

REVIEW

State of newborn health in India

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About 0.75 million neonates die every year in India, the highest for any country in the world. The neonatal mortality rate (NMR) declined from 52 per 1000 live births in 1990 to 28 per 1000 live births in 2013, but the rate of decline has been slow and lags behind that of infant and under-five child mortality rates. The slower decline has led to increasing contribution of neonatal mortality to infant and under-five mortality. Among neonatal deaths, the rate of decline in early neonatal mortality rate (ENMR) is much lower than that of late NMR. The high level and slow decline in early NMR are also reflected in a high and stagnant perinatal mortality rate. The rate of decline in NMR, and to an extent ENMR, has accelerated with the introduction of National Rural Health Mission in mid-2005. Almost all states have witnessed this phenomenon, but there is still a huge disparity in NMR between and even within the states. The disparity is further compounded by rural–urban, poor–rich and gender differentials. There is an interplay of different demographic, educational, socioeconomic, biological and care-seeking factors, which are responsible for the differentials and the high burden of neonatal mortality. Addressing inequity in India is an important cross-cutting action that will reduce newborn mortality.

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BACKGROUND

The neonatal period—the first 28 days of life—carries the highest risk of mortality per day than any other period during the childhood. The daily risk of mortality in the first 4 weeks of life is ~30-fold higher than the post-neonatal period, that is, from 1 month to 59 months of age. Still, newborn health did not receive the commensurate attention it deserved until during the past decade. This has resulted in a slow decline in neonatal mortality rate (NMR) in most countries including India, and has hampered their achieving the Millennium Development Goal-4 (MDG 4) by year 2015. This article provides an overview of the burden, trends and causes of neonatal mortality, burden of common morbidities, and coverage of key interventions in India. Table 1 enlists the common terminologies used in the article and their definitions.

NEONATAL MORTALITY: THE CHALLENGE

India contributes to one-fifth of global live births and more than a quarter of neonatal deaths. Nearly, 0.75 million neonates died in India in 2013, the highest for any country in the world.¹ The current NMR is 28 per 1000 live births.² Given the infant and under-five child mortality rates of 40 and 49 per 1000 live births, respectively, 70% of total infant deaths and more than half of under-five deaths fall in the neonatal period. Indeed, with the early NMR of 22 per 1000 live births, deaths in the first week alone account for ~45% of total under-five deaths.² Obviously, the 'Committing to Child Survival: A Promise Renewed' goal of reducing under-five mortality to 20 or less per 1000 live births by 2035 will not be attained without specific efforts to reduce newborn mortality.

NEONATAL MORTALITY: BURDEN OVER THE YEARS

There has been a significant reduction in the quantum of neonatal and child deaths in the past two decades. The annual burden of

neonatal deaths has reduced from 1.35 million in 1990 to 0.75 million in 2013 (Table 1).^{1,3} But the rate of decline in the neonatal and child mortality rates has accelerated only in the past decade—for example, neonatal deaths reduced by 33% in the period from 2000 to 2013 compared with 17% from 1990 to 2000 (Table 2).

NEONATAL MORTALITY: TRENDS AND PROJECTIONS

The NMR has declined from 44 per 1000 live births in 2000 to 28 per 1000 live births in 2013. But this rate of decline has nevertheless lagged behind that of infant mortality rate (Figure 1). The average annual rate of reduction (AARR) of NMR was only modest—at ~3.5%—in this period, compared with the rate of reduction of infant mortality rate (IMR) during the same period (4.0%). The higher AARR of post-neonatal infant deaths, that is, deaths in infants aged 1–12 months, compared with deaths during the neonatal period is the reason for this discrepancy. The slower decline in NMR has led to increasing contribution of neonatal mortality to infant mortality. Among neonatal deaths, the rate of decline in the ENMR was much lower than in the late NMR—AARR of 2.8% and 5.8%, respectively.

The projected NMRs for 2017 and 2020, based on the AARR from 2000 to 2012, are 24 and 22 per 1000 live births, respectively. The projected rates for ENMR for 2017 and 2020 are 20 and 18 per 1000 live births, whereas that for late NMR are 4 and 4 per 1000 live births, respectively. The projected rates are likely to be overestimates because the rate of decline in IMR and NMR has accelerated with the introduction of the National Rural Health Mission (NRHM) in mid-2005. For example, the AARR for NMR was 0 in the pre-NRHM (2003–2005) epoch, but had increased to 2.8% per year in the peri-NRHM epoch (2006–2008), when the program was being rolled out in a phased manner across the country. It further increased to 4.6% per year in the period between 2009 and

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Table 1. Common terminologies used and their definitions

Terminology	Definition
Neonatal mortality rate (NMR)	Number of deaths among all live births during the first 28 days of life expressed per 1000 live births.
Early neonatal mortality rate (ENMR)	Number of neonatal deaths < 7 days of life expressed per 1000 live births.
Late neonatal mortality rate (LNMR)	Number of neonatal deaths between 7 and 28 days of life expressed per 1000 live births.
Infant mortality rate	Probability of dying between birth and 1 year of age expressed per 1000 live births.
Under-5 child mortality rate	Probability of dying between birth and 5 years of age expressed per 1000 live births.
Stillbirth	Death of a fetus weighing at least 500 g (or if birth weight unavailable, after 22 completed weeks of gestation or crown heel length of 25 cm or more) before the complete expulsion from its mother.
Perinatal mortality rate (PMR)	Number of deaths of fetuses weighing at least 500 g (or if birth weight unavailable, after 22 completed weeks of gestation or crown heel length of 25 cm or more) plus the number of early neonatal deaths per 1000 total births.

Table 2. Estimates of child and maternal deaths in India for years 1990, 2000 and 2013

	1990	2000	2013	Relative reduction from 1990 to 2000 (%)	Relative reduction from 2000 to 2013 (%)	Relative reduction from 1990 to 2013 (%)
Neonatal deaths (in millions)	1.35	1.12	0.75	17	33	44
Under-5 child deaths (in millions)	3.32	2.41	1.34	27	44	60

Sources: data for year 1990 are from World Health Organization,³ and data for years 2000 and 2013 are from Liu *et al.*,¹ copyright 2015, with permission from Elsevier.

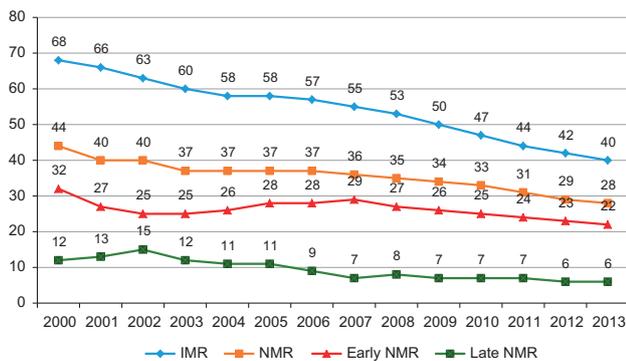


Figure 1. Trends of NMR and IMR. NMR, neonatal mortality rate. IMR, infant mortality rate.

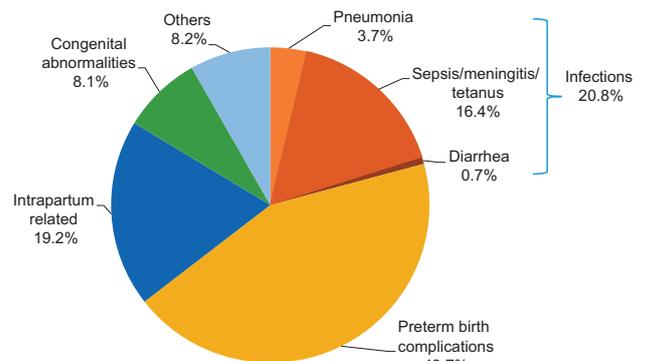


Figure 2. Causes of neonatal deaths in India.

2011 when the program had been fully implemented. The NMRs in 2017 and 2020 may therefore be lower than the projected rates.

NEONATAL MORTALITY: CAUSES

A systematic analysis of global, regional and national causes of child mortality in 2013 identified preterm birth complications and infections to be the two major causes of neonatal deaths in India (Figure 2).^{1,4} The review, which included the data from the Million Death Study from India,⁵ found perinatal asphyxia and malformations to be the other two significant causes of neonatal mortality. These findings are very similar to the overall global pattern.⁴

TIMING OF NEONATAL DEATHS

A pooled analysis of the data from three studies on the timing of neonatal deaths indicates that about three-fourths of total neonatal deaths occur in the first week of life.⁶⁻⁸ The first 24 h account for more than one-third (36.9%) of the deaths that occur in the entire neonatal period.

A recent prospective study by Baqui *et al.*⁶ provided data on the timing of cause-specific neonatal deaths: almost all deaths (97.8%) due to asphyxia occur in the first week of life, with 70% of them occurring within the first 24 h (day 0). About three-fourth of

deaths due to prematurity (74.8%) occur in the first week of life, with 30% in the first 24 h (day 0) < 50% of neonatal deaths secondary to sepsis occur in the first week of life. About 30% of sepsis-related deaths occur in the second week, whereas around one-fifth in weeks 3-4. Three-fourth of the deaths due to malformations occur in the first week of life, with day 0 alone contributing to nearly half of these deaths.⁶

NEONATAL MORTALITY: DETERMINANTS

In India, inequities with corresponding underlying axes of caste, class, gender and geographical differences define a very large segment of the population. A High-Level Expert Group appointed by the Planning Commission of India observed that considering the health inequality and social inequality interface, the poorest and most disadvantaged have a higher risk for diseases. This includes the urban and rural poor, women and children, specially abled persons, and traditionally marginalized and excluded communities such as adivasis, or STs, dalits, or SCs, and ethnic and religious minorities. They also have a higher probability of being excluded from the health services. The neonates born in these populations are expected to be the most vulnerable to morbidity and mortality.⁹

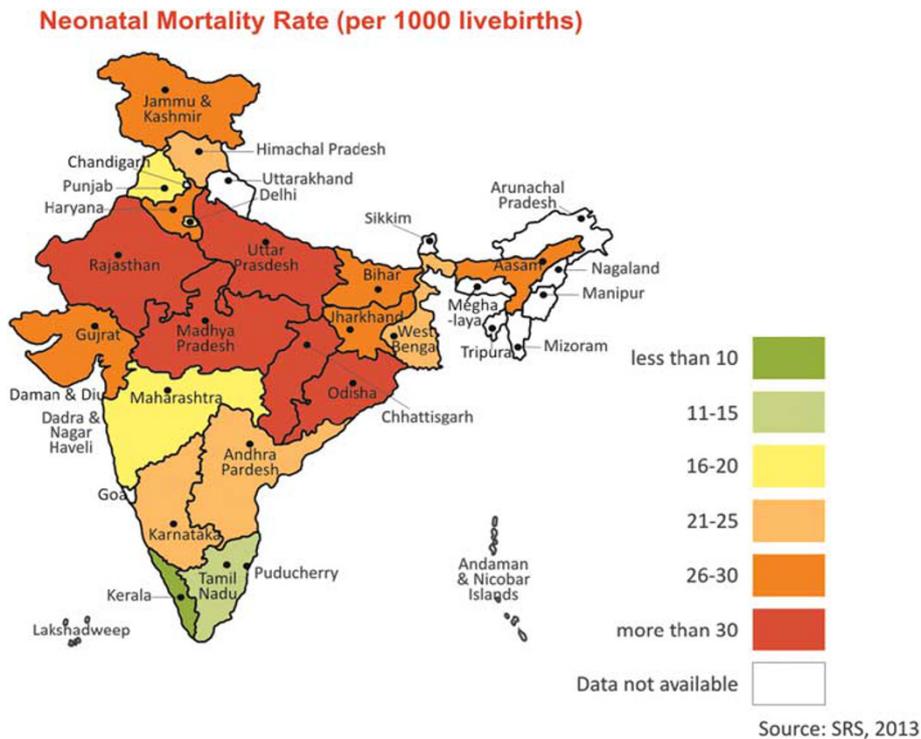


Figure 3. State-wise distribution of NMR in India.

Geographical variations

The NMR is not uniform across the country. Although Kerala and Tamil Nadu have low NMRs (< 20 per 1000 live births), Odisha, Madhya Pradesh and Uttar Pradesh have very high NMRs (35 or more per 1000 live births; Figure 3)² Four states—Uttar Pradesh, Madhya Pradesh, Bihar and Rajasthan—alone contribute to ~55% of total neonatal deaths in India^{2,10} and to ~15% of global neonatal deaths that occur every year.

Wide disparities are also observed in survival rates across districts within states. It is evident that within a given state, NMR may be more than twice as high in the ‘worst’ districts as in the ‘best’ one.¹¹

Rural–urban, poor–rich differences

There are important rural–urban and socioeconomic differences in the NMR. The NMR in rural areas is twice that in urban areas (31 vs 15 per 1000 live births). The discrepancy is more marked—difference of 60% or more—in Andhra Pradesh, Assam, Jharkhand and Kerala.²

Gender differences

Although recent sex-differentiated NMR estimates are not available, given the gender-based differences in care seeking in India, the NMR estimates for females are likely to be higher than those for males. A close proxy of NMR, the IMR, reaffirms this—39 for males and 42 for females (per 1000 live births).² The annual rate of IMR decline from 2007 to 2012 is also higher for males—5.9% compared with 4.8% for females. The sex differential rate of decline is more marked in some states—Andhra Pradesh, Delhi, Karnataka, Kerala and Madhya Pradesh.

Gender discrimination at each stage of the female life cycle contributes to gender-based health disparities including sex-selective abortions, neglect in care of the female child, and poor access to healthcare for girls.^{12–16} Recent data for admissions in special newborn care units have also demonstrated differential

care seeking for males and females. At the district level, newborn care units typically admit ~30% less females than male neonates.¹⁷ A study conducted in Uttar Pradesh (UP) demonstrates that while the overall use of health-care providers is similar across gender, the average expenditure for healthcare during the neonatal period is nearly fourfold higher in households with male newborns compared with those with female newborns. Households with female newborns use cheaper public care providers, whereas those with males prefer to use private providers who are perceived to deliver more satisfactory care.¹⁸

Per capita GDP

An inverse relationship exists between the per capita net state domestic product and NMR—states with a high NMR usually have a low per capita GDP.¹⁹ But there are a few exceptions—Haryana and Gujarat have a similar or higher per capita GDP than Tamil Nadu, but almost double the NMR.

Social status

In India’s caste-based social hierarchy, the scheduled castes (SCs), dalits, adivasis and scheduled tribes (STs) are the most backward and disadvantaged. A recent study has documented a higher vulnerability of SC children as compared with ST children: the odds of neonatal mortality among STs are lower by 28% as compared with SC communities in rural areas.²⁰ Family characteristics contribute significantly in determining the status of newborn health. Upadhyay *et al.*²¹ found that low educational status of parents (odds ratio (OR) 2.1, 95% CI; 1.4, 3.3), father’s occupation (OR 1.8, 95% CI; 1.0, 3.0) and caste (OR 2.0, 95% CI; 1.2, 3.4) appears to explain a major fraction (45.7%) of neonatal deaths in Haryana.

Environment conditions

In contrast to children born in families with better financial resources, poorer children are more at risk for diseases due to

inadequate water and sanitation, indoor air pollution, crowding and poor housing conditions.²² Access to clean water supply, and sanitation and good hygienic practices, especially at delivery points, is crucial for a safe delivery, and prevention of maternal and newborn mortality and morbidity. Creating conditions for better hygiene and reduced exposure to contamination makes children less susceptible to diseases and infections that may lead to death.^{20,23,24}

Maternal factors

Maternal factors including age at birth, educational and nutritional status, and parity influence the neonatal survival to a great extent. The median maternal age at first childbirth in India is 19.9 years; ~30% of girls give birth before the age of 20 and account for 21% of all deliveries.²⁵ It is estimated that the risks of neonatal mortality and low birth weight (LBW) are increased by almost 50% if maternal age at childbirth is < 20 years. It is also estimated that shifting age at childbirth to above 20 years would reduce overall NMR by 9.4%.^{26,27–30}

Evidence demonstrates that improving maternal education is the most effective and proven strategy to improve neonatal survival, as it improves preventive behaviors and increases the utilization of maternal and neonatal health-care services.^{31–33} Kerala's achievement of stabilizing population growth and low levels of infant and neonatal mortality is partly attributed to its high female education levels.²⁵

Utilization of health services

The heterogeneity in health service coverage has a significant role in producing inequitable health outcomes. A recently published systematic review on inequity in maternal health in India highlighted the fact that women of some population groups remained systematically and consistently disadvantaged in terms of access to and use of maternal and reproductive health services, including safe delivery and antenatal care services.³⁴ Program initiatives based on average performance achievements of states rather than on deprived groups increases disadvantages for vulnerable populations within high achieving states.^{35–37} In addition, inadequate funding, poor infrastructure and insufficient manpower at health facilities, and poor governance pose major challenges to equitable access to free or affordable health services, often forcing poor households to make high out-of-pocket expenditures on healthcare, which is often of poor quality.

PERINATAL MORTALITY AND STILLBIRTH RATE

The current perinatal mortality rate (PMR) of India (2013) is 26 per 1000 births.² It ranges from 16 per 1000 births in urban areas to 28 per 1000 births in rural areas. As with NMR, the PMR is not uniform across the country—the PMR of Kerala is only 9 per 1000 births, whereas that of Odisha is 35 per 1000 births.² The stillbirth rate (SBR) is estimated at four per 1000 births.² The estimated values of both SBR and PMR are likely to be underestimates, as stillbirths are extremely difficult to capture and may be misclassified. Interestingly, the estimated SBR of India for year 2009 is 22.1 per 1000 births;³⁸ in contrast, the SBR as reported by sample registration system for year 2010 was 7 per 1000 births.

NEONATAL MORBIDITIES

Neonatal morbidities constitute a huge burden to the health system and society in general. The SEARCH study by Bang *et al* (1995–1996) provided a detailed insight into the burden of common morbidities in rural community settings.³⁹ A recent study conducted in Lucknow among the urban poor reported upper respiratory tract infection, diarrhea, septicemia and pneumonia to

be the most common morbidities during follow-up until 6 weeks of age.⁴⁰

LBW/preterm birth

Nearly 30% of neonates—7.5 million—are born with a LBW (< 2500 g) in India.⁴¹ This accounts for 42% of the global burden, the largest for any country. About 60% of the LBW infants are born at term after fetal growth restriction, whereas the remaining 40% are born preterm.⁴² The prevalence of SGA is 46.9%, higher than all but two countries in the world (Pakistan and Mauritania have a marginally higher prevalence at 47.0%).⁴¹ Each year, ~3.5 million preterm (< 38 weeks of gestation) neonates are born in India.⁴¹ Community-based studies indicate that the LBW infants are at 11–13 times increased risk of dying than NBW infants.⁴³ Indeed, >80% of total neonatal deaths occur among LBW/preterm neonates.^{26,44}

Neonatal sepsis

The burden of neonatal sepsis is huge in the country. Hospital-based studies suggest an incidence of 30 per 1000 live births,⁴² whereas community-based studies indicate an incidence of 2.7–17% of all live births.^{42,43} Nearly, one-fifth of neonates with sepsis die in the hospital; the figure rises to up to 50% for those with culture proven sepsis (Delhi Neonatal Infection Study Group; personal communication). They stay longer in the hospital, consume more resources and are also at a high risk of major neurodevelopmental disabilities at a later age.

Perinatal asphyxia

Intrapartum-related conditions or perinatal asphyxia not only leads to neonatal deaths, but also accounts for a significant proportion of stillbirths. It is difficult to estimate the true burden of asphyxia because of the different definitions used in the studies. The reported incidence varies from 2 to 16.2% in community-based studies,⁴⁵ with the reported case fatality rates ranging from 38.5 to 74%. About 2.8 and 5.6% of all live births had moderate and severe asphyxia, respectively, in a large hospital-based study; the case fatality rate was relatively low at ~8.7%.⁴²

COVERAGE OF KEY INTERVENTIONS IN ANTENATAL, NATAL AND POST-NEONATAL PERIODS

The coverage evaluation survey in 2009 (CES 2009) assessed the coverage of key interventions in antenatal, intrapartum and postnatal periods that can influence neonatal health.⁴⁶ Only a quarter of pregnant women had full antenatal check-up, that is, three or more antenatal checkups, at least one tetanus toxoid injection and at least 100+ iron and folic acid tablets during pregnancy. About 73% of women had institutional deliveries.^{46,47} Only one-third of neonates were breastfed within 1 h after birth.⁴⁶ Less than half of the neonates received three postnatal visits by health-care providers in the first 10 days of life.^{48–54}

Although several initiatives, such as Janani Suraksha Yojana and Janani Shishu Suraksha Karyakram, have attempted to address these gaps, their impact remains limited due to poor governance, shortage of health workers in primary health-care facilities and lack of preparedness of health-care facilities.^{55,56}

Ensuring equitable access to health services requires a clear understanding of the multiple levels of inequity across many sectors. It is important that all public policies have synergy with health policies and programs. International organizations, national and state governments, civil society, and research and academic institutions have a major role to have in ensuring equitable service delivery and improved health governance. The inter-sectoral approaches need to be promoted within and between departments. Improving access to safe water and sanitation, providing adequate food security, and poverty alleviation measures

complemented by an equitable health system can ensure better health outcomes for every neonate in India.⁵⁷

CONCLUSIONS

India has witnessed a significant improvement in neonatal health after the introduction of NRHM. Apart from the JSY, the country has launched several new initiatives to improve neonatal care. Notwithstanding this newfound focus on neonatal health, the annual rate of reduction in NMR and ENMR still lags behind IMR and U5MR. There is an interplay of different demographic, educational, socioeconomic, biological and care-seeking factors, which are responsible for the disparities and the high burden of neonatal mortality. The country has to increase the coverage of key interventions and also improve the quality of care in health facilities on an urgent basis.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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