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Original Research Article

Determinants of Infant Mortality in India

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ABSTRACT

Background: India has experienced an impressive decline in infant death since the 1970s. From 130-140 deaths per 1,000 live births in the early 1970's to 41 deaths per 1,000 live births in 2013.
Objective: The prime objective of this analysis is to explore the differential and determinants of IMR at present in India.
Methods: NFHS-3 India, 2005-06 data used. To identify determinants of Infant death bivariate analysis followed by multivariate analysis was performed. The appropriate sampling weight was supplemented to perform the whole analysis.
Results: The finding suggests that hazard of death was about 28% (95% CI=1.13-1.44) higher only among women from Central region, but similar to other regions when compared to North region. Hazard of infant death was highest among women with parity more than 5 (HR=1.29, 95% CI=1.08-1.55) as compared with women with parity two or less. Working status and empowerment of women was significantly reducing infant death. Child bearing in adolescent's age and shorter spacing were the great risk of infant deaths.
Conclusion: In order to bring further quick improvement, country needs to focus more to raising marriage age, bringing attitudinal change of lesser children with adequate birth spacing by promoting contraceptive awareness and making aware and access of MCH services regionally, specially, to the states of Odisha, Uttar Pradesh, Bihar, West Bengal, Rajasthan and Madhya Pradesh that constituting nearly half of the country population.

Keywords: Infant mortality, birth order, birth interval, parity, hazard, multivariate.

INTRODUCTION

The Millennium Development Goals (MDGs) led the government of India to better planning and implementing more intensive policies and programs. The fourth goal of MGD was to focus on reduction of Child Mortality being a major issue for any nation. [1] During nineties, in India the infant mortality rate (IMR) that was major contributor to child mortality was 80 per 1,000 live births that reduced by half i.e. 40 per 1,000 live births by 2013. [2] The high IMR is the consequence of neonatal mortality that still contribute about half of the total infant deaths. Encouraging achievement in IMR is seen and as per trend it is likely to reach 39 during 2015 as against fixed target of 27 for the year. [3-6] In 2013, neonatal mortality rate was 28 ranging from 15 in urban areas to 31 in rural areas and was contributing 68% of the total infant death. [7] Only in six major states such as Odisha, Uttar Pradesh (UP), Bihar, West Bengal, Rajasthan and Madhya Pradesh (MP) constituting nearly half (45.4%) of the

country population, neonatal mortality rate is very high ranging from lowest in West Bengal (21) to highest in Odisha (37) and MP (36) as against only 6 in Kerala**.** [8] Undoubtedly, for further quick reduction in IMR, neonatal deaths contributing much needs to be addressed**.** [9,10] IMR is a very sensitive indicator of health not only for children but also to mothers and economic development as well. High infant mortality is likely to increase rates of illness and putting pressure on health care delivery system. Continued reproduction process to replace the loss of child increases the economic loss that is involved during pre and post natal care and thus obviously affecting the health and economic development of the nation as a whole. Though, the target of IMR fixed till 2015 could not be achieved, but the sharp decline in the recent years is likely to narrow the gap between the achievement and the target The policy makers always are in search of pockets with high IMR and the influencing factors so as need based feasible and cost effective policies can be formulated to achieve the maximum reduction to fulfill the target. Hence, it becomes pertinent to identify the influencing factors of IMR. Since NFHS-III provides nationwide data covering exhaustive number of characteristics, therefore, the present analysis was taken up to identify the influencing factors affecting IMR, so as a concrete suggestion on modifiable characteristics can be delivered to the policy makers.

MATERIALS AND METHODS

Present study utilizes data of third round National Family Health Survey (NFHS-III) conducted during 2005–06 under the stewardship of Ministry of Health and Family Welfare, Government of India. [11] International Institute for Population Sciences, Mumbai, being the nodal agency had involved 18 Research Organizations to conduct nationwide survey work for more than 230,000 women aged 15-49 and the men aged 15-54. In addition, more than 100,000 women and men for HIV and more than 200,000 adults and young children for anemia were also tested. NFHS-III enables to measure and compare state and nation wise trend of family welfare programs e.g. fertility, family planning practices, infant and child mortality, maternal and child health and utilization of MCH services. The present analysis is concentrated to 108504 recorded births during the last ten years preceding the survey date. The variation in IMR was viewed according to demographic characteristics (age, birth order and parity, birth spacing, child sex), socio economic characteristics (religion, caste, mother's education, wealth index, mother's working status, exposure to mass media, and child birth place) and geographical location and cultural setting (place of residence, region of birth place and women's empowerment) as well. The reason behind to include region of child birth is to adjust the estimates for regional variation. [11] To identify determinants of Infant death initially bivariate analysis was performed with regional adjustment and then multivariate to identify the real contribution of the characteristics by isolating the confounding effects. The appropriate sampling weight has been supplemented to perform the whole analysis. The analysis was carried using R version 3.2.0 and SPSS version 20.0.

RESULTS

Table-1 presents the frequency distribution of mothers of infants for their background characteristics e.g. region & place of residence, religion, caste, wealth index, age & education, mass media exposure and working and empowerment status along with infant characteristics e.g. child sex, birth spacing, parity, birth order. Among the respondents surveyed, maximum (31.1%) were from eastern region and minimum from central region (3.9%) and rest from north, north-east, west and south varying "between" "13.0% to 21.9%". About 75% belonged to rural

areas with nearly 80% being Hindu and 75% SC/ST and OBC combined. Nearly half (49.0%) were falling to poorest or poorer wealth quintile. About 65% of women were not working only being house wife. Nearly one fifth of the mothers were below the age of 20 years and 41.2% were aged ≥ 25 years during survey time. More than half (55%) mothers had no formal education and only 12.2% were fully and majority (70.6%) partially empowered. Among the babies born 52% were male. More than 42.8% respondents had birth order between two to three and those who had experienced childbirth, 65% had mass media exposure. Majority of the respondent were of parity of 3-4 and about 80% of the mother's had a birth interval of less than two years.

Table-2 shows the association of IMR with background characteristics of mother and child. All of the background characteristics except women empowerment status and child sex were found significantly associated with IMR. Highest IMR (8.1) was in central region than all other regions and among rural (6.9), almost 1.5 times than urban (4.8). Among Hindus and Muslims IMR was nearly same around 6.0 compared to 5.0 among other religion group and in caste categories maximum was in ST (7.4) followed by SC (6.9) and OBC (6.5). As wealth quintile index increased, IMR decreased significantly from 8.0 among poorest to 3.4 among richest. Highest IMR (8.8) was recorded among the born to mothers < 20 years followed by 5.9 among 20-24 years and slightly less 5.7 among 25-49 years. IMR was significantly higher among mothers not exposed to mass media. Increasing level of education had shown significant decreasing trend of IMR; highest (7.6) among illiterates and lowest less than half (3.2) among high-school & above. In first and 4th or higher order births, IMR was higher than 2nd or 3rd order. As parity increased, IMR increased significantly from 3.9 among children of parity ≤ 2 to 9.6 among parity ≥ 5.

Table 1: Frequency and percentage distribution of background characteristics of 108504 infant's NFHS-3 (2005-06), INDIA.

Background characteristics	%	95% CI	Background characteristics	%	95% CI
Region of India			**Place of residence**		
North	13.5	12.1-16.1	Rural	74.6	73.1-76.2
Central	3.9	3.3-4.7	Urban	25.4	23.8-26.9
East	31.1	28.7-33.6	**Religion**		
North-East	21.8	19.5-24.4	Hindu	78.5	76.8-80.1
West	16.6	15.2-18.2	Muslim	16.9	15.3-18.6
South	13.0	11.5-14.7	Others	4.6	4.1-5.1
Caste			**Wealth Index**		
Others	27.2	25.8-28.6	Poorest	26.2	25.0-27.5
Schedule Caste	20.9	19.9-22.0	Poorer	22.8	22.0-23.6
Schedule Tribe	10.1	9.1-11.2	Middle	19.7	18.9-20.4
OBC	41.8	40.3-43.4	Richer	17.5	16.7-18.3
Age of mother (years)			Richest	13.8	13.0-14.7
Adolescent (15-19)	19.3	18.8-19.8	**Working Status**		
Middle Age (20-24)	39.5	39.0-40.0	Not Working	64.2	63.0-65.3
Old Age (25-49)	41.2	40.5-41.9	Working	35.8	34.7-37.0
Mass Media Exposure			**Mother's Education**		
No	34.3	33.0-35.7	Illiterate	55.2	53.8-56.5
Some	65.7	64.3-67.0	Literate but below Primary	7.10	6.80-7.50
Birth Interval (Years)			Primary but below Middle	13.4	12.9-13.9
≤2	80.2	79.7-80.7	Middle but below High School	10.4	9.9-10.9
>2	19.8	19.3-20.3	High School & above	13.9	13.2-14.6
Child Sex			**Women Empowerment**		
Female	48.2	47.8-48.6	No	17.2	16.5-18.0
Male	51.8	51.4-52.2	Partial	70.6	69.8-71.4
Birth Order			Full	12.2	11.6-12.7
1	28.8	28.3-29.3	**Parity**		
2-3	42.8	42.3-43.3	≤ 2	35.4	34.4-36.3
≥ 4	28.4	27.5-29.3	3-4	36.8	36.1-37.5
			≥ 5	27.9	26.8-28.9

***Weighted percentages calculated with 95% CI using complex sampling plan

Table 2: Association of infant mortality with background characteristics of the mother: Bivariate analysis, NFHS-3 (2005-06), INDIA

Background characteristics	N	IMR (%)	Background characteristics	N	IMR (%)
Region of India			**Place of residence**		
North	155638	5.7	Rural	891651	6.9
Central	358502	8.1	Urban	302842	4.8
East	251987	6.1		$\chi^2 = 157.231$, p = 0.000	
North-East	45102	6.3	**Religion**		
West	150098	5.1	Hindu	936569	6.5
South	191982	5.1	Muslim	201698	6.0
	$\chi^2 = 257.84$, p = 0.000		Others	54953	4.9
Caste				$\chi^2 = 26.14$, p = 0.002	
Others	315925	5.5	**Wealth Index**		
Schedule Caste	243465	6.9	Poorest	313426	8.0
Schedule Tribe	117331	7.4	Poorer	271760	7.2
OBC	48731	6.5	Middle	234973	6.5
	$\chi^2 = 61.50$, p = 0.000		Richer	209419	5.0
Age of mother (years)			Richest	164904	3.4
Adolescent (15-19)	229945	8.8		$\chi^2 = 443.28$, p = 0.000	
Middle Age (20-24)	472301	5.9	**Working Status**		
Old Age (25-49)	492239	5.7	Not Working	669640	5.8
	$\chi^2 = 258.23$, p =0.000		Working	524852	7.0
Mass Media Exposure				$\chi^2 =65.496$, p = 0.000	
No	402463	7.5	**Mother's Education**		
Some	792028	5.8	Illiterate	659045	7.6
	$\chi^2 = 120.70$, p = 0.000		Literate but below Primary	85219	6.7
Birth Interval (Years)			Primary but below Middle	159835	5.5
≤ 2	955276	5.0	Middle but below High School	124152	4.8
> 2	235784	11.9	High School & above	166240	3.2
	$\chi^2 = 1383.8$, p = 0.000			$\chi^2 = 474.42$, p = 0.000	
Child Sex			**Women Empowerment**		
Female	575908	6.2	No	205965	6.7
Male	618583	6.5	Partial	843123	6.2
	$\chi^2 = 2.43$, p = 0.241		Full	145403	6.9
Birth Order				$\chi^2 = 12.19$, p = 0.059	
1	343724	6.6	**Parity**		
2-3	511513	5.4	≤ 2	422363	3.9
≥ 4	339253	7.6	3-4	689275	6.2
	$\chi^2 = 158.42$, p = 0.000		≥ 5	332854	9.6
				$\chi^2 = 926.13$, p = 0.000	

***Weighted percentages calculated with 95% CI using complex sampling plan

Table-3 reveals the results obtained using Cox Proportional Hazard Model. Bivariate analysis indicated association of IMR with all the characteristics except working status of mother; while in multivariate analysis only region, wealth index, working status & empowerment of mother, age of mother, parity, birth order and birth spacing emerged significantly associated characteristics with IMR. The critic of India on poor nursing of female child born is now disproved; indicating mothers are not discriminating nursing of infants on the basis of sex of the child. Compared to born of North India, the hazard of death during infancy was 1.28 times higher (95% CI of HR: 1.13-1.44) among born of Central India; while almost similar to born of East, North-East, West and South. The hazard of death during infancy was found lesser by 30% (HR = 0.70; 95% CI; 0.61-0.80) among richer and by 50% among the richest (HR = 0.51; 95% CI: 0.42-0.63) but almost same to born of poorer and middle families, when compared with those born in the poorest families. The hazard of death was lesser by 20% among born to working mothers than non working (HR = 0.80; 95% CI; 0.75-0.88); similarly hazard of death of born during infancy was lesser by almost 20% among mothers either fully (HR = 0.83; CI: 0.72-0.95) or partially empowered (HR = 0.80; CI: 0.72-0.87) respectively. As age of mother was increasing, hazard of death during infancy compared to adolescent age mothers (15-19) was decreasing; the hazard rate to

infancy death was o.82 (CI: 0.74-0.91) and 0.64 (CI: 0.57-0.73) among mothers of middle (20-24) and old age (25-49) groups respectively. Compared to born of parity first, the hazard of death during infancy was 1.29 (CI: 1.08-1.55) times higher to those born of parity ≥ 5 while almost similar to of parity 3-4. The hazard of death to born of 2nd or 3rd order was lesser by 20% (CI: 0.72-0.88) but almost similar to ≥ 4th order compared to 1st order. Lesser was the birth spacing higher was the risk of infancy death; the hazard rate was lesser by 20% (HR = 0.82; CI: 0.73-0.89) among born with birth spacing more than 2 years compared to born with spacing ≤ 2 years.

Table 3: Adjusted & Unadjusted Hazard Ratio (HR) of Infant Mortality estimated using Cox Regression Model NFHS-3 (2005-06), India.

Covariates	Categories	Unadjusted Hazard Ratio	Adjusted Hazard Ratio	95% C.I.
Region	North	1.00	1.00	
	Central	1.46**	1.28**	1.13 - 1.44
	East	1.14	0.98	0.85 - 1.14
	North-East	1.13	0.99	0.84 - 1.18
	West	0.89	0.94	0.80 - 1.10
	South	0.88	0.87	0.75 - 1.01
Place of Residence	Urban	1.00	1.00	
	Rural	1.47**	1.09	0.98 - 1.20
Religion	Hindu	1.00	1.00	
	Muslim	0.94	0.90	0.81 - 1.01
	Others	0.74**	0.92	0.77 - 1.09
Caste	Others	1.00	1.00	
	Schedule Caste	1.27**	1.05	0.94 - 1.18
	Schedule Tribe	1.32**	1.07	0.93 - 1.23
	OBC	1.17**	1.00	0.90 - 1.11
Wealth Index	Poorest	1.00	1.00	
	Poorer	0.92	0.92	0.84 - 1.02
	Middle	0.81**	0.85	0.76 - 0.95
	Richer	0.64**	0.70**	0.61 - 0.80
	Richest	0.43**	0.51**	0.42 - 0.63
Mass Media Exposure	No	1.00	1.00	
	Some	0.82**	1.01	0.93 - 1.09
Working Status	Not Working	1.00	1.00	
	Working	0.95	0.81**	0.75 - 0.88
Women Empowerment	No	1.00	1.00	
	Partial	0.75**	0.80**	0.72 - 0.87
	Full	0.68**	0.83**	0.72 - 0.95
Age	Adolescent (15-19)	1.00	1.00	
	Middle Age (20-24)	0.78**	0.82**	0.74 - 0.91
	Old Age (25-49)	0.72**	0.64**	0.57 - 0.73
Mother's Education	Illiterate	1.00	1.00	
	Literate but below primary	0.89	1.04	0.90 - 1.19
	Primary but below middle	0.87	0.97	0.83 - 1.14
	Middle but below high school	0.73**	0.99	0.88 - 1.11
	High school and above	0.45**	0.84	0.67 - 1.06
Child Sex	Male	1.00	1.000	
	Female	0.94	0.95	0.89 - 1.02
Parity	≤ 2	1.00	1.00	
	3-4	0.95	0.93	0.82 - 1.06
	≥ 5	1.27**	1.29**	1.08 -1.55
Birth Order	1	1.00	1.00	
	2-3	0.78**	0.79**	0.72 - 0.88
	≥ 4	1.03	0.93	0.79 - 1.08
Birth Interval (Years)	≤ 2 Years	1.00	1.00	
	>2 Years	1.13**	0.82**	0.73 - 0.89

'**=Significant' & rest 'insignificant'

DISCUSSION

In India, significant correlates of neonatal deaths identified were sex of the child, child's birth size, birth order and interval, type of childbirth, mother's age at birth, religion, mother's education, household wealth status, and region of residence had been. [12] Drastic reduction in IMR in India that is expected to be 39 per thousand live births by the end of 2015 clearly indicating India's sagging effort to controlling the early deaths of newborn

born. The present analysis has primarily focused to examine the determinants of infant mortality in India, so as need based policy can be revised. The determinants considered were all maternal e.g. geographical location, socio–economic & demographic characteristics and exposure to mass media. Geographical location only consisted as the regional division of the country and demographic as age of mother, parity, order and birth spacing and sex of new born; while socio-economic characteristics included religion, caste, place of residence, education and social group as women's empowerment, working status and standard of living Index (wealth index).

The analysis indicated risk of infant death much higher (1.28 times) in central region including states Uttar Pradesh, Madhya Pradesh and Chhattisgarh of the country compared to all other regions; these are the states economically poor and poor health care access leading to higher IMR which is definitely the consequence of high neonatal deaths. Further, the study reconfirms the regional differences in mortality indicators highlighted by several studies. [12-16] Several other studies have reiterated the case of economic inequality and health care access leading threat to the newborns at early age. [17-19] The lowest IMR amongst mothers of age group ≥ 25 years indicating group being also constituted by mothers marrying at higher ages who are of relatively higher level of education and away from cultural practice and these are expected to utilize more and more of mother and child health (MCH) care services compared to those younger and middle aged mothers. Contrary to this, the adolescents mothers are obviously of early age marriage group who are expected to belong poor economic families, comparatively of lower level education and may have poor MCH services utilization thereby experiencing higher IMR; undoubtedly, and evidenced that MCH services utilization has its direct impact on IMR. Large differences in MCH utilization by urban–rural residence, educational attainment, religion, economic status and region were reported. [20] Moreover, adolescent mothers have higher likelihood of underweight born having more susceptibility to infections and in absence of proper treatment likelihood of death is high. Hence, focus should be more on delaying marriage age following if not delaying the age at first birth among those married early. In states with high IMR marriages below 18 year in spite of enforcement of Child Marriage Act, 2006 [21] defining legal marriage age are more than 30% (46% in Bihar, 41% in Rajasthan, 36 in Jharkhand, 33% in Uttar Pradesh and 29% in Madhya Pradesh). Increasing wealth index had shown decreasing hazard of death during infancy, although IMR was similar among children belonging to families of poorest, poorer and middle wealth index but among richer and richest, hazard rate was lesser by 30% and by about 50%. The reason behind is richer and richest class have better nutrition, better utilization of mother and child health care system and better treatment in case of any infection or disease. Poor health indicators and high mortality have been established as the outcome of poor socioeconomic status, demographic stages, low female autonomy, [19,22] besides the poor health system performance and lower utilization of maternal and child health services. [12] Studies have reiterated the case of low age at marriages, premature births and frequent low spaced births following low birth weight whose likelihood of deaths during infancy is high. The risk factors for low birth weight is high among poor socioeconomic community, very young maternal age, poor diet (inadequate calorie intake, nutritional deficiencies of iron and zinc), and infections. [23,24] The empowerment of women is directly associated with her education and type of work she perform. In working or partially or fully empowered women, the hazard

rate of IMR was lesser by about 20% than non working or no empowered. The infants may have higher survival because of additional expenditure for their wellbeing with the income of the mothers, although, mother's employment may results in less care and infrequent breastfeeding, which may reduce the chance of infants' survival. [25] Work status of women show a positive effect on the infant mortality; means the risk of infant's death is higher for a working mother compared to a non-working mother which is a contradiction to what this study suggests. It seems it may be positive or negative depending upon the situation. Thus, the net effect of women employment on infant mortality is uncertain. The studies on Nepal and India [26-28] also find the negative effect of mothers' employment on child survival. Thus, although some studies do not support our findings but some of them do suggesting critical examination of type of work which is performed by the women. Our study also reveals the risk of infant mortality is 21% low amongst mothers with birth order 2-3 and 19% low amongst birth interval of greater than two years. The higher mortality risk among first order birth could be linked with the early childbearing trends resulting to more chances of underweight that leads to frequent infections and ultimately die in absence of proper treatment. Further, utilization of maternity services even in low spaced children can reduce IMR which is low in developing countries like India. This study reveals that risk of infant death is highest amongst women with parity higher than 5. Although majority of the papers do not consider parity as a significant determinants but some support our findings, but since birth order and birth spacing are significantly associated with neonatal deaths, so may be with IMR. [29,30] To combat the high IMR and maternal deaths, the move on Janani Suraksha Yojana (JSY), a cash incentive scheme launched by the Government of India appears beneficial for the poor. [31,32] However, problems related to heavy transactions, magnitude and political visibility along with growing corruption could hamper the effectiveness of JSY schemes. [33] India, by region need based focus on key determinants of IMR can lead to quick reduction in IMR.

CONCLUSION

The findings suggest that raising marriage age, adequate birth spacing, limited births through promoting family planning devices and MCH care can bring a quick substantial reduction to IMR and the target fixed can be achieved.

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