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Research Article

Trend, Differentials and Determinants of Neonatal and Infant Mortality in Rural North Karnataka

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Abstract

An attempt has been made in this paper to estimate Neonatal Mortality Rate (NNMR) and Infant Mortality Rate (IMR) for rural North Karnataka along with assessing its trend during previous three years and differentials. The study uses the baseline (2012) and endline (2015) household survey data conducted in rural areas of 8 districts of North Karnataka under the project Sukshema. The study adopted systematic stratified sampling with two stages, selection of villages and selection of households with eligible women. Baseline covered 5240 ever married women, between the age group 15-34 years and endline survey covered 5154 ever married women. Study design and methodology adopted was same in both the waves.

During women interviews, details on fertility history along with survival status of each child were asked. The same information is used here to analyze the differentials and determinants of neonatal and infant mortality. The comparison of the rates of two rounds of survey gives recent changes occurred in the Neonatal and Infant Mortality Rates in rural areas of 8 districts of North Karnataka. Mother's factors, Father's factors, Child's factors and Household factors are included as independent variables in the analysis. Still higher rates of Neonatal and Infant Mortality are observed in rural North Karnataka compared to that of whole rural Karnataka. NNMR decreased from 40 to 34 and IMR decreased from 54 to 45 per 1000 Live Births in the study area during the reference period. Decreasing rates of early childhood mortality among all the caste categories during recent years is a promising trend and indicates the positive impact of recent National health schemes, though the figures are far from reaching set goals. Attention should be on first order births, multiple births and male children. Continuing focus is required on socio economically deprived women and children. It is essential to create awareness on education of women, legal age at marriage and birth spacing in rural North Karnataka.

Introduction

The major public health interventions during the last two decades have been focused on reduction in infant and child mortality (WHO, 2005; United Nations, 1995). The global reduction in mortality of children aged <5 years between 1990 and 2015 was 53% against the aim of a two-thirds reduction by Millennium Development Goals (MDG) (You *et al.* 2015). Though there has been significant decline in the magnitude of early childhood deaths, the major cause of concern is almost stagnant Annual Decline Rate which is much below the target rate, required to reach the MDG-4. The UN inter-agency group for Under-5 mortality estimation reports an almost constant annual rate of reduction in south-east Asia during this period. Further, the proportional contribution of infant deaths to overall child mortality has increased over the years and has reached 73% and neonatal deaths still comprise about 40% of all under-5 deaths worldwide(You *et al*. 2015, WHO 2014). It has been noted that the reduction in neonatal mortality is slower than the reduction in post-neonatal, particularly in low and middle-income countries. Hence Infant Mortality Rate (IMR) still remains an important public health issue and an often used proxy indicator to assess the health and developmental status of

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a nation (Heisler, 2012). It is also a significant determinant of the overall fertility and life expectancy of a population (Canudas-Romoand Becker, 2011).

In India, IMR is unacceptably higher than many other developing and developed countries (Singh *et al*., 2011) though it is declining during recent years. The Sample Registration System (SRS) of India reported a decline in the IMR from 72/1000 live births in 1998 to 57/1000 live births in 2006, which further declined to 39/1000 live births in 2014 (RGI, 2000, 2016), which is 4 times higher than the IMR of Sri Lanka in 2009 (RGI, 2016; Annual Health Bulletin, 2012).

In Karnataka, a Southern State of India also, a declining trend in IMR has been observed during recent years. NFHS-4 (2015-16) estimates 28 deaths before the age of 1 year per 1000 live births down from NFHS-3 (2005-06) estimate of 43 and NFHS-2 (1998-99) estimate of 52 and that of NFHS-1 (1992-93) estimate of 65. NFHS-3 estimates neonatal mortality as 29 for Karnataka by considering live births reported during previous 0-4 years. Rajan and Mohanachandran (1998) estimated IMR as60 per 1000 Live births for whole Karnataka and 65 for rural Karnataka using Census 1991 information. District level estimates given by them clearly indicate higher infant mortality in North Karnataka compared to South. IMR is significantly higher in rural areas than in urban areas (NFHS2; NFHS3; RGI 2016; Rajan and Mohanachandran 1998; Ram *et al.* 1985). IMR is estimated to be 34 for rural areas and 19 for urban areas for 1000 live births in Karnataka as per NFHS4 and NFHS-3 estimates NNMR as 28 for urban areas, 30 for rural areas of Karnataka. Hence, though Karnataka State average is better than the National average, still North districts of Karnataka especially the rural region lags much behind than the expected in terms of child survival.

The reasons of infant deaths can broadly be divided into two – endogenous and exogenous factors. The endogenous factors are biological in nature, related to any impairment during the formation of fetus in the womb and other cognitive or neurological deformities inside the womb. Contrary to this, the exogenous factors are more of a social, cultural, economic and environmental nature that cause infant deaths, especially during the post-natal period. (Patel and Gouda, 2017). Mosley and Chen (1984) Framework categorizes Maternal factors, Environmental contamination, Nutrient deficiency, Injury and Personal illness control as Proximate determinants of infant mortality and Sahu et al.(2015) categorize them into3 categories - biological factors, socio-economic factors and environmental factors.

Most of the studies conducted so far have focused on maternal factors and socio economic factors. Risk of infant deaths is found to be strongly associated with maternal age (Singhi et al. 1989; Patel and Gouda 2017; Claeson et al. 2000; Holla 1985; Pandey et al. 1998; Sahu et al. 2015) and with female education (Pandey et al. 1998; Simmons and Bernstein, 1982; Roy *et al*. 1979; Patel and Gouda 2017; Claeson et al. 2000; Zachariah and Patel, 1983; Holla 1985; Srinivasan 2000). DLHS2 also indicated mother's education up to secondary level reduced neonatal mortality (Singh et al. 2013). Children born to mothers under the age of 20 years are more likely to die during infancy than those children born to mothers during prime child bearing ages. Infant mortality is estimated as high as 74 among children born to teenage mothers compared to 47 for every 1000 live births if mothers are in the age group 20-29 (NFHS3). Children whose mothers have no education are almost twice as likely to die before their 1st birthday compared to those children whose mothers have completed at least 10 years of schooling (NFHS3). Female labour-force participation is also associated with increased relative survival chances of female children, but, in this case, mainly via an increase in male child mortality (Bhattacharya, 1999). Analysis of NFHS1 data indicated that infant mortality did not vary by mother's employment status but it had a negative impact on infant survival, especially male infants (Kishor and Parasuraman, 1998). Lower neonatal deaths were observed among women engaged in household work than those engaged in agricultural or labor work (Singh et al. 2013).

Further, Infant mortality is found to be associated strongly with sex of the child, birth order, previous birth interval and single or twin status of birth. Male infant mortality continues to be high compared to that of female (Ram *et al*. 1985; NFHS3; Sahu et al. 2015) and gender disparity is observed to be still more during neonatal period (Pandey et al. 1998; Arora 1979; (Singh *et al*. 2013). Infant mortality is found to follow a U-shaped pattern with Birth order, similar to that with mother's age. It is observed to be very high among first order and higher order births (Singhi et al. 1989;

Pandey et al. 1998; Pathak 1979; Holla 1985; Srinivasan 2000). NFHS3 estimated 61 for first order births vs. 48 infant deaths for higher order births per 1000 live births. Further, the risk of death during 1st year of life is observed to be much higher if children are born at shorter birth interval of less than 2 years after a previous birth (Patel and Gouda, 2017; Pandey et al. 1998; Sahu et al. 2015) (76 vs. 46 infant deaths per 1000 live births as per NFHS3). Srivastava (1990) in Uttar Pradesh and Singhi et al. (1989) in Haryana have identified the adverse effect of short birth spacing along with early termination of breast feeding on children, with maximum impact among mothers who began childbearing under the age 18. These effects were observed across all socioeconomic levels. Birth spacing of at least 3 years reduced infant mortality by 51%. More children who are multiple at birth are found to die before their first birthday compared to those who were born single (Zachariah and Patel, 1983; Pandey et al. 1998).

As far as Household factors are concerned, Religion/Caste, availability of basic amenities (like source of water supply, toilet facility) and household assets and household annual income are considered in most of the studies focused on socio economic factors so far. Infant mortality and Neonatal mortality is significantly associated with Caste (Zachariah and Patel 1983). Hindu children are found to have a high risk of mortality (Ram *et al*. 1985), especially from Backward category (NFHS3; Pandey et al. 1998; Singh et al. 2013). Mahadevan 1985 in rural Andhra Pradesh estimated that Infant mortality was higher among Muslims and *Harijans* than among Hindus. He identifies all demographic variables except age at marriage and number of living children affected the 3groups uniformly. Studies have identified that Socioeconomic factors in general are more important than culture or religion in their influence on infant mortality. Despite various health-related interventions, the reduction in infant mortality in the disadvantaged group has not been satisfactory (Rai et al. 2017; Pandey et al. 1998). Poor economic condition of the family (Zachariah and Patel 1983; Srinivasan 2000; Pandey et al. 1998) and having less access to basic civic amenities are also identified as household related covariates of high Infant Mortality and Neonatal mortality (Pandey et al. 1998; Ram 1999; Patel and Gouda 2017; Holla 1985; Singh et al. 2013; Bhattacharya 1999). However, Zachariah and Patel (1983) did not find significant association with land holding, access to basic amenities with Infant mortality.

Dwivedi et al. (2013) by analysing NFHS2 data reported that community level characteristics still have a major role regarding infant mortality in India. The results indicated that even after consideration of the covariates, variation in infant mortality remains significant not only between States but also between Districts. Further, as an additional observation, the probability of infant mortality is still high in rural areas of districts having health facility beyond three kilometers than their counterparts.

Thus, the review of existing literature indicates that SRS continues to be the main source for measure of infant mortality on an annual basis at the national and sub national levels and for urban and rural areas along with NFHS data. Other than this, little is known about the mortality pattern: how it varies from one region of the State to another, how it differs between various socio-economic groups within the State (Zachariah and Patel, 1983; Holla, 1985). We don't have any estimates of early childhood mortality specifically for Rural North Karnataka. This paper attempts to fill some of the gaps in our knowledge about the early childhood mortality situation in rural North Karnataka. In particular, it provides an estimate of trends in the neonatal and infant mortality rates in rural areas of 8 districts of North Karnataka for recent periods, along with an analysis of their socio-economic differentials with the following objectives:

- To estimate the levels and trend in Neonatal and Infant Mortality
- To analyze the socio-economic and demographic differentials in Neonatal and Infant Mortality
- To identify the determinants of Neonatal and Infant Mortality

Materials and Methods

The present paper utilizes the household survey data of project '*Sukshema'* carried out in two rounds (baseline during 2012 and endline during 2015). Both the surveys were cross-sectional,

conducted in a representative sample of households in rural areas of 8 districts of North Karnataka. The study adopted Systematic Stratified Sampling with two stages; one at the selection of villages and the second at the selection of households. In the first stage, 167 villages or Primary Sampling Units (PSUs) were selected from all the villages of 8 districts using Probability Proportion to Size (PPS) with district and taluka as strata. For this, 2001 Census was used as a base for baseline and Census 2011 was used as a base for endline survey. Size of the village and proportion of Scheduled Caste (SC) / Scheduled Tribe (ST) population were also considered for stratification.

In each of the selected PSU, house listing was done either for the complete village or in the selected segments depending upon the size of the village. If a village is having more than 200 SC/ST households, it was segmented so that each segment has around 150-200 households. Same procedure was adopted for Non SC/ST household listing also. For second stage of selection i.e., households, the list of households was used and 30 households were selected from each PSU (15 SC/ST households and 15 Non SC/ST households) with at least one ever married woman (EMW) between 15-34 years by using Systematic Sampling Method with equal probability and without replacement. To adjust for over sampled SC/ST population, proper weights have been used in the analysis. The data collection was done during March-June, 2012 for baseline and it was during April-June, 2015 for endline. Data analysis is done using STATA and SPSS software packages.

Altogether, baseline survey covered 5240 EMW from 4881 households and endline survey covered 5154 EMW from 4882 households. This household survey was basically conducted to provide reliable information about awareness on service utilization of RCH services, fertility history of women and child survival. The present paper aims to calculate trend and differentials in neonatal and infant mortality in rural North Karnataka by using baseline and endline data. Among the women interviewed, 4659 and 4568 live births were reported during baseline and endline respectively during previous 0-4 years. The present paper focuses on these live births to assess the infant and neonatal mortality. Among live births that occurred during the reference period, total 246 infant deaths occurred out of which 187 were neonatal deaths during baseline survey. Similarly, during the reference period of endline survey, 200 infant deaths were identified and among them 153 were neonatal deaths.

Analytical Approach

Here the neonatal deaths and infant deaths are considered as outcome variables. The neonatal death is defined as “any death occurred during first 28 completed days of life” and infant death is defined as “any death occurred before celebrating first birthday of life”. Here neonatal mortality rate is defined as number of neonatal deaths per 1000 live births and infant mortality rate is defined as number of infant deaths per 1000 live births. Further, Neonatal and Infant Mortality Rates are estimated by survival analysis using Life Table technique also. To investigate which factors best explain and predict the neonatal and infant deaths, Binary Logistic Regression is applied wherein neonatal as well as infant deaths are recoded as a binary variable; 0 indicates that the child survived for more than 28 days / more than 1 year; whereas 1 indicates otherwise, that is, death of the child before completing 28 days / before completing 1 year, for neonatal death and infant death respectively. The analysis includes only live births and excludes still births as well as fetal deaths. Multiple births are considered as two separate life births. To understand the differences in neonatal and infant mortality, following predictor variables are considered. All the variables are categorized into 4 major categories as mother’s factors, father’s factors, child factors and household factors. The definition and classification of predictor variables considered here is as below.

Mother’s factors

Education of mother: It is defined based on the years of schooling and divided into 3 categories. Illiterate - 0 years of schooling, Primary and middle - 1–7 years of schooling, High school and above - 8 or more years of schooling. Occupation of mother: It is divided into 4 categories; cultivation, agricultural or non-agricultural laborer, household work and other category. Other

category mainly included salaried and women involved in business activity. Age of mother at birth: Maternal age at birth is divided into 3 categories; less than 18 years, 18-24 years and 25-34 years.

Father's factors

Father's education : It is divided again based on the years of schooling and divided into 4 categories; Illiterate - 0 years of schooling, Primary and middle - 1–7 years of schooling, High school - 8-10 years of schooling, Above high school - more than 10 years of schooling. Occupation of Father: It is divided into 4 categories, Cultivation, Agricultural or Non-agricultural laborer, Salaried/Business and Other/Not working category.

Child factors

Birth Order: It refers to the order in which the child was born; 1st order, 2nd order, 3rdor higher order birth. Sex of the child: It is categorized as Boy or Girl. Type of birth: It refers to number of births at a time; Singleton or Multiple births.

Birth Intervals: Birth interval is considered only for other than 1st order births and singleton births and divided into 2 categories; Less than 24 months and 24 months or more.

Household factors

Household size: Household size is defined as the number of persons live in the house and is categorized into 3 categories; Less than 5 members, 5-7 members and 8 and more members.

Standard of Living Index (SLI): Standard of living index is used here as a proxy for economic status of the household. It is based on variables related to household amenities and assets. Principal Component Analysis (PCA) has been used to construct the SLI index. The index is divided into 3 categories; Low, Middle and High.

Caste: The caste categories considered here are Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Class (OBC) and Forward Caste. The Government of India has identified certain castes as socially and economically backward, considering the need to protect them from social injustice and all forms of exploitation. As per the Constitution of India, special protection is conferred on them.

Round: As mentioned earlier, the survey was conducted in 2 rounds -baseline and endline. Variation between baseline and endline estimates gives recent changes that have taken place in neonatal and infant mortality in rural North Karnataka.

Results and Discussion

To estimate neonatal and infant mortality in rural areas of 8 high focus districts of North Karnataka, live births and infant deaths occurred to the interviewed women during 0-4 years preceding the survey were considered and its association has been identified with predictor factors. As presented in Table 1 and Figure 1&2, during baseline, 187 neonatal deaths among 4659 live births estimates neonatal mortality as 40.1 and 246 infant deaths during this period estimates IMR as 52.8 per 1000 live births. Endline estimated NNMR as 33.5 (153 neonatal deaths among 4568 live births) and 43.8 IMR (200 infant deaths) during 0-4 years preceding the survey.

These NNMR and IMR estimates during two rounds clearly indicate that there has been a reduction of 6 neonatal deaths and 9 infant deaths per 1000 live births in rural North Karnataka during the period of 3 years (2012-15). Further, during baseline, both NNMR and IMR were high among SC/ST children compared to Non SC/ST children (43 vs. 37 for NNMR and 54 vs. 52 for IMR). During endline, again NNMR is comparatively high among SC/ST children than that of Non SC/ST children (36 vs. 31). However, during endline, IMR is found to be slightly less among SC/ST children than Non SC/ST group (43 vs. 46). This clearly indicates reduction in NNMR and IMR irrespective of caste categories in Rural North Karnataka during recent years.

Further, both the mortality rates (NNMR and IMR) are estimated by survival analysis using Life Table technique (Table 2, Figure 1 &2). Though not much change is observed in the NNMR by survival analysis, IMR is found to increase slightly by this technique, compared to that of earlier estimates. IMR is found to be 54 during baseline and 45 during endline for 1000 Live births by life table technique. Reduction in NNMR and IMR has been observed during recent years in the survival analysis also and reduction is prominent among all the caste categories. Again SC/ST children are at higher risk of death during neonatal period compared to Non SC/ST category. On the other way, IMR is found to be more among Non SC/ST children compared to SC/ST children during endline. NNMR and IMR estimated here are higher when compared with NFHS-4 estimates. As mentioned earlier, the area covered here is8 high focus districts of North Karnataka, which is comparatively poor from South Karnataka districts in terms of socio economic characteristics and infrastructure.

Further, Table 3 gives NNMR and IMR for both the rounds for different socioeconomic and demographic characteristics. Under Mother factors, during baseline it is observed that slightly lesser proportion of neonatal as well as infant deaths are reported if mother is at least high school educated. However, this pattern is not observed during endline. As far as occupation of mother is concerned, higher rates of neonatal and infant mortality are observed both during baseline and endline among mothers engaged in other activities like salaried and business. During baseline no clear cut difference is observed in the NNMR and IMR by age of mother at birth. However, during endline, neonatal and infant mortality is found to be high among those born to teenage mothers than those born to mothers in the age group 18-24 years. Under Father Factors, as such, both education and occupation of father did not show much significant and systematic variation in neonatal and infant mortality. Though, comparatively higher deaths are observed among children born to fathers engaged in agricultural or non-agricultural labor work. All the considered child factors show a significant influence on neonatal deaths and infant deaths. Higher proportions of neonatal as well as infant deaths are reported among first order births during baseline as well as endline. During baseline, 47 neonatal deaths are reported and during endline, 50 neonatal deaths are reported per 1000 live births among first order births which are very high when compared to deaths among higher order births.

Interpretation of Binary Logistic Regression Analysis

To investigate which factors best explain and predict neonatal and infant deaths, further Binary Logistic Regression has been done for both neonatal mortality and infant mortality separately for two rounds. The background characteristics included mother factors, father factors, child factors and household factors and their covariates as explained earlier. Table 4 gives Odds ratio of Binary Logistic Regression for neonatal mortality.

As far as impact of Mother factors are concerned, slight reduction in Odds of neonatal deaths are observed as increase in the mother's education. Probability of dying during neonatal period decreased by about 30 percent, if mother's education increased from illiterate to at least primary level. However, children born to high school and above educated mothers show slightly increased probability of dying during neonatal period, though the results are not significant. The risk of neonates dying is observed to be less if their mothers are engaged in household work than cultivation during endline however; the impact of occupation of mother on neonatal deaths is not statistically significant. As observed in earlier bivariate table, neonatal mortality rate is comparatively more if age of mother at birth is less than 18 years. However, when considered by controlling other factors, age of mother did not show significant impact on neonatal mortality. On the other way, probability of dying of children during neonatal period increased with increase in the age of mother at birth. Probability of dying is increased by 38 percent if age of mother is more compared to reference group, during endline. Hence, though bivariate analysis gives comparatively higher levels of neonatal and infant deaths among illiterate mothers, mothers engaged in labor work and among teenage mothers, Logistic regression analysis nullifies the effect of mother's factors on neonatal and infant deaths.

Both the factors of father - education and occupation - as such do not show significant impact on the risk of neonatal death. During baseline, risk of neonatal deaths reduced with increase in the educational level of father, however, such trend is not observed during endline. With regard to occupation of father, children born to those fathers who are engaged in 'Other' activities or not working found to die more than 2 times during baseline, but, such impact is not observed during endline.

The risk of neonatal death is more if birth order is first. As indicated in the table, the risk of dying during neonatal period reduced by about 50 percent among second order births in both the rounds compared to reference category and it reduced by 60 percent among 3rd or higher order births during endline. The impact of birth order on risk of death during neonatal period is statistically highly significant. Again, sex of the child shows a significant impact on neonatal mortality. The probability of dying during neonatal period is 30 percent less among girls during baseline and it is less by 10 percent during endline compared to that of male neonates. The risk of dying during neonatal period is more than 16 times if it is a multiple birth as compared to singleton birth during baseline. The difference between single births and multiple births is reduced to only 16 percent during endline. The risk of neonatal deaths significantly reduced (about 40 percent during baseline and 13 percent during endline),if birth interval is more than 2 years compared to those children who are born within a short birth interval. It is interesting to note here that all the 4 child factors considered here - birth order, sex of the child, type of birth and birth interval show statistically highly significant influence on risk of dying during neonatal period, especially during baseline and impact is not significant (except Birth order) during endline.

Among household factors, significant reduction in the neonatal mortality is observed as size of the household increased. Probability of dying during neonatal period decreased by about 50 percent among households with more than 5 members compared to reference category. Though higher SLI reduced the neonatal mortality by 10 percent, it did not show significant impact on neonatal mortality. On the other way, children born in middle level SLI index households show 95 percent higher risk of dying compared to those children born in lower SLI index households in baseline. When considered the impact of caste by controlling all the other factors, during baseline, children born to SC women show the lesser risk of dying whereas it is more by 35 percent among forward caste. Whereas in endline survey, the risk of dying is less by 45 percent among children born to ST women and less by 27 percent among OBC children and it reduced by 85 percent among children born to forward caste women compared to neonates belonging to SC. The above analysis clearly indicates that risk of neonatal deaths is more if it is a first order birth, a male baby, among multiple births, if born within 24 months birth interval and among the households with less household size. On the other hand education and occupation of parents as well as their standard of living and caste do not show significant impact on neonatal mortality,when controlled for other factors.

Results of Binary Logistic Regression of infant mortality (Table 5) are also found to follow the similar pattern as that of neonatal mortality. Again, education of mother, occupation of mother and age of mother at birth did not show significant impact on infant mortality in both the rounds. However, probability of dying during infancy reduced slightly with increase in the education of mother during baseline. Odds ratios of Infant mortality is found to be comparatively high among children born to mothers engaged in Salaried/Business work (Other category) during both the rounds and low among mothers engaged in household work during endline. Reduction in Odds ratio of infant deaths is observed if mother's age is between 18-24 years at the time of birth during endline compared to the reference category. Similarly, as such, education and occupation of father also did not show significant impact on infant mortality when controlled for other factors. Probability of dying during infancy is increased by 76 percent if fathers are not working during baseline.

Similar to earlier discussion, all the 4 child factors considered here show strong impact on risk of dying during infancy. Probability of dying during infancy is reduced among second order births compared to first order births in both the rounds and it reduced by 55 percent among 3rd or higher order births compared to first order births during endline. The differences in the Odds ratio of infant deaths by birth order are statistically highly significant. The difference in the infant mortality by sex of the child indicates reduction by 30 percent among girl babies compared to male infants

during baseline and it is 6 percent during endline. This indicates that the risk of dying during infancy is lesser among female compared to that of male infants. The probability of infant death is 13 times higher if it is a multiple birth compared to singleton birth during baseline and this risk is found to reduce during endline just to 89 percent. Again, the longer birth interval reduced the risk of dying during infancy by 41 percent and 15 percent compared to that of children born with shorter birth interval during baseline and endline respectively. It is important to mention here that all the 4 child factors show a significant impact on the risk of dying during infancy when controlled for mother, father and household factors.

Among household factors, again infant mortality reduced with increase in the household size. Significant differences are observed in the infant mortality rate as more than double among children born in households having less than 5 members. Increase in standard of living index though reduced the risk of dying during infancy it did not show statistically significant impact during endline, however, odds ratio is found to be 45 percent more and significant among households belonged to Middle SLI compared to Low SLI households during baseline. As far as the impact of caste is concerned, during baseline, comparatively less infant deaths are observed among children born in SC households, but the reverse trend was observed in endline survey. As such, caste does not have any impact on infant mortality when controlled for other factors. The above analysis of infant mortality indicates that order of birth, sex of the child, type of birth and previous birth interval of child as well as size of the household decides the risk of infant mortality when controlled for mother, father and socio-economic characteristics of households. This clearly indicates that child factors have a dominating and determining role on neonatal and infant mortality.

Conclusion

Though we are far from reaching MDG4 goal, positive and remarkable changes are taking place in neonatal mortality and infant mortality during recent years in rural North Karnataka among all the caste categories. Child factors have a dominating and determining role on mortality during first year of life as still a large proportion of early childhood deaths take place among first order births, among male babies, among multiple births and if it is born with shorter birth interval. At least high school level education of mother and child bearing after 18 years reduces the neonatal and infant mortality. Attention is required on education of woman, age at marriage, birth spacing and follow up of high risk pregnancies. Continuing focus on SC and ST children is essential. Focus should be on improving the socio economic condition of socially deprived category, as once background characteristics are improved, as such caste category does not show much impact on mortality of children during their first year of life.

Limitations of the Study

The study collected ANC, delivery and PNC related information only for the Last pregnancy of the women interviewed. However, to analyse IMR and NNMR, all Live Births occurred during previous 3 years are considered. Hence Covariates relating to ANC, Delivery and PNC cannot be included in the Binary Logistic Model.

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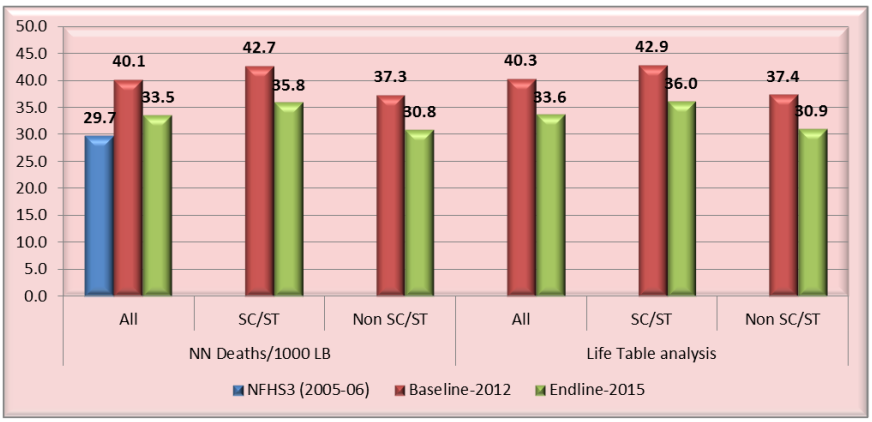
Table 1: Neonatal and Infant Mortality Rate (Deaths per 1000 Live Births), for preceding 0-4 years, in rural North Karnataka, by caste for baseline and endline surveys

Round	Caste	Live Births	Neonatal Deaths	Infant deaths	NNMR	IMR
Baseline	SC/ST	2,460	105	132	42.7	53.7
	Non SC/ST	2,199	82	114	37.3	51.8
	ALL	4,659	187	246	40.1	52.8
Endline	SC/ST	2,456	88	106	35.8	43.2
	Non SC/ST	2,112	65	94	30.8	44.5
	ALL	4,568	153	200	33.5	43.8

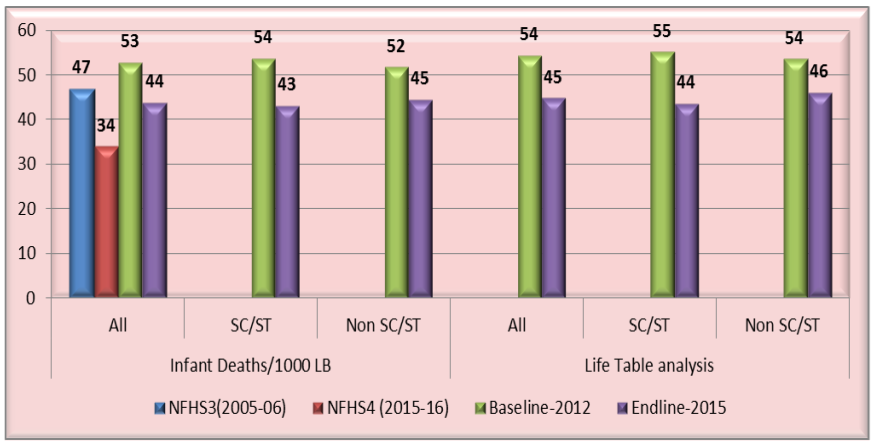
Note: NNMR-Neonatal mortality rate; IMR-Infant mortality rate

Figure 1: Neonatal Mortality Rate during baseline and endline by Caste categories



Note: NFHS rates are for State level, rural areas

Figure 2: Infant Mortality Rate during baseline and endline by Caste categories



Note: NFHS rates are for State level rural areas

Table 2: Neonatal and Infant Mortality Rate by Life Table analysis per 1000 Live Births, for preceding 0-4 years, in rural North Karnataka according to caste by baseline and endline surveys

Round	Caste	NNMR	95% C. I.		IMR	95% C. I.	
Baseline	SC/ST	**42.9**	51.7	35.6	**55.2**	65.1	46.7
	Non SC/ST	**37.4**	46.3	30.3	**53.6**	64.1	44.8
	ALL	**40.3**	46.4	35.0	**54.4**	61.5	48.2
Endline	SC/ST	**36.0**	44.2	29.3	**43.6**	52.5	36.2
	Non SC/ST	**30.9**	39.2	24.3	**46.1**	56.2	37.8
	ALL	**33.6**	39.3	28.8	**44.8**	51.2	39.1

Table 3: Neonatal and Infant Mortality Rate (per 1000 Live Births) by background characteristics, according to baseline and endline surveys

Background characteristics	Baseline					Endline				
	Live Births	NN Deaths	Infant Deaths	NNMR	IMR	Live Births	NN Deaths	Infant Deaths	NNMR	IMR
ALL	**4,659**	**187**	**246**	**40.1**	**52.8**	**4,568**	**153**	**200**	**33.5**	**43.8**
Mother Factors										
Education of mother										
Illiterate	2,610	108	145	**41.4**	**55.6**	2,387	79	102	**33.1**	**42.7**
Primary and Middle	1,029	43	54	**41.8**	**52.5**	928	31	38	**33.4**	**40.9**
High school and above	1,019	36	47	**35.3**	**46.1**	1,253	43	60	**34.3**	**47.9**
Occupation of mother										
Cultivation	591	18	24	**30.5**	**40.6**	640	25	31	**39.1**	**48.4**
Agri./Non Agri laborer	1,631	71	95	**43.5**	**58.2**	1,615	52	73	**32.2**	**45.2**
Household work	2,260	88	114	**38.9**	**50.4**	2,127	63	81	**29.6**	**38.1**
Other	172	9	12	**52.3**	**69.8**	185	13	15	**70.3**	**81.1**
Age of mother at birth										
Less than 18	659	27	34	**41.0**	**51.6**	721	34	45	**47.2**	**62.4**
18-24	3,237	132	174	**40.8**	**53.8**	3,095	95	123	**30.7**	**39.7**

25-34	763	28	38	**36.7**	**49.8**	752	24	32	**31.9**	**42.6**
Father Factors										
Education of father										
Illiterate	1,888	79	101	**41.8**	**53.5**	1,787	62	77	**34.7**	**43.1**
Primary and Middle	1,027	44	56	**42.8**	**54.5**	924	31	46	**33.5**	**49.8**
High school	891	36	49	**40.4**	**55.0**	915	37	45	**40.4**	**49.2**
Above High school	741	25	34	**33.7**	**45.9**	816	20	27	**24.5**	**33.1**
Occupation of father										
Cultivation	1,398	59	76	**42.2**	**54.4**	1,251	42	52	**33.6**	**41.6**
Agri./Non Agri laborer	2,282	95	126	**41.6**	**55.2**	2,268	80	106	**35.3**	**46.7**
Salaried/Business	653	22	27	**33.7**	**41.3**	731	24	30	**32.8**	**41.0**
Other/Not working	222	8	11	**36.0**	**49.5**	212	4	7	**18.9**	**33.0**
Child Factors										
Birth order										
First	1,575	74	88	**47.0**	**55.9**	1,517	76	100	**50.1**	**65.9**
Second	1,445	50	70	**34.6**	**48.4**	1,493	40	48	**26.8**	**32.2**
Third and above	1,635	63	88	**38.5**	**53.8**	1,558	37	52	**23.7**	**33.4**
Sex of the child										
Boy	2,403	111	146	**46.2**	**60.8**	2,332	83	105	**35.6**	**45.0**
Girl	2,256	76	100	**33.7**	**44.3**	2,236	70	95	**31.3**	**42.5**
Type of birth										
Single	4,593	165	221	**35.9**	**48.1**	4,507	149	195	**33.1**	**43.3**
Multiple	66	22	25	**333.3**	**378.8**	61	4	5	**65.6**	**82.0**
Birth interval										
Less than 24 months	1,113	45	65	**40.4**	**58.4**	1,198	36	46	**30.1**	**38.4**
24 months or more	1,917	51	73	**26.6**	**38.1**	1,808	39	52	**21.6**	**28.8**
Household Factors										
Household size										
1-4	652	44	61	**67.5**	**93.6**	580	32	41	**55.2**	**70.7**
5-7	1,936	63	87	**32.5**	**44.9**	1,965	60	82	**30.5**	**41.7**
8 and above	2,071	80	98	**38.6**	**47.3**	2,023	61	77	**30.2**	**38.1**
SLI index										
Low	1,504	51	79	**33.9**	**52.5**	1,452	56	74	**38.6**	**51.0**
Middle	1,504	76	95	**50.5**	**63.2**	1,510	43	56	**28.5**	**37.1**
High	1,557	58	68	**37.3**	**43.7**	1,585	51	67	**32.2**	**42.3**
Caste										
Scheduled Caste	1,924	83	102	**43.1**	**53.0**	1,887	74	87	**39.2**	**46.1**
Scheduled Tribe	536	22	30	**41.0**	**56.0**	569	14	19	**24.6**	**33.4**
Other Backward class	1,581	63	86	**39.8**	**54.4**	1,930	62	88	**32.1**	**45.6**
Forward	618	19	28	**30.7**	**45.3**	182	3	6	**16.5**	**33.0**

Table 4: Results of Binary Logistic Regression analysis for Odds Ratio of Neonatal Mortality by background characteristics for baseline and endline Surveys (Weighted)

Background characteristics	Covariates	Baseline	Endline
Education of mother	Illiterate(R)	1	1
	Primary and Middle	0.764	0.705
	High school and above	1.039	0.939
Occupation of mother	Cultivation(R)	1	1
	Agri./Non Agri laborer	0.972	0.894
	Household work	1.021	0.686
	Other	1.335	1.408
Age of mother at birth	Less than 18(R)	1	1
	18-24	1.217	0.901
	25-34	1.007	1.382
Education of father	Illiterate(R)	1	1
	Primary and Middle	0.877	1.281
	High school	0.831	1.332
	Above High school	0.728	1.044
Occupation of father	Cultivation(R)	1	1
	Agri./Non Agri laborer	1.235	1.106
	Salaried/Business	0.860	1.103
	Other/Not working	**2.335****	0.780
Birth order	First(R)	1	1
	Second	**0.549****	**0.518****
	Third and above	0.807	**0.411****
Sex of the child	Boy(R)	1	1
	Girl	**0.691***	0.913
Type of birth	Single(R)	1	1
	Multiple	**16.125*****	1.164
Birth interval	Less than 24 months(R)	1	1
	24 months or more	**0.602****	0.865
Household size	1-4(R)	1	1
	5-7	**0.557****	**0.547***
	8 and above	**0.530****	**0.541***
SLI index	Low(R)	1	1
	Middle	**1.951*****	0.744
	High	0.945	0.880
Caste	Scheduled Caste(R)	1	1
	Scheduled Tribe	1.174	0.546
	Other Backward class	1.172	0.731
	Forward	1.354	**0.147***
Constant		0.089***	0.163***
Hosmer & Lemeshow test $\chi 2$		11.794	2.367
-2 Log likelihood		1508.651	1178.733
Cox & Snell R square		0.039	0.011
Note :(R) Reference Category; * <0.001, ** <0.01, * <0.05**			

Table 5: Results of Binary Logistic Regression analysis for Odds Ratio of Infant Mortality by background characteristics for baseline and endline Surveys (Weighted)

Background characteristics	Covariates	Baseline	Endline
Education of mother	Illiterate(R)	1	1
	Primary and Middle	0.831	0.841
	High school and above	0.918	1.145
Occupation of mother	Cultivation(R)	1	1
	Agri./Non Agri laborer	1.056	0.948
	Household work	1.173	0.647
	Other	1.639	1.162
Age of mother at birth	Less than 18(R)	1	1
	18-24	1.276	0.742
	25-34	1.364	1.041
Education of father	Illiterate(R)	1	1
	Primary and Middle	0.956	1.384
	High school	1.051	1.287
	Above High school	0.891	1.011
Occupation of father	Cultivation(R)	1	1
	Agri./Non Agri laborer	1.191	1.212
	Salaried/Business	0.764	1.100
	Other/Not working	**1.762***	1.076
Birth order	First(R)	1	1
	Second	**0.667***	**0.476*****
	Third and above	0.824	**0.445****
Sex of the child	Boy(R)	1	1
	Girl	**0.704****	0.944
Type of birth	Single(R)	1	1
	Multiple	**13.047*****	1.894
Birth interval	Less than 24 months(R)	1	1
	24 months or more	**0.586*****	0.852
Household size	1-4(R)	1	1
	5-7	**0.472*****	**0.615***
	8 and above	**0.475*****	**0.574***
SLI index	Low(R)	1	1
	Middle	**1.448***	0.686
	High	0.697	0.797
Caste	Scheduled Caste(R)	1	1
	Scheduled Tribe	1.420	0.743
	Other Backward class	1.255	0.965
	Forward	1.469	0.635
Constant		0.115***	0.181***
Hosmer & Lemeshow test $\chi 2$		23.087**	11.276
-2 Log likelihood		1809.026	1478.176
Cox & Snell R square		0.041	0.013
Note : (R) Reference Category; * <0.001, ** <0.01, * <0.05**			