 6). Two districts, Patna and Rohtas, had 62.0% and 60.9% deliveries in the private sector in 2020–2021. The district-wise coverage of delivery by type of private sector provider for 2020–2021 ranged from 3.3% to 50.3%, 0 to 7.5%, and 0 to 13.1% for the private hospital, private clinic, and private nursing home, respectively (Additional file 1: Table 7).

In the survey of 2020–2021, among the 1630 women who had delivered in a private sector facility, 55.3% of them had planned to deliver in the private sector, 35.2% had planned to deliver in the public sector, and 4.7% each had planned to deliver at home or not planned for place of delivery. Among the 617 women who had planned to deliver in the public sector but delivered at the private sector, 34% of them were referred from the public sector to the private sector and the rest had made decisions on their own.

Delivery and post-delivery service provision

Distribution of delivery and post-delivery service provision indicators in private sector deliveries are shown in Table 2. A statistically significant increase in referred delivery (34.1%; 95% CI 16.9 to 51.4), C-Section. (19.0%; 95% CI 12.1 to 25.9), skin-to-skin care (20.4%; 95% CI 7.8 to 33.0), and measurement of birthweight (6.3%; 95%

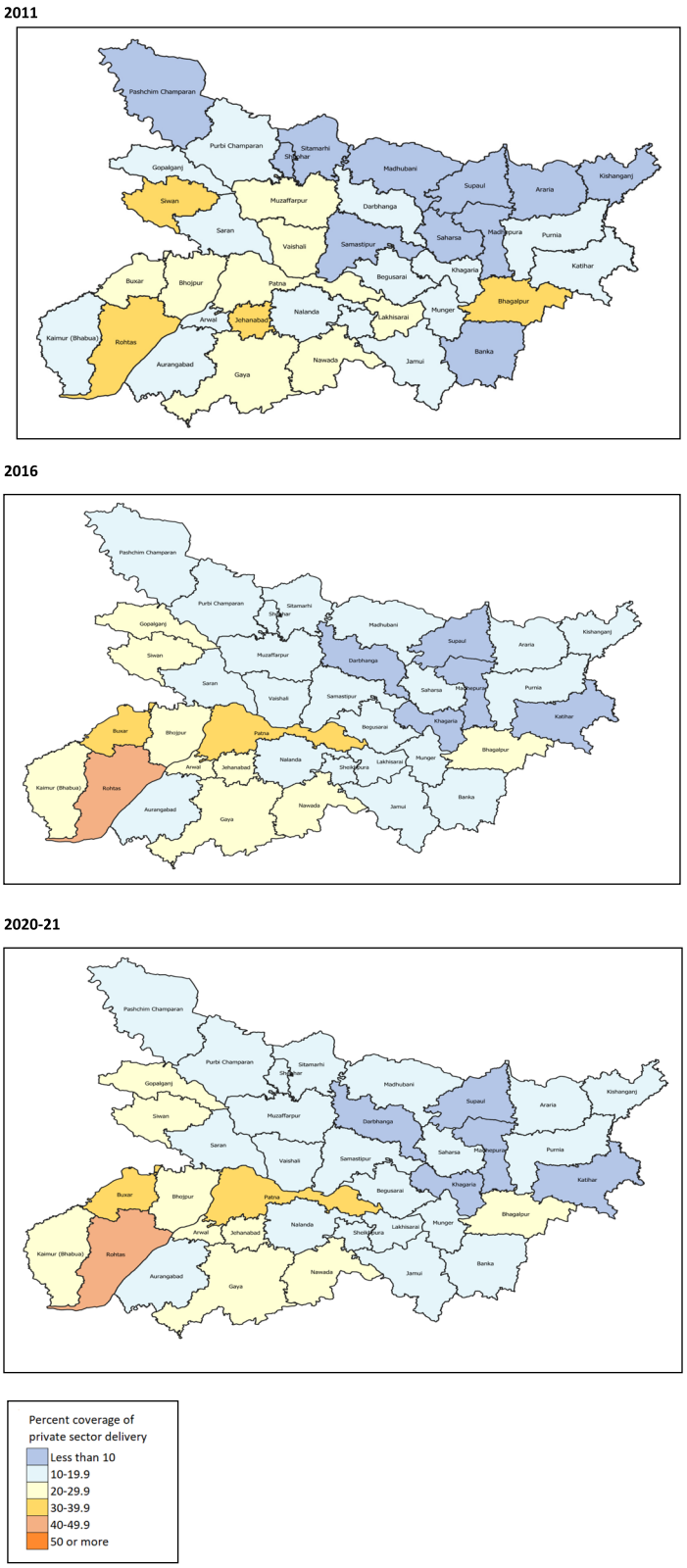

Fig. 1 Coverage of private sector delivery by district in the Indian state of Bihar in the survey of 2011, 2016 and 2020–2021* (weighted coverage)

Table 2 Delivery and post-delivery service provision by the private sector providers in the Indian state of Bihar in 2011, 2016 and 2020–2021

	Percent of livebirths *N* = 2259 (% to *N*) 2011	Percent of livebirths *N* = 3314 (% to *N*) 2016	Percent of livebirths *N* = 1630 (% to *N*) 2020–2021[a]	Percent change (95% CI) 2011 to 2016	Percent change (95% CI) 2016 to 2020–2021
Delivery indicators					
Referred delivery	NA	407 (12.3)	322 (16.5)	NA	34.1 (16.9 to 51.4)
Oxytocin use in labour	NA	2695 (81.3)	1134 (74.4)	NA	−8.5 (−11.6 to −5.4)
Delivery by C-section[b]	441 (19.5)	1413 (42.7)	786 (50.8)	119.0 (106.9 to 131.0)	19.0 (12.1 to 25.9)
Push/pull during delivery by the health provider[c]	NA	291 (8.8)	99 (6.0)		−35.7 (−52.3 to −19.2)
Post-delivery indicators					
Birthweight measured[d]	1622 (71.8)	2989 (91.5)	1555 (97.2)	27.4 (24.5 to 30.3)	6.3 (4.9 to 7.6)
Antiseptic cord care[b]	1227 (54.9)	926 (27.9)	468 (27.2)	−49.2 (−53.8 to −44.5)	−2.5 (−12.0 to 6.9)
Skin-to-skin care[e]	496 (22.0)	626 (19.6)	423 (23.6)	−10.9 (−20.8 to −1.0)	20.4 (7.8 to 33.0)
Delayed bathing of the baby (> 2 days)[b,f,g]	956 (42.7)	2011 (61.7)	1231 (81.6)	44.5 (38.3 to 50.7)	32.3 (28.1 to 36.4)
Breast-fed within 1-h post-delivery[b,f,h]	1005 (44.9)	1391 (42.7)	333 (20.0)	−4.9 (−10.9 to 1.1)	−53.2 (−59.3 to −47.0)
Neonate referred elsewhere at birth[b]			293 (15.6)		

[a] Data missing for 1 case for all indicators in 2020–2021

[b] Data missing for 1 case in 2020–2021

[c] Data missing for 1 case in 2016

[d] Data missing for 46 cases in 2016

[e] Data missing for 9 and 39 cases in 2011 and 2016, respectively

[f] Not applicable for 20, 56 and 62 neonates who died immediately post-delivery in 2011, 2016 and 2021 respectively

[g] Data missing for 10, and 7 cases in 2011 and 2016, respectively

[h] Data missing for 19 cases in 2016

CI 4.9 to 7.6) was documented between surveys of 2016 and 2020–2021. A statistically significant decrease was documented in the coverage of breast-feeding within one-hour post-delivery (−53.1%; 95% CI −59.1 to −47.0), use of push/pull during delivery by the health provider (−35.7; 95% CI −52.3 to −19.2), and in the use of oxytocin in labour (−8.5; 95% CI −11.6 to −5.4).

The distribution of delivery and post delivery service provision indicators by sub-categories of private sector providers in the survey of 2020–2021 is shown in Additional file 1: Table 8. The coverage of C-section was statistically significantly lower in the clinic (25.3%) as compared with hospital (56.1%) and nursing home (43.2%) deliveries ($p < 0.001$). Push/pull during delivery by the health provider was reported significantly higher in the nursing home (8.1%) than in private hospital (5.7%) and clinic (5.3%) deliveries ($p = 0.002$). Breastfeeding within 1-h post-delivery was significantly higher in the clinic as compared with private hospital and nursing home deliveries ($p < 0.001$).

NMR

Among the livebirths in private facilities, 2.6%, 3.7% and 3.9% were neonatal deaths in surveys of 2011, 2016 and 2020–2021, respectively. The estimated NMR in private sector deliveries was 41.3 (95% CI 31.4–51.2), 36.6 (95% CI 29.4–43.8), 38.6 (95% CI 34.4–43.3) per 1,000 livebirths in 2011, 2016 and 2020–2021, which was similar over the years (Table 3). A statistically significant decline was seen in 8–27-day mortality (−40.9, 95% CI −81.3 to −0.6) between 2016 and 2020–2021. NMR for boys and girls was similar in the three surveys, and there was no significant change in the private sector NMR for rural and urban areas (Table 3).

Causes of neonatal death

Birth asphyxia was the leading cause of 0–27 days death in surveys of 2016 (37.8%) and 2020–2021 (33.9%) followed by preterm delivery and neonatal pneumonia (Table 4). A statistically significant reduction in 0–27 days neonatal deaths due to meningitis/sepsis was documented between 2016 and 2020–2021 (77.8%;95% CI −145.4 to −10.1). The distribution of causes of death varied for the three neonatal age sub-categories in 2016 and 2020–2021. Birth asphyxia (55.2% and 43.4%) was the leading cause of death in 0–2 days followed by preterm delivery (28.3% and 30.4%); neonatal pneumonia (38.7% and 47.0%) was the leading cause of death in 3–7

Table 3 Neonatal mortality rate (NMR) for private sector livebirths in the Indian state of Bihar in 2011, 2016 and 2020–2021. CI denotes confidence interval

	NMR per 1000 livebirths (95% CI)			Percent change in NMR from 2011 to 2016 (95% CI)	Percent change in NMR from 2016 to 2020–2021 (95% CI)
	2011	2016	2020–2021		
Age at death					
0–27 days	41.3 (31.4–51.2)	36.6 (29.4–43.8)	38.6 (34.4–43.3)	−11.3 (−35.6 to 12.9)	5.3 (−14.5 to 25.1)
0–2 days	29.8 (21.3–38.3)	22.7 (17.0–28.4)	25.7 (22.3–29.6)	−23.7 (−51.7 to 4.3)	13.1 (−12.6 to 38.8)
3–7 days	5.5 (1.8–9.2)	6.2 (3.2–9.2)	8.3 (6.4–10.7)	12.3 (−58.2 to 82.8)	33.8 (−17.4 to 85.0)
8–27 days	6.6 (2.6–10.7)	7.7 (4.4–11.1)	4.6 (3.2–6.4)	16.8 (−48.1 to 81.7)	−40.9 (−81.3 to −0.6)
Sex of the baby					
Boy	43.7 (30.3–57.1)	40.2 (29.9–50.5)	42.2 (36.3–49.0)	−8.1 (−39.7 to 23.5)	5.1 (−20.5 to 30.6)
Girl	37.5 (22.8–52.1)	32.6 (22.7–42.5)	34.3 (28.6–41.1)	−13.0 (−51.6 to 25.6)	5.2 (−26.1 to 36.6)
Place of residence					
Rural	49.3 (36.0–62.6)	42.2 (33.8–50.6)	45.2 (39.8–51.5)	−14.4 (−40.4 to 11.7)	7.2 (−14.1 to 28.6)
Urban	23.4 (10.5–36.2)	19.2 (8.7–29.7)	24.9 (19.3–32.0)	−17.8 (−75.8 to 40.2)	29.6 (−25.7 to 84.8)

Table 4 Causes of neonatal death in private sector delivery in the Indian state of Bihar in 2016 and 2020–2021

Age at death	Cause of death	Percent of all neonatal deaths		% change between 2016 and 2020–2021 (95% CI)
		2016	2020–2021	
0–27 days	Birth asphyxia	37.8	33.9	−10.3 (−38.1 to 17.5)
	Preterm delivery	31.1	32.4	4.2 (−28.4 to 36.8)
	Neonatal pneumonia	15.3	23.6	54.2 (−0.3 to 108.8)
	Congenital malformation	8.2	6.5	−20.7 (−91.4 to 49.9)
	Neonatal meningitis/sepsis	7.2	1.6	−77.8 (−145.4 to −10.1)
0–2 days	Birth asphyxia	55.2	43.4	−21.4 (−45.9 to 3.2)
	Preterm delivery	28.3	30.4	7.4 (−36.3 to 51.2)
	Neonatal pneumonia	6.9	17.7	156.5 (37.5 to 275.5)
	Congenital malformation	5.8	5.1	−12.1 (−120.1 to 95.9)
	Neonatal meningitis/sepsis	3.7	1.6	−56.8 (−182.9 to 69.4)
3–7 days	Birth asphyxia	11.1	13.8	24.3 (−122.5 to 171.1)
	Preterm delivery	30.4	30.2	−0.7 (−76.7 to 75.4)
	Neonatal pneumonia	38.7	47.0	21.4 (−42.3 to 85.2)
	Congenital malformation	11.7	6.8	−41.9 (−171.5 to 87.8)
	Neonatal meningitis/sepsis	7.9	1.6	−79.7 (−229.2 to 69.7)
8–27 days	Birth asphyxia	1.5	13.5	800.0 (−67.7 to 1,667.7)
	Preterm delivery	40.8	42.9	5.1 (−60.0 to 70.3)
	Neonatal pneumonia	22.1	25.0	13.1 (−90.1 to 116.3)
	Congenital malformation	13.4	12.8	−4.5 (−140.5 to 131.5)
	Neonatal meningitis/sepsis	22.2	1.9	−91.4 (−171.0 to −11.9)

days followed by preterm delivery (30.4% and 30.2%); and preterm delivery (40.8% and 42.9%) was the leading cause of death in 8–27 days followed by neonatal pneumonia (22.1% and 25.0%) in both 2016 and 2020–2021, respectively. A statistically significant reduction of 91.4% (95% CI −171.0 to −11.9) in neonatal meningitis/sepsis was documented in 8–27 days between 2011 and 2016.

Variations were seen in the causes of neonatal death by the private sector sub-categories in the survey of 2020–2021 (Additional file 2: Fig. S1). Birth asphyxia as the cause of neonatal death was significantly higher in the clinics as compared with hospitals and nursing homes ($p=0.0001$) whereas pneumonia was

significantly lower in the clinics as compared with nursing homes ($p=0.010$).

The distribution of cause of death by the place of delivery and wealth index quartiles is shown in Fig. 2. A statistically significant drop was seen in neonatal meningitis/sepsis as cause of death in both rural ($p=0.028$) and urban areas ($p=0.008$), and a statistically significant increase in neonatal pneumonia in rural areas ($p=0.043$ and pre-term delivery in urban areas ($p=0.030$) between 2016 and 2020–201. No significant change was seen in cause of death by wealth index except a statistically significant drop in neonatal meningitis/sepsis for wealth index quartile 1 ($p=0.005$) between the two surveys. Some variations were seen in cause of death between the wealth index quartiles in 2020–2021 but these were not statistically significant.

Discussion

To the best of our knowledge, these are among the first evidence syntheses for private sector deliveries in an Indian state covering trends in coverage, service provision, NMR, and cause of death over a decade. The quantification of private sector coverage and trends at the district level provides important insights into MNH services within the state towards facilitating engagement with the private sector.

The coverage of private sector delivery increased from nearly 1 in 6 deliveries to 1 in 4 deliveries between 2016 and 2020–2021, with no significant change between 2011 and 2016. As previously reported [19], we believe that the increased coverage of the private sector in 2020–2021 is likely due to the reluctance of the community in use of public sector facilities for delivery as many of these facilities were treating COVID-19 patients during the pandemic [26]. This shift towards the private sector possibly countered the access-related issues for MNH services in this population [27], a phenomenon also documented elsewhere [28]. We have also reported previously for the private sector to be a major service provider for antenatal care services in this population from the survey of 2020–2021 [18]. The trends at the district level indicated a two-fold increase in the coverage of private sector delivery in a quarter of all districts in Bihar, with 3 in 5 deliveries in the private sector in two districts in 2020–2021. Importantly, the private sector health facilities in Bihar are not a homogenous group and range from tertiary care hospitals to clinics with varied levels of infrastructure, capacity and skills [27]. We documented a wide coverage by the sub-type of private sector facilities at the district level in the survey of 2020–2021, noting that the sub-type is based on as reported by the survey respondents and not by undertaken private sector facility assessment. It is important to note that there is little literature available on infrastructure, capacity, and skills in the private sector for MNH services in India [29–32]. Hence, our latest survey offers a reasonable understanding of what constitutes the private sector for MNH care in the state and the extent of utilisation of these subtypes at the district-level.

The largest shift towards private sector delivery in the recent survey was documented in women belonging to wealth index quartile 1 in the urban areas of the state. This is of concern with reports of increased out-of-pocket expenditure and distress financing for those belonging to lower socio-economic strata for C-section deliveries and for institutional delivery in the private sector [33–35].

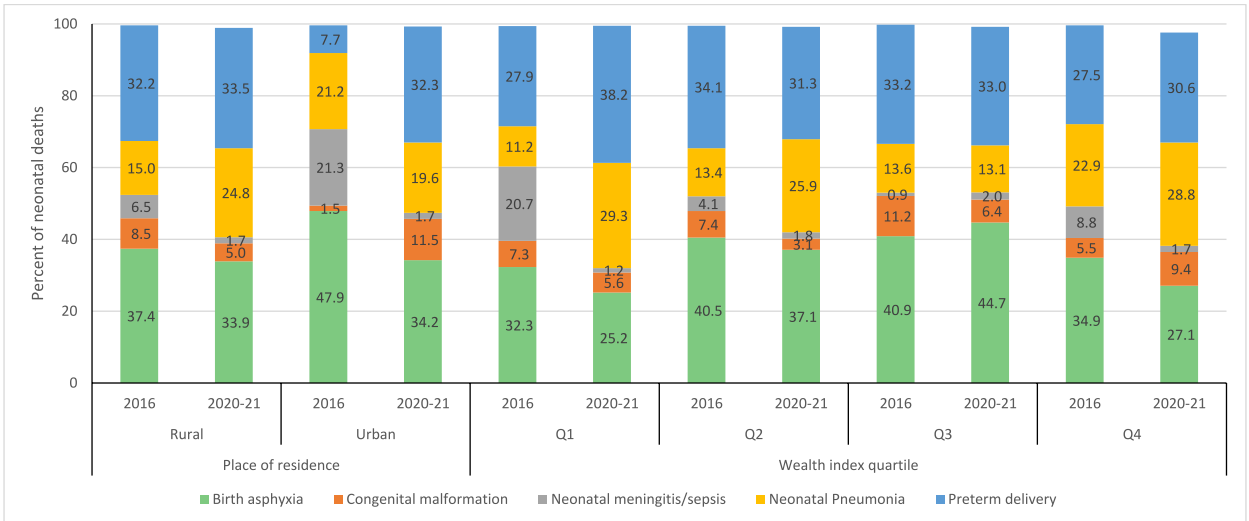

Fig. 2 Comparative distribution of causes of neonatal death for private sector deliveries in the surveys of 2016 and 2020–2021

On the other hand, a recent systematic review of experiences of private care amongst mothers and newborns concluded that experience of care including patient-centeredness, timeliness, effectiveness, and equity, seemed to be a stronger determining factor in MNH services decision-making than the quality of services provided in the private sector [36]. Therefore, an understanding of the geographic coverage patterns of private sector use and the extent of change over the decade as documented in this study can be utilised to further assess the variations in the levels of community demand for private sector services and the reasons for it for a more meaningful engagement with the private sector in the state [37].

The estimated NMR in private sector deliveries in Bihar was 28%, 48%, and 38% higher than the overall state NMR in the years 2011, 2016, and 2020–2021, with no significant change over the decade [14, 20]. This finding is of significant concern as the INAP has set an ambitious target of less than 10 for NMR by 2030 [9]. The higher NMR in the private sector needs to be viewed within the context of referral for delivery in this population and a significant increase in referred deliveries was documented between 2016 and 2020–2021. Most referred deliveries were reported to be complicated deliveries; one-third of the referrals were from the public sector to the private sector facilities and a notable proportion of women who had planned to deliver in the public sector delivered in the private sector without a referral. Therefore, more in-depth understanding is needed about the decision-making to deliver in private and the continued referral from the public sector to the private sector in the state. This also needs to be viewed in the context of a significant increase in C-sections over time in the private sector in the state. A higher proportion of C-section deliveries in the private sector as compared with the public sector is well-established in India [38], which cannot be explained by medical reasons alone. The oversupply of avoidable C-sections in the private sector was recently estimated at 21% in India as a result of physician-induced demand and perverse financial incentives [39]. Furthermore, we also documented significant improvements in delivery and post-delivery indicators in the private sector deliveries over time. Hence, these findings suggest a cautious interpretation of a higher NMR in the private sector. It is well known that the private sector in India provides most of the emergency obstetric care and also serves as a referral facility for the public sector for complicated deliveries [40, 41].

Assessing the quality of delivery care per se was beyond the scope of our surveys, but given the global evidence of poor quality of health care being a major driver of neonatal mortality [2], in-depth studies are needed to assess the quality of these deliveries and for providing the private sector facilities opportunities to engage with the government of India's labour room and quality improvement initiative (*LaQshya)* which was launched in 2017 to improve quality of labour and delivery care in the public sector facilities [42]. Additionally, INAP also has the quality of care as one of the six guiding principles, and care during labour and childbirth is one of the strategic intervention packages [9], and exploring private sector engagement for quality needs further exploration. We have previously reported from this population that the causes of neonatal death and its determinants at 0–2 days are different from those for deaths between death at 3–7 days, and that the distribution in the latter is similar to those in 8–27 days neonatal deaths [14]. Given this emerging evidence, it may be useful to monitor neonatal mortality at 0–2 and 3–7 days separately within the private sector deliveries to enable more effective programming to reduce neonatal mortality further. Addressing high NMR would need specific actions on the major causes of neonatal deaths in the private sector facilities. Birth asphyxia, neonatal pneumonia and pre-term delivery accounted for the majority of neonatal deaths in the private sector deliveries in the state. This pattern of cause of death is similar to that reported for all neonatal deaths irrespective of the place of delivery from Bihar [14], and also for India in general [15]. Engagement with the private sector and understanding the adverse outcomes by the type of private sector is urgently needed to address adverse pregnancy outcomes [43, 44]. The interventions undertaken in the state to improve the quality of services to address specific risk factors and causes of death could possibly be extended to include the private sector providers of maternal and newborn care as well to ensure impact on a larger scale which is needed to effectively address reduction in NMR in the state [45–48].

Achieving universal health coverage requires engaging with the private sector as an increasing proportion of mothers and newborns access care in the private sector, particularly as the private sector has evolved to be a prominent provider of MNH services across the districts and different wealth quintiles in the state. As part of the World Health Organization's (WHO) private sector engagement strategy [1], the Strategic and Technical Advisory Group of Experts on Maternal, Newborn, Child and Adolescent Health and Nutrition has recommended that the WHO identify key provisions and effective strategies for private sector engagement that are specifically necessary for, or will help to achieve, equity with improved outcomes for all women, children and adolescents as part of quality universal health coverage [49]. Strengthening of the governments' stewardship of mixed health systems is the key to engaging the private sector [1, 50]. The Tuberculosis Private Provider Mix

success story in India saw a vertical health programme leveraging the private sector to affect health system change [51]. Opportunities to learn from the other health programmes, identifying facilitators and addressing barriers to private sector participation in government-led schemes for maternity services are much needed to sustain and expand the gains achieved in newborn survival is a major national agenda, in which Bihar has a significant role to play [52–54].

The major strength of this analysis is the availability of NMR and causes of neonatal death in private sector deliveries in a state-representative sample of livebirths over a decade. Strengthening of the numerator and denominator for neonatal mortality estimation by documenting all in/out-migration among the reproductive age women with pregnancy outcomes in the period of interest is a major strength. Presenting the findings by the three age sub-groups for neonatal deaths supports the need for a continuum of care as the core principle to address the further decline in neonatal mortality. Furthermore, the availability of private sector sub-types in the recent survey improves understanding of what the private sector comprises of in the state and the coverage trends over time at the district level are value-add. There are some limitations to the study findings. As is the case with surveys, the findings should be interpreted within the context of recall bias of the respondent. We believe the recall bias to be relatively lower in our surveys as the most recent livebirth was documented and analysed. The quality measures used in the survey for delivery and post-delivery services are not comprehensive and were captured as dichotomous indicators, wherein the survey respondents answered yes or no, which does not capture the appropriateness nor timeliness of services. However, it is not possible to measure such nuances in a population-level survey. Considering these limitations, there may be over-estimation of some service components. The change in sampling strategy in the most recent survey was needed due to restrictions imposed on data collection due to the COVID-19 pandemic; however, all neonatal deaths were sampled and sampling weights were used for data to be comparable with the other two surveys.

Conclusions

This evidence synthesis addresses knowledge gaps in the coverage of delivery care, changes in NMR and causes of neonatal death in private sector deliveries that are pertinent for effective engagement desired with the private sector under INAP to improve and sustain the quality of MNH services. With the NMR target of less than 10 by 2030 committed under INAP, these findings could facilitate specific actionable engagement with the private sector to reduce high NMR in the state. We believe that the study findings are potentially generalisable to other less developed states of India.

Abbreviations

CI	Confidence interval
INAP	Indian Newborn Action Plan
MNH	Maternal and Newborn Health
NMR	Neonatal mortality rate
PHMRC	Population Health Metrics Research Consortium
VA	Verbal autopsy
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12916-025-03894-6.

Additional file 1: Table 1. Details on survey design and sample for the surveys in 2011, 2016 and 2002-21. Table 2. Comparative variables available for analysis from the surveys 2011, 2016 and 2020-21. Table 3. Distribution of private facility utilisation for delivery in the Indian state of Bihar in 2011, 2016 and 2020-21 by select variables. Table 4. Distribution of private facility utilisation for delivery in the Indian state of Bihar in 2011, 2016 and 2020-21 by wealth index and place of residence. CI denotes confidence interval. Table 5. Distribution of type of private facility utilization for livebirth delivery in survey of 2020-21 by select variables in the Indian state of Bihar. Table 6. Distribution of coverage of private sector delivery by districts in the Indian state of Bihar in the survey of 2011, 2016 and 2020-21. Table 7. District-wise coverage of delivery by type of private sector provider in the Indian state of Bihar in the survey of 2020-21. Table 8. Delivery and post-delivery service provision by type of private sector provider in the Indian state of Bihar in the survey of 2020-21

Additional file 2: Fig S1. Distribution of causes of neonatal death by type of private sector in the Indian state of Bihar in the survey of 2020-21

Acknowledgements

The team acknowledges the time and effort contributions of the participants and field investigators towards the successful gathering of the quality data used for this study.

Authors' contributions

RD and GAK conceptualised this study; RD drafted the paper with contributions from GAK; SG, MM, SSPD, and MA contributed to study design, data collection supervision, data analysis, and interpretation; RD, GAK and SG directly accessed and verified the underlying data reported in the manuscript; GAK ran the data analysis; TM contributed to interpretation; RD is the guarantor for the overall content of the paper; All authors read and approved the final manuscript..

Funding

This work was supported by the Bill & Melinda Gates Foundation (grant number INV-007989).

Data availability

All data relevant to the study are included in the article or uploaded as supplementary information.

Declarations

Ethics approval and consent to participate

The surveys were approved by the Institutional Ethics Committee of the Public Health Foundation of India (study numbers TRC-IEC 104/11, TRC-IEC 327/17 and TRC-IEC 462/21). Participants gave informed consent to participate in the study.

Consent for publication

Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Public Health Foundation of India, New Delhi, India. [2]Piramal Swasthya Management and Research Institute, Hyderabad, India. [3]Institute for Health Metrics and Evaluation, University of Washington, Seattle, USA.

Received: 15 June 2024 Accepted: 23 January 2025
Published online: 29 January 2025

References

1. World Health Organization. Engaging the private health service delivery sector through governance in mixed health systems: strategy report of the WHO Advisory Group on the Governance of the Private Sector for Universal Health Coverage. Geneva: WHO; 2020.
2. Kruk ME, Gage AD, Joseph NT, Danaei G, Garcia-Saiso S, Salomon JA. Mortality due to low-quality health systems in the universal health coverage era: a systematic analysis of amenable deaths in 137 countries. Lancet. 2018;392:2203–12.
3. Chou VB, Walker N, Kanyangarara M. Estimating the global impact of poor quality of care on maternal and neonatal outcomes in 81 low- and middle-income countries: A modeling study. PLoS Med. 2019;16(12): e1002990.
4. Benova L, Macleod D, Footman K, Cavallaro F, Lynch CA, Campbell OM. Role of the private sector in childbirth care: cross-sectional survey evidence from 57 low- and middle-income countries using Demographic and Health Surveys. Tropical Med Int Health. 2015;20(12):1657–73.
5. Campbell OM, Benova L, MacLeod D, Baggaley RF, Rodrigues LC, Hanson K, Powell-Jackson T, Penn-Kekana L, Polonsky R, Footman K, et al. Family planning, antenatal and delivery care: cross-sectional survey evidence on levels of coverage and inequalities by public and private sector in 57 low- and middle-income countries. Tropical Med Int Health. 2016;21(4):486–503.
6. Lattof SR, Maliqi B, Yaqub N, Jung AS. Private sector delivery of maternal and newborn health care in low-income and middle-income countries: a scoping review protocol. BMJ Open. 2021;11(12): e055600.
7. Lattof SR, Maliqi B. Private sector delivery of quality care for maternal, newborn and child health in low-income and middle-income countries: a mixed-methods systematic review protocol. BMJ Open. 2020;10(2): e033141.
8. Morris G, Maliqi B, Lattof SR, Strong J, Yaqub N. Private sector quality of care for maternal, new-born, and child health in low-and-middle-income countries: a secondary review. Frontiers in global women's health. 2024;5:1369792.
9. Ministry of Health and Family Welfare, Government of India: INAP: India Newborn Action Plan. New Delhi: GoI; 2014.
10. International Institute for Population Sciences (IIPS) and ICF: National Family Health Survey (NFHS-5), 2019–21: India. Mumbai: IIPS; 2021.
11. Verma A, Cleland J. Is newborn survival influenced by place of delivery? A comparison of home, public sector and private sector deliveries in India. J Biosoc Sci. 2022;54(2):184–98.
12. Darmstadt GL, Pepper KT, Ward VC, Srikantiah S, Mahapatra T, Tarigopula UK, Bhattacharya D, Irani L, Schooley J, Chaudhuri I, et al. Improving primary health care delivery in Bihar, India: Learning from piloting and statewide scale-up of Ananya. J Glob Health. 2020;10(2): 021001.
13. Creanga AA, Srikantiah S, Mahapatra T, Das A, Sonthalia S, Moharana PR, Gore A, Daulatrao S, Durbha R, Kaul S, et al. Statewide implementation of a quality improvement initiative for reproductive, maternal, newborn and child health and nutritionin Bihar, India. J Glob Health. 2020;10(2): 021008.
14. Dandona R, Kumar GA, Bhattacharya D, Akbar M, Atmavilas Y, Nanda P, Dandona L. Distinct mortality patterns at 0–2days versus the remaining neonatal period: results from population-based assessment in the Indian state of Bihar. BMC Med. 2019;17(1):140.
15. India State-Level Disease Burden Initiative Child Mortality Collaborators. Subnational mapping of under-5 and neonatal mortality trends in India: the Global Burden of Disease Study 2000–17. Lancet (London, England). 2020;395(10237):1640–58.
16. GBD 2021 Results. [https://vizhub.healthdata.org/gbd-results/]
17. Kochar PS, Dandona R, Kumar GA, Dandona L. Population-based estimates of still birth, induced abortion and miscarriage in the Indian state of Bihar. BMC Pregnancy and Childbirth. 2014:14:413.
18. Dandona R, Kumar GA, Majumder M, Akbar M, Dora SSP, Dandona L, ENHANCE 2020 team: Poor coverage of quality-adjusted antenatal care services: a population-level assessment by visit and source of antenatal care services in Bihar state of India. Lancet Reg Health Southeast Asia. https://doi.org/10.1016/j.lansea.2023.100332.
19. Dandona R, Kumar GA, Akbar M, Dora SSP, Dandona L. ENHANCE 2020 team: Substantial increase in stillbirth rate during the COVID-19 pandemic: results from a population-based study in the Indian state of Bihar. BMJ Glob Health. 2023;8(7): e013021.
20. Kumar GA, Dandona R, Chaman P, Singh P, Dandona L. A population-based study of neonatal mortality and maternal care utilization in the Indian state of Bihar. BMC Pregnancy Childbirth. 2014;14:357.
21. Tripathi S, Srivastava A. Quality of maternity care provided by private sector healthcare facilities in three states of India: a situational analysis. 2019;19(1):971.
22. Flaxman AD, Vahdatpour A, James SL, Birnbaum JK, Murray CJ. Direct estimation of cause-specific mortality fractions from verbal autopsies: multisite validation study using clinical diagnostic gold standards. Popul Health Metrics. 2011;9:35.
23. Flaxman AD, Vahdatpour A, Green S, James SL, Murray CJ. Random forests for verbal autopsy analysis: multisite validation study using clinical diagnostic gold standards. Popul Health Metrics. 2011;9:29.
24. Serina P, Riley I, Stewart A, James SL, Flaxman AD, Lozano R, Hernandez B, Mooney MD, Luning R, Black R, et al. Improving performance of the Tariff Method for assigning causes of death to verbal autopsies. BMC Med. 2015;13:291.
25. Bustreo F, Harding A, Axelsson H. Can developing countries achieve adequate improvements in child health outcomes without engaging the private sector? Bull World Health Organ. 2003;81(12):886–95.
26. Government of India: Effective Response in the face of a Pandemic: Measures Adopted by the Government of India to Combat COVID-19. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2021/dec/doc2021122421.pdf. Accessed 27 Jan 2025.
27. World Bank. Bihar - A Rapid Private Health Sector Assessment. Washington, DC: World Bank; 2005.
28. Mhajabin S, Hossain AT, Nusrat N, Jabeen S, Ameen S, Banik G, Tahsina T, Ahmed A, Sadeq-Ur Rahman Q, Gurley ES, et al. Indirect effects of the early phase of the COVID-19 pandemic on the coverage of essential maternal and newborn health services in a rural subdistrict in Bangladesh: results from a cross-sectional household survey. BMJ Open. 2022;12(2): e056951.
29. Malhotra S, Zodpey SP, Vidyasagaran AL, Sharma K, Raj SS, Neogi SB, Pathak G, Saraf A. Assessment of essential newborn care services in secondary-level facilities from two districts of India. J Health Popul Nutr. 2014;32(1):130–41.
30. Kaur J, Franzen SRP, Newton-Lewis T, Murphy G. Readiness of public health facilities to provide quality maternal and newborn care across the state of Bihar, India: a cross-sectional study of district hospitals and primary health centres. BMJ Open. 2019;9(7): e028370.
31. Krishnan A, Mathur P, Kulothungan V, Salve HR, Leburu S, Amarchand R, Nongkynrih B, Chaturvedi HK, Ganeshkumar P, K S VU, et al. Preparedness of primary and secondary health facilities in India to address major non-communicable diseases: results of a National Noncommunicable Disease Monitoring Survey (NNMS). BMC Health Serv Res. 2021;21(1):757.
32. DLHS [https://www.data.gov.in/dataset-group-name/dlhs]
33. Singh RR, Sharma A, Mohanty SK. Out of pocket expenditure and distress financing on cesarean delivery in India: evidence from NFHS-5. BMC Health Serv Res. 2023;23(1):966.
34. Mishra S, Mohanty SK. Out-of-pocket expenditure and distress financing on institutional delivery in India. International journal for equity in health. 2019;18(1):99.
35. Manna S, Singh D, Ghosal S, Rehman T, Kanungo S, Pati S. Out-of-pocket expenditure and its correlates for institutional deliveries in private and public healthcare sectors in India: findings from NFHS 5. BMC Public Health. 2023;23(1):1474.
36. Strong J, Lattof SR, Maliqi B, Yaqub N. Experiences of private sector quality care amongst mothers, newborns, and children in low- and

middle-income countries: a systematic review. BMC Health Serv Res. 2021;21(1):1311.
37. Molla YB, Rawlins B, Makanga PT, Cunningham M, Ávila JE, Ruktanonchai CW, Singh K, Alford S, Thompson M, Dwivedi V, et al. Geographic information system for improving maternal and newborn health: recommendations for policy and programs. BMC Pregnancy Childbirth. 2017;17(1):26.
38. Roy N, Mishra PK, Mishra VK, Chattu VK, Varandani S, Batham SK. Changing scenario of C-section delivery in India: Understanding the maternal health concern and its associated predictors. Journal of family medicine and primary care. 2021;10(11):4182–8.
39. Bhatia M, Dwivedi LK, Banerjee K, Dixit P. An epidemic of avoidable caesarean deliveries in the private sector in India: Is physician-induced demand at play? Soc Sci Med. 1982;2020(265): 113511.
40. Salazar M, Vora K, De Costa A. The dominance of the private sector in the provision of emergency obstetric care: studies from Gujarat. India BMC health services research. 2016;16:225.
41. Mony PK, Krishnamurthy J, Thomas A, Sankar K, Ramesh BM, Moses S, Blanchard J, Avery L. Availability and distribution of emergency obstetric care services in Karnataka State, South India: access and equity considerations. PLoS ONE. 2013;8(5): e64126.
42. Labour room and quality improvement initative [https://nhm.gov.in/index1.php?lang=1&level=3&sublinkid=1307&lid=690#:~:text=In%20this%20respect%2C%20Ministry%20of,and%20immediate%20post%2Dpartum%20period.]
43. Langlois EV, McKenzie A, Schneider H, Mecaskey JW. Measures to strengthen primary health-care systems in low- and middle-income countries. Bull World Health Organ. 2020;98(11):781–91.
44. Clarence C, Shiras T, Zhu J, Boggs MK, Faltas N, Wadsworth A, Bradley SE, Sadruddin S, Wazny K, Goodman C, et al. Setting global research priorities for private sector child health service delivery: Results from a CHNRI exercise. J Glob Health. 2020;10(2): 021201.
45. Ghosh R, Cohen S, Spindler H, Vincent D, Sterling M, Das A, Gore A. Mahapatra T. Walker D: Simulation and nurse-mentoring in a statewide nurse mentoring program in Bihar, India: diagnosis of postpartum hemorrhage and intrapartum asphyxia. 2022;6:70.
46. Joudeh A, Ghosh R, Spindler H, Handu S, Sonthalia S, Das A, Gore A, Mahapatra T, Walker D. Increases in diagnosis and management of obstetric and neonatal complications in district hospitals during a high intensity nurse-mentoring program in Bihar, India. Gates open research. 2021;16(3): e0247260.
47. Ahmed S, Srivastava S, Warren N, Mayra K, Misra M, Mahapatra T, Rao KD. The impact of a nurse mentoring program on the quality of labour and delivery care at primary health care facilities in Bihar. India. 2019;4(6): e001767.
48. Kane S, Dayal P, Mahapatra T, Kumar S, Bhasin S, Gore A, Das A, Reddy S, Mahal A, Krishnan S, et al. Enabling change in public health services: Insights from the implementation of nurse mentoring interventions to improve quality of obstetric and newborn care in two North Indian states. 2020;4:61.
49. World Health Organization. Strategic and Technical Advisory Group of Experts (STAGE): Handbook on Maternal, Newborn, Child, Adolescent Health & Nutrition. Geneva: WHO; 2020.
50. Mackintosh M, Channon A, Karan A, Selvaraj S, Cavagnero E, Zhao H. What is the private sector? Understanding private provision in the health systems of low-income and middle-income countries. Lancet. 2016;388(10044):596–605.
51. Ministry of Health with Family Welfare, Government of India. National Strategic Plan to End Tuberculosis in India: 2020–25. In. New Delhi: GoI; 2020.
52. Ganguly P, Jehan K, de Costa A, Mavalankar D, Smith H. Considerations of private sector obstetricians on participation in the state led "Chiranjeevi Yojana" scheme to promote institutional delivery in Gujarat, India: a qualitative study. BMC Pregnancy Childbirth. 2014;14:352.
53. Diwan V, Joshi SC, Jehan K, De Costa A. Participation in the state led "Janani Sahayogi Yojana" public private partnership program to promote facility births in Madhya Pradesh, India: views from private obstetrician partners. BMC Health Serv Res. 2019;19(1):599.
54. Yadav V, Kumar S, Balasubramaniam S, Srivastava A, Pallipamula S, Memon P, Singh D, Bhargava S, Sunil GA, Sood B. Facilitators and barriers to participation of private sector health facilities in government-led schemes for maternity services in India: a qualitative study. BMJ Open. 2017;7(6): e017092.

Publisher's Note