Original Article

Neonatal Morbidity and Mortality in Tribal and Rural Communities in Central India

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ABSTRACT

Background and Objectives: Little is known about the natural history of neonates born in the rural and tribal areas in India. The Neonatal Disease Surveillance Study (NDSS) measures the incidence of high-priority neonatal diseases, neonatal health events and associated risk factors to plan appropriate and effective actions. **Materials and Methods:** The NDSS is being conducted in Ramtek Revenue Block, Nagpur district, Maharashtra state, given its considerably high level of neonatal mortality. All households from five selected primary health centers were screened. Both active and passive surveillance systems were used for systematic collection of mother's health during pregnancy and of baby's health from birth to 4 months after birth. First-year results from November 2006 to October 2007 are presented. **Results:** Pregnancy outcomes were available for 1,136 women, with an overall neonatal mortality of 73 per 1,000 live births. The pregnancy outcomes varied by gestational age of the baby; miscarriages and abortions were higher in tribal than in non-tribal women, and tribal women had higher rates of low-birth weight (LBW) neonates than non-tribal women. The main cause of neonatal mortality was LBW, followed by sepsis and respiratory illness. The mortality of non-tribal babies was most strongly associated with pre term. For tribal babies, mortality was also associated with maternal morbidity and delay in the initiation of breastfeeding. **Interpretation and Conclusions:** The NDSS provides valuable information on the potentially modifiable factors associated with increased likelihood of neonatal mortality and morbidity. The Neonatal Health Research Initiative is now developing community-based interventions to reduce the high rate of neonatal mortality and morbidity in the rural areas of India.

Keywords: Neonatal morbidity, neonatal mortality, rural communities, tribal communities

Introduction

One of the United Nations Millennium Development Goals is the reduction by two-thirds of the mortality among children <5 years of age by 2015.[1,2] The global burden of neonatal death is primarily concentrated in developing countries, where care of neonates is practically non-existent.[3] Of the 4 million neonatal deaths that occur every year, 98% are in the poorest countries of the world.[4] In India, as many as 1.72 million children die annually before reaching their first birthday and, of these, 72% die during their first month of life, the neonatal period. The neonatal mortality rate varies by state but, overall, it is reported to be 43 per 1,000 live births.[5]

A key component of health development is the availability and access to proper health care. Rural, tribal and difficult-to-reach areas of India are particularly lacking in healthcare facilities, and this has been recognized as one of the determinants of the high infant mortality and morbidity in this country.[6] Thus, population-specific, systematic and comprehensive strategies are required to reduce neonatal mortality at the national level.[7]

There is little known about the natural history of pregnancies and of neonates born in rural and tribal areas in India.[6,8] Recently, the profile of neonatal deaths of five rural sites in India was obtained in a cross-sectional

study, with information collected retrospectively.[2] Few prospective studies exist,[9] and none have randomly sampled households and included them in a surveillance study of pregnant women and their subsequent neonates.

The Neonatal Health Research Initiative (NHRI) is a comprehensive research endeavour funded jointly by the United States Agency for International Development (USAID) and the International Clinical Epidemiology Network (INCLEN Trust) to study in depth the many aspects of neonatal health in India. A baseline survey of 24 existing healthcare facilities in rural and tribal communities in the vicinity of Nagpur, in the central India state of Maharashtra, was undertaken within the NHRI, and it showed that midwives were not uniformly available, drug supplies for routine care were not readily available and that the healthcare staff were not adequately trained and did not have the knowledge and skills for addressing the specific problems of neonates.[7] The location and distance from the community of the healthcare facility did have an effect on the community stakeholders' choice and preference in seeking neonatal care. This was especially true in tribal areas, where women had to travel long distances to reach a healthcare facility.

The Neonatal Disease Surveillance Study (NDSS), which is a part of the larger NHRI, is a prospective cohort study of pregnant women and their subsequent neonates from a probability sample of households in rural and tribal communities in the district of Nagpur, in the central Indian state of Maharashtra. The overall aim of the NDSS is to obtain information on the incidence of high-priority neonatal diseases, neonatal health events and associated risk factors in order to plan appropriate and effective actions for these communities that have unequal health care. This manuscript describes the design, methodology used and the first-year results of this surveillance study, and suggests possible short-term and long-term prevention and control measures to be considered.

Materials and Methods

Sampling and setting

The NDSS was undertaken in Ramtek tehsil (an administrative revenue block) of the Nagpur district, an area predominantly inhabited by tribal and rural communities [Figure 1]. Agriculture is the main occupation and thus the study population has been relatively stable. Even with the continuous presence of government and non-government health systems, a considerably high level of neonatal mortality has been reported from this region. This site was selected also considering its proximity to the city of Nagpur and the convenience of extending required logistics, support and management of surveillance activities over a long period of time. Moreover, this site has not been engaged, either in the past or currently, in any other neonatal health research or programmatic activities.

The reported birth rate of the state of Maharashtra is of 19 per 1,000 population per year,[10] and its neonatal mortality rate is 32 per 1,000 live births per year.[11] Based on these estimates, it was anticipated that if the proposed surveillance activity were to be carried out in a block with a population >100,000, then a cohort of >2,000 pregnant women would be available annually and that ~60 neonatal deaths would occur. This assumption implied including five primary health centers (PHCs) as the primary sampling units, as their average population is ~20,000. A sampling frame of PHCs that is being served by both public and private health facilities was obtained from the tribal and non-tribal areas of the selected tehsil. From among those PHCs with the highest levels of neonatal mortality, two PHCs from non-tribal and three PHCs from tribal areas were randomly selected. The tribal PHCs are located in the thick and dense forest areas and the rural PHCs are located along the contiguous areas bordering the tribal belt. The total population of these five PHCs was 114,222, and we were able to cover 112,003, or 98%.

All the households in the communities and villages from the five selected PHCs were screened for the purpose of the surveillance activities. Each sampled community was visited in its entirety by the study health workers, carefully mapped out and all households with pregnant women identified over an initial period of 10 weeks. Each house was geo-coded with a Global Positioning System (GPS) which provides reliable location and time information in all weather; and also marked on the outside wall with a visible unique serial number
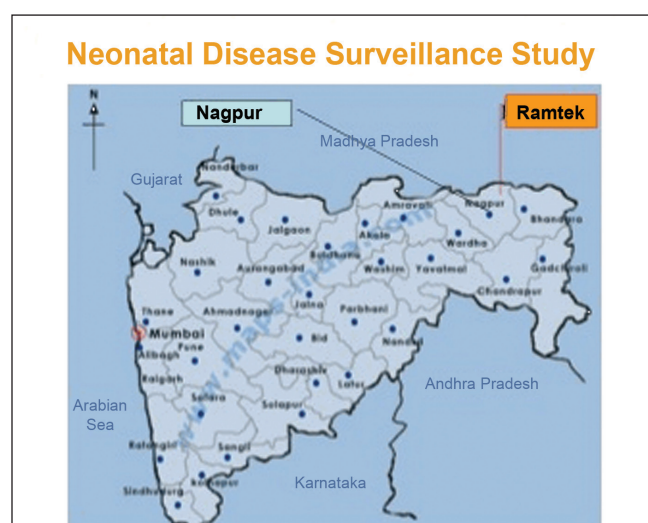

Figure 1: Location of the studied area: Ramtek tehsil, Nagpur district, Maharashtra state, India

to identify and help track the pregnancy during the antenatal care (ANC) period and the newborn's health status during the post-natal period.

Surveillance methodology

Both active and passive surveillance systems were instituted for the systematic collection of information on mother's health during pregnancy and of the baby's health at birth, day 1, day 7, day 28, 2 months and 4 months after birth. For the active surveillance, study research assistants (RAs) visited each household and talked directly to the mother and to the concerned attendees. They also communicated with the local community health worker (*anganwadi* worker or *dais*), which was essential for knowing when a child was born and the health status thereafter. The RAs were trained in recognizing the danger signs for some commonly occurring neonatal diseases so as to identify the sick newborns in the community. In the case of an immediate health care need, a "rapid active team" was available for care of the participants. The passive component of the surveillance involved interviews of clinical staff at government PHCs as another measure to identify sick newborns or those requiring additional care (especially low-birth weight [LBW] babies).

Three standard approaches, following the World Health Organization's guidelines for surveillance of diseases,[12,13] were used in the NDSS. First, for active surveillance, the syndromic surveillance approach identified cases through the recognition of signs and symptoms of sick neonates by the trained RAs. This approach helped in the early detection and notification of adverse health events in children. The remaining two approaches were used for the passive surveillance. The presumptive surveillance approach was based on investigations of neonates by medical officers through clinical examinations and their presumption of diagnosis based on the typical history of illness. Finally, the confirmed case surveillance approach used confirmation of clinical diagnosis by the laboratory technician and a neonatologist through positive laboratory findings. A reference laboratory with the required infrastructure, logistics and manpower was set up at the study site. Blood samples of referred sick neonates were analyzed for C-reactive protein and culture testing at this laboratory. Written informed consent of the caregiver (usually a parent or guardian) was sought before drawing blood from the sick neonates. Verbal and social autopsy tools were also employed to ascertain the causes of neonatal deaths as perceived by the stakeholders and RAs that were subsequently confirmed by the trained neonatologist member of the team.

Variables measured

Key variables measured on the mothers and households

included: socioeconomic characteristics (education of mother and of husband, occupation of husband), maternal factors (age, parity, height, weight, blood pressure, fever, ability to perform physical activities), extent of utilization of ANC services, maternal morbidity along with treatment and referrals (before, during and after pregnancy) and maternal mortality.

On the babies, the key outcome variables measured included: birth weight, health status of the newborn, danger signs for common neonatal diseases and morbidities, adverse health events and mortality (i.e., survival) at day 1, day 7, day 28, month 2 and month 4 and, if sick, treatment and referral.

Additional potential risk factors predictive of health outcomes in the babies included: duration or term of pregnancy, delivery outcomes and complications, weight gain after birth, immunizations, fever, infections, newborn and child care practices by stakeholders, family type, family size and tribal or non-tribal nature of the communities.

Data management

Data were collected on paper forms on site and at the health care centers, reviewed by field supervisors and entered at the centralized statistical coordinating centre in Nagpur, both manually and through ABBY Form Reader® software. Editing and data cleaning were performed on a timely basis. Stringent quality assurance measures were followed at various stages of data handling so as to ensure completeness, accuracy and reliability of the data.

Statistical analysis

Statistical analyses are mainly descriptive – estimating incidence rates and confidence intervals for outcome variables among the tribal and non-tribal groups. Unadjusted relative risks and 95% confidence intervals for morbidity and mortality were calculated for each of the potential risk factors and multiple linear logistic regression models were used to obtain adjusted odds ratios for morbidity and mortality. Kaplan-Meier estimates of the survival curves were used to study time to mortality and to the first sickness. All statistical analyses were performed using STATA 9.1 software.

Results

The results presented cover the first year of the NDSS, the period from November 2006 to October 2007. The 112,003 individuals in the study sample came from a total of 23,856 households (12,774 tribal and 11,082 non-tribal), located in 151 (102 tribal and 49 non-tribal) communities and villages [Table 1].

Table 1: Baseline characteristics of the cohort of pregnant women by type of community (tribal versus non-tribal)

Variable	Tribal (%)	Non-tribal (%)
Number of communities	102	49
Number of households	11,082	12,774
Number of pregnant women	980	989
Number of pregnant women lost to follow-up	120	76
Number of pregnant women analyzed	860	913
Age in years (mean ± SD)	23.0 ± 3.0	23.0 ± 3.1
Education (number and %)		
Illiterate	140 (16.3)	66 (7.2)
1–4 standard	235 (27.3)	204 (22.3)
5–9 standard	352 (40.9)	390 (42.7)
10–12 standard	101 (11.7)	185 (20.3)
Graduate and above	32 (3.7)	68 (6.4)
Gravidity (mean ± SD)	1.9 ± 1.08	1.86 ± 1.04
Parity (mean ± SD)	0.86 ± 1.05	0.76 ± 1.0
Joint family structure	66.7	56.1
Family size (mean ± SD)	5.2 ± 2.5	4.7 ± 2.4
Height in cm (mean ± SD)	148.8 ± 6.6	149.1 ± 4.8
Weight in kg (mean ± SD)	46.0 ± 6.5	46.9 ± 6.9
BMI (mean ± SD)	20.9 ± 3.2	21.1 ± 3.2
Systolic blood pressure in mmHg (mean ± SD)	113.4 ± 8.1	111.1 ± 9.3
Diastolic blood pressure in mmHg (mean ± SD)	70.7 ± 7.8	68.3 ± 8.2
ANC registration in government (versus private) hospitals	98.4	98.7
Gestational age in weeks at first registration with health system (mean ± SD)	15.6 ± 5.6	17.2 ± 7.6
Number of ANC visits (mean ± SD)	2.8 ± 1.7	3.3 ± 2.0
Tetanus immunization (2nd or booster dose) received	88.9	84.7
Iron (folic acid) supplementation received	90.9	85.8
Physical inability to perform routine activities during pregnancy	18.3	25.0
Fever and/or sickness (morbidity) during pregnancy	23.0	34.1

Tribal pregnant women were in general less educated than their rural counterparts, were smaller in body mass index and had slightly higher blood pressures. They also had fewer antenatal clinic visits. Despite these risk factors, they were less sick and worked more during their pregnancy. All women received high health care during this period.

At the time of analysis, pregnancy outcomes were available for 1,136 women (571 tribal and 565 non-tribal). Ten pregnancies did not go to their end and there were 39 stillborns [Table 2].

Including the stillborns, neonatal mortality (during the first 28 days) was high, 73.3 per 1,000 (42 of 573) live births in tribal women and 73.7 per 1,000 (42 of 569) live births in non-tribal rural women. A considerable proportion of babies were sick in the first week of life;
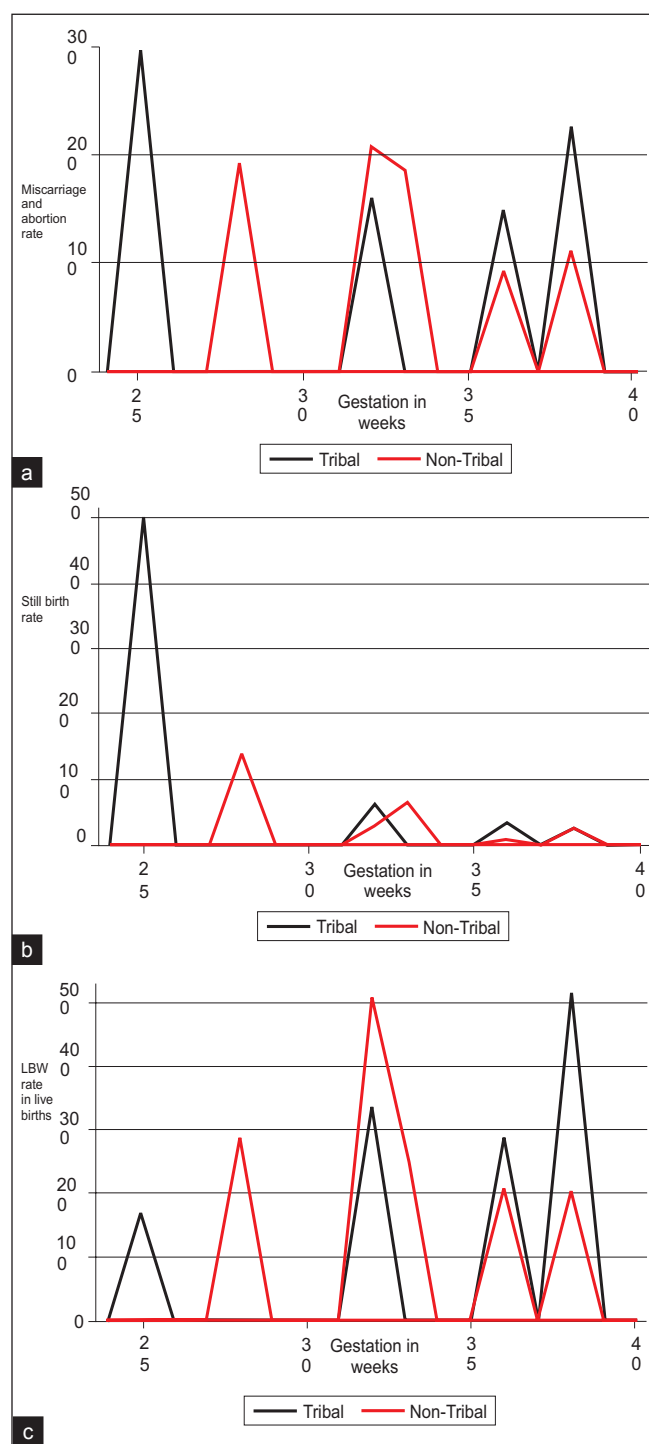
Figure 2: Rates of adverse pregnancy outcomes per 1,000 live births: (a) miscarriage or abortion, (b) stillbirths and (c) low-birth weight live births, by gestational age

this decreased some during the first month, but increased between month 2 and month 4.

Pregnancy outcomes varied by gestational age of the baby and by tribal and non-tribal status of the woman [Figure 2]. Miscarriages and abortions were higher in tribal than in non-tribal women, and they tended to

occur as early as 25 weeks of gestational age. Stillbirths were less common and thus the rates were affected by small numbers; for tribal women, the rate at 25 weeks peaked at 500/1,000. LBW babies were more common; interestingly, tribal women had higher rates of LBW than non-tribal women at gestational ages close to 40 weeks.

Neonatal mortality varied considerably with birth weight [Table 3]. As expected, babies born with lower weight died in higher percentages than those with higher birth weights. Almost no babies died if born with a weight of 2,500 g or higher. Stillborns had lower birth weights than babies that died later in the first month. The main cause of neonatal mortality was LBW, followed by sepsis and respiratory illness [Table 3a].

Mother's health was an important determinant of the pregnancy outcome. Those in poorer health, with fever or sickness, tended to have babies with lower birth weights, to have lost the pregnancy or to have a stillborn [Table 4]. This trend was also present if women were unable to perform daily physical activities.

The effect of mother's health was similarly reflected on their baby's outcome. Thus, among neonates that died early, we had 10–12% of mothers in poorer health and 18–19% of mothers unable to perform physical activities [Table 5].

Non-tribal babies' survival experience was worse than for tribal babies, with their Kaplan-Meier survival curve entirely below the one for tribal babies [Figure 3a]. The picture is almost the reverse for morbidity, with tribal babies getting sick earlier than non-tribal babies [Figure 3b].

Table 2: Pregnancy outcomes, neonatal mortality and neonatal morbidity outcomes by type of community

	Tribal	Non-tribal
Number of pregnant women analyzed	860	913
Pregnancy outcomes		
Not available – still pregnant	289	348
Miscarriage, abortion	7	3
Still born	22	17
Live birth	542	545
Twins	9	7
Neonate health status (% sick)		
Day 1	15.3	15.7
Day 7	18.3	15.7
Day 28	9.6	7.7
Month 2	5.7	10.2
Month 4	3.7	4.7
Neonate mortality (number deaths)		
Day 1	7	8
Day 7	5	6
Day 28	4	6
Month 2	2	4
Month 4	2	1

Table 3: Neonatal outcome by birth weight categories

	Total	<1,000 g	1,000–1,499 g	1,500–1,999 g	2,000–2,499 g	2,500 g+
No. of still births	39	0	1 (2.6)	24 (61.5)	13 (33.3)	1 (2.6)
No. of live births	1,087	0	0 (0.0)	10 (0.9)	302 (27.8)	775 (71.3)
Deaths at day 1	15	0	1 (6.7)	7 (46.6)	6 (40.0)	1 (6.7)
Deaths at day 7	11	0	1 (9.2)	5 (45.4)	5 (45.4)	0 (0.0)
Deaths at day 28	10	0	0 (0.0)	4 (40.0)	6 (60.0)	0 (0.0)

Table 3a: Cause of neonatal death by birth weight categories

	Total	<1,000 g	1,000–1,499 g	1,500–1,999 g	2,000–2,499 g	2,500 g+
Low-birth weight	20	0	1	10	9	0
Sepsis	5	0	0	2	2	1
Acute respiratory illness	5	0	0	3	2	0
Birth asphyxia	2	0	1	0	1	0
Pre-term	2	0	0	1	1	0
Jaundice	1	0	0	0	1	0
Sudden death	1	0	0	0	1	0

Table 4: Distribution of mother and pregnancy characteristics by pregnancy outcome

|	Live birth of normal weight	Live birth of low weight	Miscarriage or abortion	Stillbirths
Age (mean ± SD)	23.2 ± 3.2	22.6 ± 2.9	23.0 ± 3.0	23.0 ± 2.7
BMI (mean ± SD)	21.5 ± 2.8	20.9 ± 2.8	21.0 ± 3.2	21.3 ± 2.8
Gravidity (mean ± SD)	1.97 ± 1.1	1.71 ± 1.1	1.91 ± 1.1	1.85 ± 1.1
Parity (mean ± SD)	0.86 ± 1.0	0.64 ± 1.0	0.81 ± 1.0	0.77 ± 1.0
Mothers with poor health (fever and/or morbidity)	25.2%	32.0%	29.2%	39.4%
Mothers with inability to perform physical activities	15.3%	17.7%	33.6%	35.2%
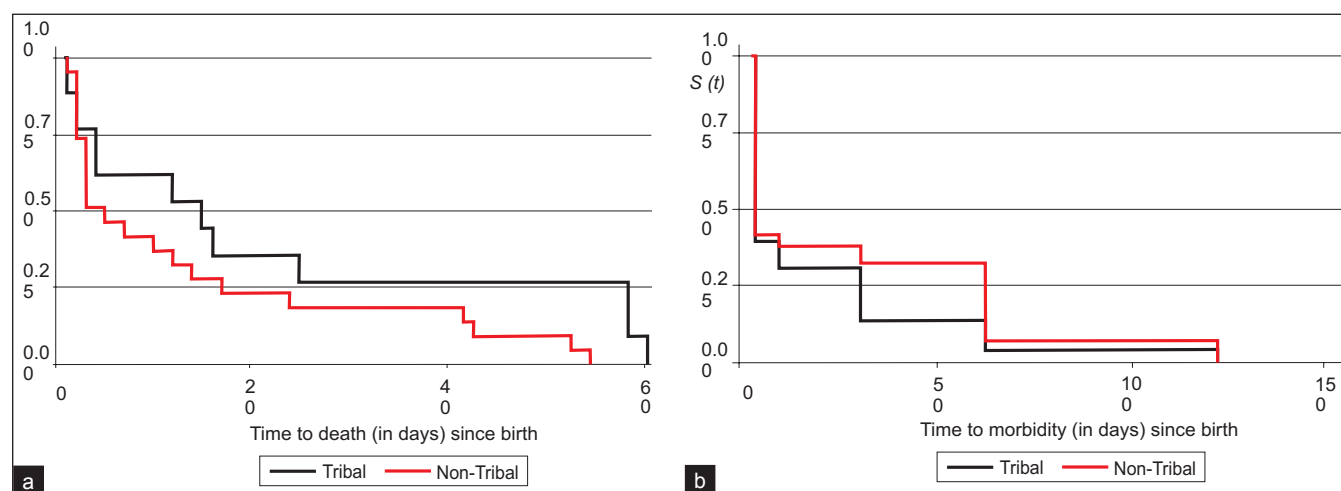
Figure 3: Kaplan-Meier estimate of time to (a) mortality and (b) morbidity, by location, from birth to 4 months

Table 5: Distribution of mother and pregnancy characteristics by neonatal outcome

	Deaths by day 1 (%)	Deaths by day 7 (%)	Deaths by day 28 (%)	Sick during the first month (non-fatal) (%)
Age of mother (mean ± SD)	22.7 ± 2.8	22.5 ± 3.0	22.4 ± 2.6	23.0 ± 3.0
BMI of mother (mean ± SD)	20.9 ± 3.2	21.0 ± 3.2	21.0 ± 3.2	21.0 ± 3.2
Gravidity (mean ± SD)	1.8 ± 1.1	1.6 ± 0.9	1.9 ± 1.1	1.9 ± 1.1
Parity (mean ± SD)	0.7 ± 1.2	0.5 ± 0.9	0.7 ± 0.9	0.2 ± 0.4
Mothers with poor health (fever and/or morbidity)	10.0	12.1	7.4	28.1
Mothers with inability to perform physical activity	17.9	18.9	12.5	21.9
Birth characteristics				
Did not cry	50.0	0.0	0.4	2.5
Convulsions	0.0	0.2	0.6	4.5
Vomiting	50.0	0.5	1.0	2.1
Not able to take feed	50.0	3.4	1.1	12.8
Sluggish	0.0	0.1	0.7	1.3
Low-birth weight	50.0	71.3	43.1	28.6
Sepsis	0.0	14.8	5.2	14.3
Birth asphyxia	0.0	8.8	8.6	7.1
"Sick" baby	9.5	16.8	9.8	5.9

The unadjusted relative risks for mortality reflect what was seen in the descriptive analyses, namely that there is a strong risk for neonatal death if there is a pre-term delivery and that sepsis and birth asphyxia are the main causes of neonatal deaths [Table 6]. This was true for both tribal and non-tribal women. For morbidity, the strongest associations were seen for pre-term delivery, non-immunization of the mother against tetanus, non-supplementation of Iron and Folic Acid (IFA) to mother, delay in initiation of breastfeeding, sepsis and birth asphyxia. In addition, the morbidity of tribal babies was very strongly associated with unhygienic cord care practices. Large and joint family practices were associated with increased neonatal morbidity.

After adjustment using multiple linear logistic regression, the most important factors related to mortality differed between tribal and non-tribal babies. The mortality of non-tribal babies was most strongly associated with pre-term delivery only, and marginally with neonatal morbidity and high parity [Table 7]. For tribal babies, mortality was also strongly associated with pre-term delivery, but was also associated with maternal morbidity and delay in initiation of breastfeeding. Pre-term delivery was still strongly associated with neonatal morbidity in both tribal and non-tribal women, and differences between these groups was not as marked – with the following practices strongly associated with morbidity: joint family, delay in initiation of breastfeeding, inadequate number of visits for ANC and non-immunization of the mother against tetanus. The main difference between the groups was that unhygienic cord care practices was important for tribal babies' morbidity, while maternal illiteracy was for non-tribal babies.

Sepsis has been shown previously to be one of the important causes of neonatal mortality in this region.[7] In order to investigate sepsis further, in this study, C-Reactive Protein (CRP) testing was carried out in a total

Table 6: Unadjusted relative risks (with corresponding 95% confidence intervals and *P*-values) for neonatal morbidity and mortality by locality*

Variable	Morbidity						Mortality					
	Tribal			Non-tribal			Tribal			Non-tribal		
	RR	95% CI	*P* value	RR	95% CI	*P* value	RR	95% CI	*P* value	RR	95% CI	*P* value
Maternal illiteracy							1.7	1.0–2.8	0.0436			
High parity										1.9	1.0–3.6	0.0534
Pre-term delivery	1.9	1.6–2.2	0.0001	1.7	1.5–2.0	0.0001	4.9	2.6–9.2	0.0001	7.8	4.1–15.1	0.0001
Non-immunization of the mother against tetanus	3.6	2.0–6.6	0.0001	5.3	3.0–9.4	0.0001						
Non-supplementation of IFA to the mother	1.9	1.2–3.1	0.0014	1.8	1.3–2.4	0.0001						
Short stature of the mother	1.3	1.0–1.7	0.0292									
Low-birth weight										2.1	0.9–4.5	0.0683
Inadequate number of antenatal clinic visits	0.8	0.7–1.1	0.0847	1.3	1.2–1.7	0.0001						
Delay in initiation of breastfeeding	2.2	1.7–2.7	0.0001	2.4	2.0–2.9	0.0001	2.6	1.0–7.1	0.0468			
Unhygienic cord care practices	2.6	2.0–3.3	0.0007									
Neonatal morbidity							4.5	1.1–18.6	0.0197			
Sepsis	3.3	3.0–3.8	0.0001	3.2	2.9–3.6	0.0001	3.3	3.0–3.8	0.0001	3.0	2.7–3.3	0.0001
Birth asphyxia	3.0	2.7–3.3	0.0001	2.9	2.7–3.2	0.0001	3.0	2.7–3.3	0.0001	3.0	2.7–3.3	0.0001
Joint family	1.4	1.1–1.7	0.0027	1.3	1.1–1.6	0.0027						
Large family size				1.2	1.0–1.5	0.0208						

*Only statistically significant variables are reported; IFA: Iron folic acid

Table 7: Adjusted odds ratios (with corresponding 95% confidence intervals and *P*-values) for neonatal mortality and morbidity, from multiple linear logistic regressions, by locality*

Variable	Morbidity						Mortality					
	Tribal			Non-tribal			Tribal			Non-tribal		
	OR	95% CI	*P* value	OR	95% CI	*P* value	OR	95% CI	*P* value	OR	95% CI	*P* value
Maternal illiteracy				1.7	1.0–2.9	0.071						
Unhygienic cord care practices	10.2	1.2–86.2	0.033									
Non-immunization of the mothers against tetanus	4.0	2.2–7.3	0.0001	7.5	3.9–14.1	0.0001						
Inadequate number of visits for antenatal care	1.5	1.1–2.1	0.033	1.6	1.2–2.2	0.001						
Delay in initiation of breastfeeding	4.1	1.9–8.1	0.0001	6.0	2.0–18.0	0.001	3.1	0.9–10.1	0.073			
Pre-term delivery	2.6	1.9–3.6	0.0001	2.2	1.6–3.1	0.0001	6.2	3.1–12.7	0.0001	10.3	5.0–21.2	0.001
Neonatal morbidity										2.1	1.0–4.3	0.047
Maternal morbidity							2.7	1.4–5.4	0.004			
High parity										2.1	1.0–4.4	0.065
Joint family	1.5	1.1–2.1	0.009	1.6	1.2–2.1	0.004						

*Only statistically significant variables are reported

of 96 suspected sepsis cases (newborns). This includes 57 tribal and 39 non-tribal cases. Of these, approximately one-third, i.e. 32/96 (19/57 tribal and 13/39 non-tribal), were confirmed cases with a positive blood culture. Common organisms found among these confirmed sepsis cases were:

Tribal: Klebsiella (5/19), *E. coli* (5/19), *Streptococcus pneumoniae* (5/19) and *Staphylococcus aureus* (4/19) and

Non-tribal: *Staphylococcus aureus* (4/13), *E. coli* (4/13), *Streptococcus pneumoniae* (3/13) and Klebsiella (2/13).

Discussion

The NDSS is the first population-based prospective study of rural and tribal communities in India that focused on a cohort of pregnant women and their neonates and followed them through their 4th month of life. As such, it enables comparison over time of neonatal morbidity and mortality across different types of communities, especially providing information about tribal communities, an understudied and poorly accessible subgroup of the population but one with substantial inequality in healthcare access. As a

prospective study, the NDSS also is able to measure community, household and mother characteristics that may be related to neonatal outcome and to, thus, enable proposing interventions based on identified and modifiable risk factors. As a probability sample of a rural district in central India, it is also representative of the situation in many rural communities elsewhere in India and possibly in other poor countries.

The NDSS results of the first year confirm expectations that neonatal mortality is strongly related to pre-term delivery, in both tribal and non-tribal women. Our study's findings for morbidity showed that tribal women's babies experience higher sickness based on mothers' practices – delay in initiation of breastfeeding, unhygienic cord care practices, inadequate number of visits for ANC and non-immunization of the mother against tetanus. Some of these may be attributed to the fact that tribal women have less ready-access to healthcare facilities than non-tribal women. An interesting finding was that living in a joint family was associated with increased morbidity.

Our results on the types and timing of neonatal deaths are similar to those reported in rural communities in other states of India, with sepsis and birth asphyxia being the main reasons, coupled with LBW.[14,15] One of the unique features of this study was the in-depth study of sepsis cases among the neonates. This is the first study conducted in this region, where a reference laboratory was set up in the field practice area and an attempt was made to identify the load of sepsis in tribal and non-tribal communities and where clinical evidence was further supported with laboratory diagnosis. The importance of these findings can be gauged from the fact that because of such support only, early detection and proper treatment of 32 sepsis cases was made possible.

The district of Nagpur, in the central Indian state of Maharashtra, has nearly a 14% tribal population.[8] The infant mortality rate in tribal areas of the state is reported to be 110 per 1,000 births, while in the state of Maharashtra it is reported to be 32–59 per 1,000.[8,11] In our studied communities, we found a much higher neonatal mortality, with 73 per 1,000 in both non-tribal and tribal communities. The value of any surveillance system is that it can provide ongoing information useful to identify outbreaks, high-risk population subgroups and regional or community differences over time, not only in outcome rates but also of problems in the healthcare system. The disadvantage is the requirement for institutionalizing such information gathering and, thus, for the financial, personnel and training support to carry out this activity. Our methodology, based on adhering to international standard guidelines,[12] is one that is applicable in other settings, and provided us with comprehensive prospective follow-up data on a timely basis.

One can thus study hard-to-reach tribal communities following similar methods as our methodology. Tribal communities have inequalities in health care due to the distances that they have to travel. The rates for neonatal sickness and mortality were higher than those for other rural communities.

India's policy makers and health workers have recognized that saving the lives of newborn babies does not require enormous resources or complicated expertise.[16] Several approaches have offered evidence that rates of neonatal deaths can be successfully reduced by offering community healthcare workers new skills in home visiting, counselling young mothers and families, home-based neonatal care and teaching even those with little formal education about detection and prompt referral of sick children.[3,10]

One of the biggest challenges in implementing any strategy across communities in India is to reach them, especially tribal areas with poor infrastructure, lack of human resources and different cultural norms.[10] In fact, we had a 10% overall loss to follow-up in our study, 12.2% in tribal versus 7.7% in non-tribal communities. Most of these were due to migration – it is a custom for women to go to their native area and family for giving birth, such that outcome is only available on a reduced number – we do not anticipate this missing information to be informative or to bias the results, but it is a study limitation that needs to be mentioned when studying these populations.

The NDSS has provided valuable information on the potentially modifiable factors associated with increased likelihood of neonatal mortality and morbidity. The next actions being undertaken by the NHRI are developing, implementing and evaluating the effectiveness of community-based interventions to reduce the high rate of neonatal mortality and morbidity in the rural areas of India. Recent interventions have shown promising results from the socioculturally contextualized, community-based intervention of Kumar and colleagues,[17] which targeted high-risk newborn-care practices and showed that one can substantially modify behavior and thus reduce neonatal mortality. According to the Indian Council of Medical Research and its Young Infant Study Group, the first 3 days of life are the most hazardous phase in the life of a neonate.[2] Health programs for reducing the burden of neonatal morbidity and mortality are thus essential and must be based on evidence from well-conducted prospective studies, such as the NDSS.

Acknowledgment

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