

Differential and Determinants of Neonatal Mortality: A Comparative Study in Northern and Southern Regions of India

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Abstract

Background: The Government of India initiated different programs to reduce neonatal mortality. However, the variability of neonatal deaths occurs among states of India. **Objective:** This study aimed to identify the differential determinants associated with neonatal deaths in northern and southern regions of India. **Materials and Methods:** Bivariate analysis and Cox regression analysis have been performed to evaluate the predictors of neonatal mortality from National Family Health Survey (NFHS-4) data. **Results:** For neonatal mortality, mother and child factors became more consistent in the southern region than northern regions of the country, while household factor was almost the same in both regions of India. **Conclusions:** Primary intervention is also required to reduce public health problem as neonatal mortality. It should be focused on education of mother, birth interval, age at birth, antenatal care, poverty reduction programs, and proper health facility to pregnant mothers.

Keywords: Cox regression, India, neonatal mortality, northern regions, southern regions

INTRODUCTION

In the world approximately 130 million infants born annually and more than 4 million infants die within first 28 days of life^[1] and most of deaths occur in low and middle income countries.^[2] Last 30 years, the diminution in neonatal mortality rates had been found slower as compared to under-five and child mortality rates.^[3,4] A study indicates that community education has a significant positive effect on child mortality in northeastern India. The study unfolds that community education effect is more than maternal factors on child mortality.^[5] Socioeconomic factors such as place of residence, woman's education, and economic condition are known as full power determinants of infant and child mortality.^[6] It has investigated the positive effect of mother's education on child survival.^[7] Gender disparity in health and education is higher in South Asian countries than anywhere else in the world. The various differentials and determinants of neonatal and infant mortality rates were estimated in rural southern states of India. The trend and pattern were also found which are based on household survey data.^[8] The under-five and neonatal mortality rates of different districts of India were analyzed to explore the district-level variability in neonatal and under-five mortality

with the reference of Sustainable Development Goal 3 and National Family Health Survey (NFHS-4).^[9] A study has been done to identify the cause of under-five mortality at national, regional, and state levels in India.^[10]

It has found spatial contours where poverty, infant, under-five mortality, and child malnutrition are clustered. The factor of geographical regions influences child nutrition and infant and under-five mortality in India.^[11]

In India, around one million babies die every year before completing their 1st month of life, contributing to one-fourth of the global burden. South-North differences in neonatal mortality exist with the mortality rate higher in North as compared to South India from NFHS-4.^[12] The frequent causes of neonatal deaths in India include infections, birth asphyxia, and prematurity. Henceforth, the present study aims to explore

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How to cite this article: Patel KK, Kumar M. Differential and determinants of neonatal mortality: A comparative study in Northern and Southern Regions of India. *Indian J Community Med* 2021;46:405-10.

Received: 31-05-20, **Accepted:** 22-04-21, **Published:** 13-10-21

Access this article online

Quick Response Code:



Website:
www.ijcm.org.in

DOI:
10.4103/ijcm.IJCM_425_20

the specific factors that affect neonatal mortality in northern and southern states of India.

MATERIALS AND METHODS

The study used the data of NFHS-4, which is available in public domain and based on national representative sample of 699,686 women aged 15–49 years and 112,122 men aged 15–54 years from all 36 states. A principal objective of the survey has been to provide information about the estimates of fertility family planning, reproductive and child health, infant and child mortality, nutrition of women and children, the quality of health and family welfare services, and socioeconomic conditions. The northern and southern states of India were divided geographically. Moreover, the states of southern part (Andhra Pradesh, Telangana, Karnataka, Kerala, and Tamil Nadu) and northern states (Delhi, Haryana, Himachal Pradesh, Jammu Kashmir, Punjab, Uttar Pradesh, and Uttarakhand) are included in the study in Figure 1. Bivariate analysis has been applied to check the association of the covariates. Cox regression analysis is used to obtain the risk of an infant dying before completing 4 weeks of their life. The dependent variable in the model is neonatal death in neonatal period in Figure 2.

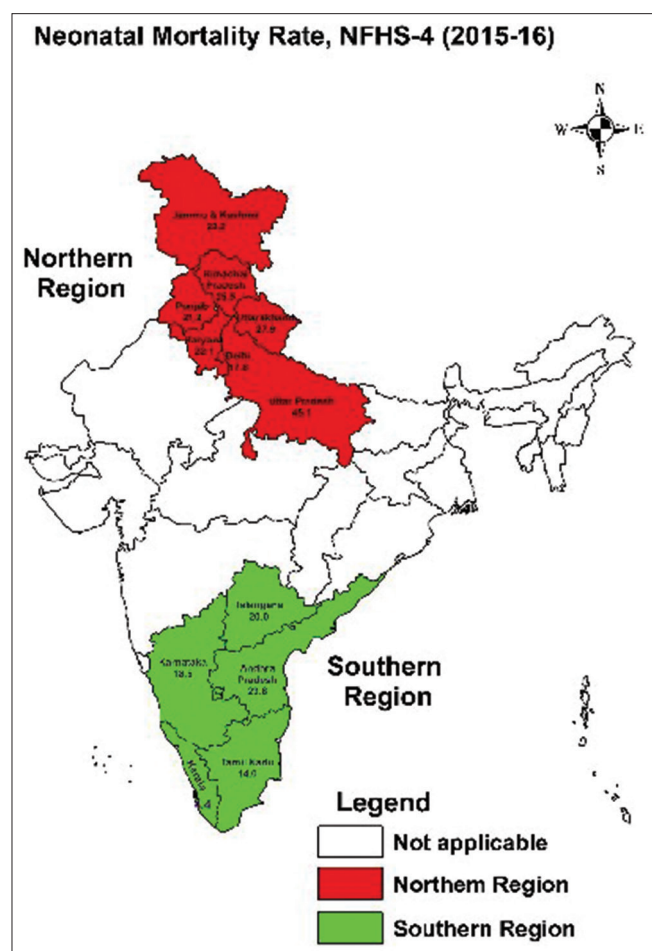


Figure 1: Prevalence of neonatal mortality rate in northern and southern states of India

RESULTS

Prevalence of neonatal mortality in southern and northern regions of India

Mother factors

Mother factors include mother education, occupation, institutional delivery, and age at first birth. In North India, illiterate women experience more neonatal deaths. The neonatal mortality is higher among noninstitutional delivery as compared to institutional delivery. Mother age at first birth after 20 years was less likely to have neonatal mortality than before 20 years in northern states. In general, southern states of India had less neonatal mortality among all the background characteristics except occupation one [Table 1].

Child factors

Neonatal mortality was high in <2 years of birth interval in northern states of India. Neonatal mortality was high in northern India as compared to southern India. When the birth size of the baby was very small, neonatal mortality was high in North India compared to South India. Neonatal mortality was very high among currently nonbreastfed children than breastfed children in both South and North India. Furthermore, high neonatal mortality was observed in male children in both South and North India. Although, birth-interval, birth size, child sex, and breastfeeding were the most important predictors of neonatal mortality in both southern and northern states of India, which was statistically significant at 5% level of significance [Table 1].

Household factors

Neonatal mortality was significantly high among poor- and middle-class families, while this mortality was substantially equal in average economic family in both northern and southern India. There was a vast disparity in neonatal death between rural and urban areas. Results also show high mortality

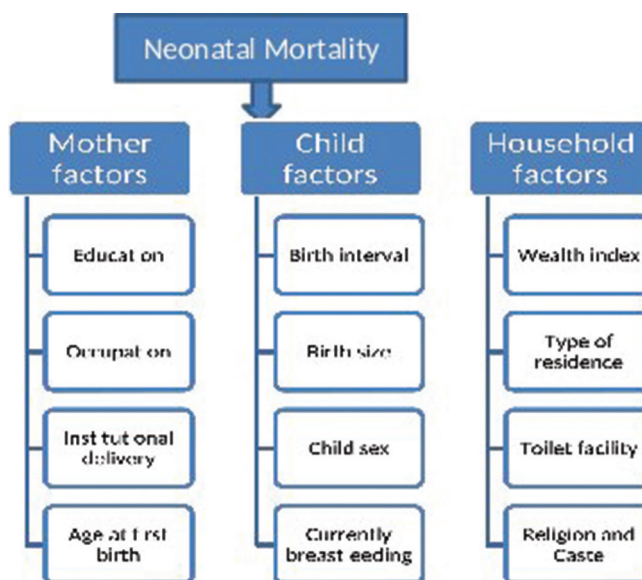


Figure 2: Factors associated with neonatal mortality

Table 1: Differential determinants of neonatal mortality (per 1000 live birth) by mother, child, and household factors in southern and northern regions of India (2015-2016)

Background characteristics	Southern regions (n=752)	Northern regions (n=2394)
	n (%)	n (%)
Mother factors		
Education		
Not educated	180 (31.4)*	1041 (44.9)*
Educated	572 (14.7)	1352 (34.2)
Occupation		
Not working	711 (16.6)	2330 (38.2)
Working	41 (21.0)	64 (36.9)
Institutional delivery		
Not institutional	64 (31.8)*	751 (43.3)*
Institutional	688 (16.1)	1642 (36.2)
Age at first birth (years)		
<20	325 (16.5)	1198 (43.0)*
>20	427 (17.1)	1195 (34.3)
Child factors		
Birth interval (years)@		
<2	139 (18.2)	700 (52.2)*
>2	245 (15.2)	799 (28.6)
Birth size		
Average and larger	495 (12.3)*	1748 (33.0)*
Small and very small	222 (51.6)	641 (66.2)
Child sex		
Male	447 (19.3)*	1359 (41.0)*
Female	305 (14.2)	1035 (35.0)
Currently breastfeeding		
No	517 (23.8)*	1549 (66.7)*
Yes	235 (10.2)	845 (21.4)
Household factors		
Wealth index		
Poor	244 (27.1)*	1323 (47.6)*
Middle	274 (21.5)	484 (42.4)
Rich	234 (10.2)	587 (24.9)
Type of residence		
Urban	200 (10.7)*	490 (28.6)*
Rural	552 (21.2)	1903 (41.7)
Toilet facility		
No facility	371 (25.1)*	1241 (47.1)*
Facility	381 (12.8)	1152 (31.7)
Caste		
SC/ST	289 (22.8)*	679 (38.2)*
OBC	370 (14.6)	1236 (41.8)
General	73 (14.9)	440 (31.9)
Religion		
Hindu	648 (17.9)*	1861 (39.4)*
Muslim and others	104 (12.3)	533 (34.2)

* Significant ($p < 0.001$), @ First births are excluded

among SC/ST in northern India whereas, in southern India, it was significantly high in other backward classes. Households with toilet facility show less mortality as compared to the

households without toilet facility. Neonatal mortality is more in rural and SC/ST families than the counterpart. Respondents belonging to Hindu religion were more mortality than Muslim and other religions [Table 1].

Cox regression analysis for neonatal mortality

Factors associated with mother factors

The results of the Cox regression models revealed that mother's education was highly responsible (hazard ratio [HR] = 0.57 [0.44–0.71], HR = 0.81 [0.74–0.87]) for neonatal mortality in South and North India, respectively. In working women, the risk of neonatal mortality was higher (HR = 1.18 [0.80–1.74], HR = 0.85 [0.67–1.06]) compared to those who were not working in southern and northern states, respectively. The chances of neonatal mortality were more in noninstitutional delivery of mothers as compared to institutional delivery (HR = 1.01 [0.67–1.48], HR = 1.03 [0.94–1.11]) in southern and northern states, respectively. The risk of neonatal mortality was also higher in mothers who were below 20 years of age at first birth as compared to the age of mothers above 20 years (HR = 1.13 [0.92–1.37], HR = 0.89 [0.82–0.96]) in South and North India, respectively [Table 2].

Factors associated with child factors

The risk of neonatal mortality was lower in children born above 2 years of birth interval (HR = 0.69 [0.51–0.91], HR = 0.60 [0.54–0.66]) in both southern and northern regions of India. Children who were having small or very small birth size (HR = 4.57 [3.38–6.16], HR = 2.30 [2.06–2.56]) were four times and two times higher risk than those having average size of birth in South and North India, respectively. The chances of neonatal mortality were more in male children (HR = 0.93 [0.69–1.22], HR = 0.91 [0.82–1.00]) in southern and northern states, respectively. Nonbreastfed children than breastfed children had more risk of mortality (HR = 0.63 [0.44–0.89], HR = 0.50 [0.44–0.55]) in South and North India, respectively [Table 2].

Factors associated with household factor

The risk of neonatal mortality was less among rich class families (HR = 0.48 [0.35–0.66], HR = 0.59 [0.52–0.66]) in South and North India, respectively. The risk of neonatal mortality was higher in rural areas as compared to urban areas (HR = 1.09 [0.85–1.38], HR = 1.04 [0.93–1.16]) in southern and northern states, respectively. The risk of neonatal mortality was higher among SC/ST and other backward classes (OBC) as compared to general category (HR = 0.80 [0.64–0.98], HR = 1.09 [0.99–1.19]) in southern and northern states, respectively. Households with toilet facility have less risk as compared to the households without toilet facility (HR = 0.94 [0.73–1.19], HR = 0.98 [0.88–1.08]) in southern and northern states, respectively. The risk of neonatal mortality was higher among Hindu religion families (HR = 0.88 [0.65–1.19], 1.01 [0.92–1.10]) as compared to Muslim and other religions in southern and northern states, respectively [Table 2].

Table 2. Cox regression analysis for neonatal mortality by mother, child, and household factors in southern and northern regions of India (2015-2016)

Background characteristics	Northern regions																								
	Southern regions				Northern regions				Northern regions																
	Mother factors		Child factors		Household factors		All factors		Mother factors		Child factors		Household factors		All factors										
	Model 1	HR	95% CI	Model 2	HR	95% CI	Model 3	HR	95% CI	Model 4	HR	95% CI	Model 1	HR	95% CI	Model 2	HR	95% CI	Model 3	HR	95% CI	Model 4	HR	95% CI	
Mother factors																									
Education																									
Not educated [®]	1.00																								
Educated	0.57***	0.44-0.71																							
Occupation																									
Not working [®]	1.00																								
Working	1.18	0.80-1.74																							
Institutional delivery																									
Not institutional [®]	1.00																								
Institutional	1.01	0.67-1.48																							
Age at first birth (years)																									
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Child factors																									
Birth interval (years)																									
<2 [®]	1.00																								
>2	0.69***																								
Birth size																									
Average and larger [®]	1.00																								
Small and very small	4.57***	3.38-6.16																							
Child sex																									
Male [®]	1.00																								
Female	0.93	0.69-1.22																							
Currently breastfeeding																									
No [®]	1.00																								
Yes	0.63***	0.44-0.89																							
Household factors																									
Wealth index																									
Poor [®]	1.00																								
Middle	0.85	0.66-1.07																							
Rich	0.48***	0.35-0.66																							
Type of residence																									
Urban [®]	1.00																								
Rural	1.09	0.85-1.38																							

Contd...

Table 2: Contd...

Background characteristics	Southern regions						Northern regions									
	Mother factors		Child factors		Household factors		All factors		Mother factors		Child factors		Household factors		All factors	
	Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Toilet facility																
No facility [®]			1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Facility			0.94	0.73-1.19	1.01	0.69-1.47					0.98	0.88-1.08	0.96	0.84-1.09		
Caste																
SC/ST [®]			1.00		1.00		1.00		1.00		1.00		1.00		1.00	
OBC			0.80**	0.64-0.98	0.93	0.67-1.27					1.09**	0.99-1.19	1.09	0.97-1.22		
General			0.94	0.65-1.35	1.07	0.62-1.83					0.91	0.81-1.02	0.78***	0.70-0.87		
Religion																
Hindu [®]			1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Muslim and others			0.88	0.65-1.19	0.88	0.57-1.36					1.01	0.92-1.10	0.96	0.85-1.08		

P<0.10; **P<0.05; ***P<0.01; [®]Reference category. HR: Hazard ratio, CI: Confidence interval

DISCUSSION

This is a comparative study between the northern and southern regions of India.

Neonatal mortality is high in the northern region than the southern part of India. The study shows that acute respiratory infections, diarrhea, measles, and malaria are the probable causes of neonatal mortality.^[12] Deaths from diarrhea are much less frequent than for children under-five and measles and malaria are extremely rare in neonatal age group.^[13] This study has also indicated that mother's age at first birth is significantly associated with neonatal mortality in both North and South India after adjustment of child and household factors. A study has highlighted the findings which indicate that maternal age differentials have a significant association with neonatal mortality or preterm birth and low birth weight after adjustment for socioeconomic status or other control variables.^[14]

Average and larger birth size is strongly associated with neonatal mortality after adjustment for mother and household factors. This mortality is just half in the northern region while around 70% less in average and larger birth size of children, i.e., death in small birth size, is higher than the average and larger size in the southern region of India. This finding is supported by other literatures that have identified low birth weight as reliable predictors of neonatal mortality.^[2] A study in Bangladesh reported that approximately 75% of neonatal deaths associated with low birth weight were accredited to preterm birth rather than small for gestational age infants.^[14,15] The sex of neonates does not have a significant association with odds of dying but has more mortality in male children than females. Although, the results of this study are contradicted by some other studies which indicate that females had lower odds of mortality than males during the 1st month of life.^[16] This increased odd may also be due to the large proportion of neonatal deaths happening in the initial week, which is the time when sex differences in neonatal mortality are more pronounced. The biological factors that have been concerned with this increased risk of neonatal deaths in male infants include immunodeficiency increasing the risks of infectious diseases in men, late maturity^[17] resulting in a high prevalence of respiratory diseases in males, and congenital malformations of the urogenital system.

Birth interval is significantly high in both northern and southern parts of India, supported by some more studies^[18-20] which indicate a strong association between short preceding birth interval and risk of neonatal death. Similarly, in this study, a higher birth interval provides lower odds than the lower birth interval. This could be connected to maternal depletion syndrome and resource contention between siblings, in addition to a deficiency of care and attention experienced by high-ranked infants.^[19,20]

Some of the existing studies have also shown that maternal occupation outside the home significantly increased the odds of neonatal death. Maternal contribution in the labor force may have harmfully affected the care provided to the newborn.

Infrequent breastfeeding practiced by infants born to working mothers has been reported to increase the odds of neonatal death.^[21] This study has also indicated that currently breastfed children have significantly less experienced neonatal death in both northern and southern regions of India. This mortality is higher in rural, poor households and the house having no toilet facility. The neonatal mortality is the same among the educated mothers, while it was varied significantly in illiterate women between North and South India. Neonatal mortality is higher among female workers as compared to nonworking women in both North and South India. It might be due to the majority of women worked in the nonformal sector that is unskilled labor. More pronounced neonatal death differential is observed with a higher proportion of mortality when the birth size was very small. Neonatal mortality is the same in <2 years of the birth interval in both North and South India. A higher proportion of neonatal mortality was observed in North India when child factors were taken into account. Wealth index had a negative association with neonatal mortality in both North and South India. Deaths were more concentrated in a rural area in both South and North India. Further, neonatal mortality is lower in households with toilet facility, general caste, and in Hindu women than the counterpart.

CONCLUSION

For neonatal mortality, mother and child factors became more consistent in the southern region than northern regions of the country, while household factor was almost the same in both regions of India. Primary intervention is also required to reduce public health problem neonatal deaths. It should be focused on education of mother, birth interval, age at birth and antenatal care, and poverty reduction programs. It should be reduced delivery complications of pregnant mothers through proper health facility.

Acknowledgment

The authors would like to thank the editor in chief Dr. Pradeep Kumar and learned referee for their suggestions to improve the quality of contents of the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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