Determinants of Neonatal Mortality in Empowered Action Group States of India

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Background

Among eight goals of Millennium declaration, goal 4 and 5 aimed at reducing child mortality and improving maternal health worldwide respectively. The global progress in attaining these health-related goals is largely contingent on India's efforts in enhancing maternal and child health status. According to World Health Organization (WHO), out of 5 million infant deaths worldwide in 2012, about one-fifth of these deaths were from India. The improvement in maternal and child health is a necessary prerequisite for population stabilisation and bringing qualitative change in the state of human development.

In line with Millennium declaration, the Government of India has taken several initiatives towards accelerating the progress in maternal and child survival status. The most notable move in this direction was the launching of National Rural Health Mission (NRHM) on 12th April, 2005. Under this mission, several schemes namely Janani Suraksha Yojana (JSY), Janani Shishu Suraksha Karyakarm (JSSK), Rashtriya Bal Swasthya Karyakram (RBSK) etc. were introduced to improve maternal and new-born health The heavy investment done under NRHM has large opportunity cost. The total funding allocated to be spent under NRHM for the five-year period (2005-12) was ₹ 70231 crores [NRHM 2011].

The promotion of institutional delivery has been used as a strategy to reduce maternal and neonatal mortality under the safe motherhood intervention called JSY. Nevertheless, about half of the deliveries in India are being conducted at home without any skilled assistance (Mohanty and Srivastava 2012). Among various measures to improve the maternal and child health, many of the developing countries including India have been adopting skilled birth assistance as the key strategy. Accordingly, the promotion of Skilled Birth Attendants (SBAs) is one of the monitoring indicators in Millennium Development Goal 5. The neonatal deaths could be prevented through increasing institutional deliveries or by improving quality of care provided to a new born during the initial days of life after birth. For analysing neonatal mortality, place of delivery is of prime importance to avert the preventable neonatal and maternal deaths.

Research suggests that despite a plethora of newly implemented interventions, the attainment of reducing maternal mortality by three-quarters and child mortality by two-thirds are very unlikely in developing countries. Interventions emphasizing on training SBAs, promoting institutional deliveries and newborn care programmes are not reaching the poorest and needy households where most mothers prefer home deliveries (Costello 2004).

Research suggests that the institutional deliveries in Indonesia are associated with a reduced risk of early neonatal mortality among women in urban areas with delivery complications (Titaley *et al.* 2011). Study conducted by Ajaari in rural Tanzania confirms that pregnant women delivering outside health facility experiences higher odds of neonatal deaths compared with those delivering in a health facility (Ajaari *et al.* 2012).

NRHM has brought about increased institutional delivery in public health centres in all the EAG states of India. Janani Suraksha Yojana (JSY) under NRHM has made a sound impact on the number of institutional deliveries both among illiterate and lower socio-economic strata. Study conducted in a tertiary-care hospital of Madhya Pradesh, India, witnessed a 42.6% increase in institutional deliveries after implementation of JSY including those among rural, illiterate and primary-literate persons of lower socioeconomic strata (Gupta *et al.* 2012). Hence, the need of the hour is to understand the role of institutional delivery in improvement of neonatal mortality among EAG states of India.

Rationale of the Study

Studies focussed on exploring neonatal mortality have rarely considered the impact of place of delivery affecting the sensitive indicator of national development. A multiplicity of factors are involved for limited research in this direction. Majority of deliveries and neonatal deaths in rural areas take place at home and are not assisted by skilled birth attendants in EAG states. Also, a large number of endogenous factors are responsible for neonatal deaths which could take the shape of unhealthy status of mother during pregnancy leading to congenital malformation, low birth weight, premature birth. These factors which may result in loss of life of a new born often remain unidentified in case of deliveries being conducted at home and not assisted by trained attendants.

Moreover, most of the maternal and child deaths occur during labour, delivery and the first 24 hours postpartum as well as due to the pregnancy and delivery-related complications which gets difficult to be predicted or prevented in the absence of medically sound procedure to be followed during gestational and intrapartum period. Institutional protocols are difficult to be maintained at home. This demands further enhancing institutional deliveries as well as ameliorating the quality of care provided during the post-delivery hours to both the mothers as well as the neonatals. Identification as well as treatment of the problems is very expeditious in institutional deliveries as it is carried out in a well-equipped ambience.

The scheme of Janani Suraksha Yojana has been successful to a certain extent in achieving its objective of promotion of institutional deliveries. However, merely achieving the target of maximum institutional deliveries does not suffice the concern of minimising neonatal deaths. The need of the hour is to investigate whether the increase in institutional deliveries is conducive to improvement in neonatal survival particularly among the EAG states of India.

Objectives of the Study

The objectives of the study are:

1. To understand the trends in institutional deliveries and neonatal mortality rate.
2. To investigate the differentials in Neonatal Mortality by place of delivery among EAG states of India.
3. To explore the significant determinants of Neonatal Mortality in EAG states of India.

Data and Methodology

Data

Data has been used from the following sources:

1. Sample Registration System Statistical Reports, 2001-2012
2. District Level Household Survey (DLHS-3), 2007-08

We have used the published data of institutional deliveries, neonatal mortality rate and infant mortality rate from Statistical Report of Sample Registration System (SRS). The state level data are compiled for a period of 12 years, 2001-12 to understand the trends of Institutional Deliveries (ID), Neonatal Mortality Rate (NMR) and Infant Mortality Rate (IMR) in India over time. The SRS is the largest demographic survey in the country vested with the responsibility of providing reliable estimates of birth rate, death rate and infant mortality rate at the State and National level. The data collected in SRS regarding live births from 2004 provides information separately for deliveries conducted in 'Government Hospital' and 'Private Hospital'. For the required analyses, the broad categories of 'Government Hospital' and 'Private Hospital' have been merged into one category namely 'Institutional Delivery'. The time period 2001-12 is broadly classified into Pre-NRHM period (2001-04) and Post-NRHM (2005-12) period.

We have also used the unit data from the third round of District Level Household Survey (DLHS-3). The analysis is based on assessing the utilisation of place of delivery and its effect on neonatal mortality rate across EAG states of India. The DLHS-3 was a nationwide survey conducted during December 2007 to December 2008 by 17 research organizations under the technical supervision of International Institute for Population Sciences (IIPS). DLHS-3 interviewed ever married women (age 15-49) and never married women (age 15-24) unlike the previous two rounds which focussed on only currently married women aged 15-44 years. Information related to the programmes under the National Rural Health Mission (NRHM) was also collected in this round. A total of 7,20,320 households, 6,43,944 ever married women and 1,66,260 unmarried women were interviewed from 601 districts of India.

The ever married women questionnaire canvassed for DLHS-3 incorporated questions related to the outcome of pregnancy which was categorised into live birth, still birth, induced abortion and spontaneous abortion and it also included question related to the age at death of the new born. These

questions were asked for all pregnancies since January 1, 2004. However, the questions related to the place of delivery and assistance provided during delivery were asked only for the last pregnancy since January 1, 2004. The question on delivery was asked as: "Where did your last delivery take place?". The distribution of last pregnancy showed that 94.61% were live births, 0.95% were still births, 1.39% were induced abortions and 3.05% were spontaneous abortions. The question on conduct of last delivery was asked as: "Who conducted your last delivery?" The information provided was recoded into assistance provided by health personnel, dai, relatives/friends, someone and no one. We have confined our analyses to last live births only which was 2,16,013 of the last pregnancies.

The information about the age at death of the last birth which was recorded in days, months and years has been used to estimate the neonatal mortality. The cut-off point of neonatal mortality was used as 27 days of life. The information on place of last delivery was reclassified as "Institutional Deliveries", "Deliveries at home" and "Deliveries on the way to hospital/Workplace/Other". Similarly, a variable combining the EAG and Non-EAG states is computed. The information from the year 2004 to 2008 regarding year of births/abortions of the last pregnancy was categorized into "Pre-NRHM period (2004)" and "Post-NRHM period (2005-08)" to examine the role of NRHM in promoting institutional deliveries and in reducing neonatal deaths. The sampling weights for India as well as for different states have been provided in the data set. The missing cases have been excluded from the analyses.

Methodology

The methodology used in the analyses includes bivariate analyses, descriptive analyses, the ordinary least square (OLS) regression, estimation of neo-natal mortality rate, computation of composite index and Cox Proportional Hazard Regression Model. The dependent variable used in the study is Neonatal Mortality Rate. The independent variables used are place of delivery and type of delivery attendants, EAG and Non-EAG states, maternal education, age at marriage, marital status, wealth index, place of residence, working status of the women, sex of the child, maternal age at birth of the child, birth order, antenatal care, tetanus toxoid injection, Iron and Folic acid tablets, government financial assistance for delivery care under Janani Suraksha Yojana (JSY)/State Specific Scheme, NRHM, availability of toilet facility and delivery-related complications.

The trends of institutional delivery, neonatal mortality rate and infant mortality rate have been analyzed for 12 consecutive years (2001-12).While there are eight Empowered Action Group (EAG) states namely Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Uttarakhand, the SRS provided information of only seven EAG states except Uttarakhand. . The Non-EAG states have been clubbed into one category as "Non-EAG States".

To understand the effects of institutional delivery, and Pre and Post-NRHM period on Neonatal, OLS regression analyses are attempted for national level, Non-EAG and individual EAG states.

The regression equation used to understand the relationship of neonatal mortality rate, institutional delivery and time at state level is given as:

$NMR(i,t)=\alpha+\alpha_1.ID(i,t)+\alpha_2.\text{Pre-Post NRHM}(i,t)$

where i= State; t=Time Period (in years); NMR= Neonatal Mortality Rate; ID= Institutional Delivery; NRHM= National Rural Health Mission; α=constant; α_1, α_2= Coefficient of ID and Pre-Post NRHM respectively.

We have used the formula of Neonatal Mortality Rate to estimate the neonatal deaths per 1000 live births by place of delivery and different socio-economic, bio-demographic and health variables across EAG and Non-EAG states of India.

The Neonatal Mortality Rate (NMR) is estimated as:

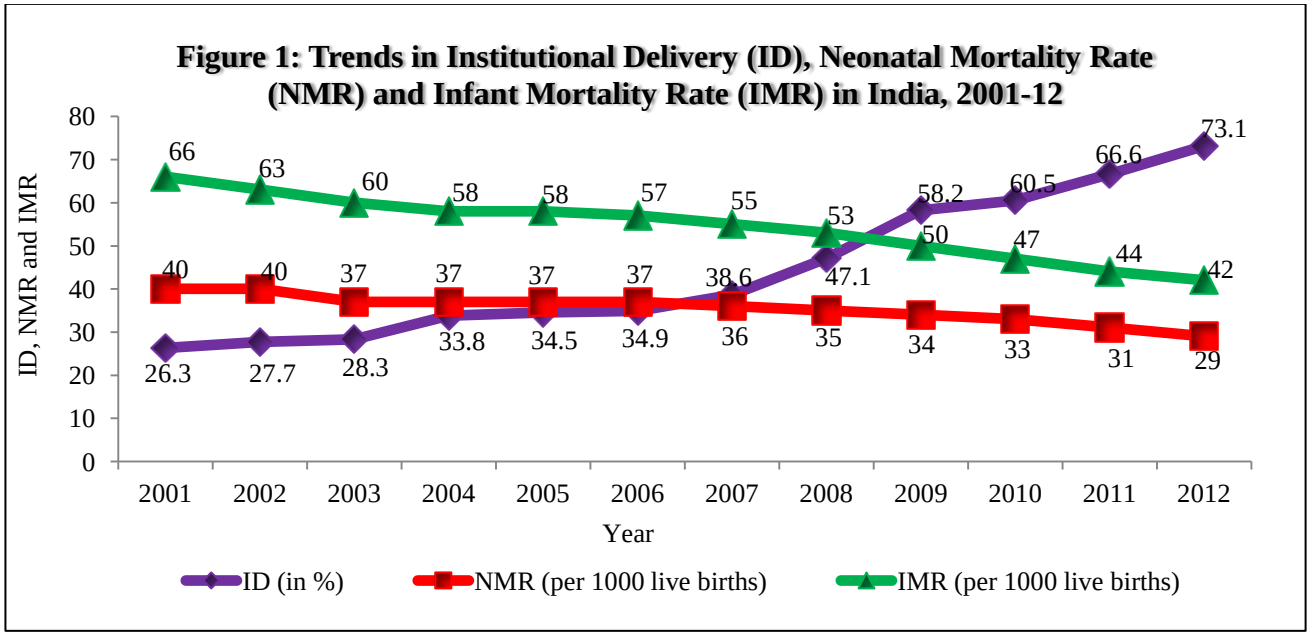
$$NMR = \frac{\text{Number of neonatal deaths within 27 days of life}}{\text{Total number of Live births}} \times 1000$$

We have used Cox Proportional Hazard Regression Model to examine the association between the study dependent and the independent variables through obtaining crude hazard ratio (HR) from univariable analyses and adjusted HR from multivariable analyses.

Findings

Trends in Institutional Deliveries, Neonatal Mortality Rate and Infant Mortality Rate in India

Figure 1 presents the trends in Institutional Delivery, Neonatal Mortality Rate and Infant Mortality Rate in India for the period 2001-12.



Source: SRS 2001-12

While the infant mortality rate has shown a declining trend, the institutional delivery has shown an increasing trend. The decline in neonatal mortality rate was slow and almost plateaus in the last four

years (2009-12). This indicates that the post neonatal mortality rate has declined faster than the neonatal mortality rate and has brought about a remarkable decline in infant mortality rate. Further decline in infant mortality rate is largely contingent with decline in neonatal mortality rate.

The institutional delivery has shown a record increase in last 12 years. The increase has been 26.3% in 2001 to 73.1% by 2012. The neonatal mortality rate has declined from 40 per 1000 live births in 2001 to 29 per 1000 live births by 2012. Similarly, the infant mortality rate has declined from 66 per 1000 live births in 2001 to 42 per 1000 live births by 2012. These results justify the heavy investment done under NRHM with the objective of reducing infant mortality rate in India by promoting institutional delivery among poor pregnant women.

State level analyses of Neonatal Mortality Rate and Institutional Delivery in Pre-NRHM (average of 2001-04) and Post-NRHM (average of 2005-12) period

To understand the role played by NRHM in bringing about a change in neonatal mortality rate and institutional delivery, we have carried out state level analyses in **Table 1** for pre and post-NRHM period. The average of years 2001-04 and 2005-12 has been considered as Pre-NRHM and Post-NRHM period respectively. During post-NRHM period, the institutional deliveries at the national level have increased by 78%. In EAG states, during post-NRHM period, the maximum percentage of institutional deliveries was observed in Rajasthan (51%) followed by Madhya Pradesh and Odisha (each having 46%), Chhattisgarh (40%), Bihar (35%), Uttar Pradesh (30%) and minimum in Jharkhand (23%). Among Non-EAG states, Kerala has shown the maximum percentage of 99% institutional deliveries during the post-NRHM period followed by 85% in Tamil Nadu and minimum of 44% in Assam. NFHS-3 reveals that Kerala is the only state with almost 100% deliveries being conducted in institutions. Due to its 100% institutional deliveries, high coverage of immunizations and universal health care, the state of Kerala is becoming an ideal model for the developing countries (IIPS and Macro 2007).

India has shown a decline of 12% in neonatal mortality rate during post-NRHM period. Among the EAG states of India, the maximum decline for neonatal mortality rate was observed in Bihar (14%) followed by Odisha (12%), Chhattisgarh (11%), Uttar Pradesh (9%), Madhya Pradesh (9%), Rajasthan (9%) and minimum by Jharkhand (7%). On the other hand, among the non-EAG states, the neonatal mortality rate of Tamil Nadu has shown a remarkable decline (35%) followed by Karnataka (24%) and then Assam (19%). The minimum decline was observed in Kerala (2%). Kerala tops the rank due to its lowest neonatal mortality rate in the country because of its rigorous training programmes of healthcare workers and inherent superior healthcare infrastructure.

The above increase in institutional delivery and decline in neonatal mortality rate is attributable to the increased central government expenditure on health particularly during the period 2004-11 as well as

the increased efforts under NRHM in addressing both the demand and supply constraints through increased public health expenditure for accessible, affordable and quality health care to the rural population particularly to the vulnerable groups (Mohanty and Srivastava, 2013).

Relationship of Neonatal Mortality Rate and Institutional Delivery in EAG and Non-EAG states of India

Table 2 shows the results of ordinary least square (OLS) regression analysis of Neonatal Mortality Rate for individual EAG and combined Non-EAG states of India. The independent variable in model 1 is institutional delivery and model 2 consists of two independent variables namely institutional delivery and time period i.e. Pre-NRHM (2001-04) and Post-NRHM (2005-12) period. In model 1, the regression coefficients of institutional deliveries for all the states as well as for India were negative (in the expected direction) and were significant for all states except Jharkhand. The regression coefficients of institutional delivery varied from -0.02 to -0.30 indicating that with increase in institutional deliveries the neonatal mortality rate decreases. For example, in the state of Chhattisgarh, for each additional unit increase in the institutional delivery, our model predicted a 30% decline in the neonatal mortality rate. Similarly, for each additional unit increase in the institutional delivery of Odisha, neonatal mortality rate declined by 29% and the decline for the state of Uttar Pradesh was 21%. The decline in the neonatal mortality rate for each additional unit increase in the institutional delivery among the Non-EAG states of India has been predicted to be 29%. Among EAG states, the maximum percentage decline in neonatal mortality rate has been observed for Chhattisgarh (30%) and minimum for Rajasthan (13%). 96% of the variation in the neonatal mortality rate has been explained by the institutional delivery and the remaining 4% can be attributed to unknown, lurking variables or inherent variability.

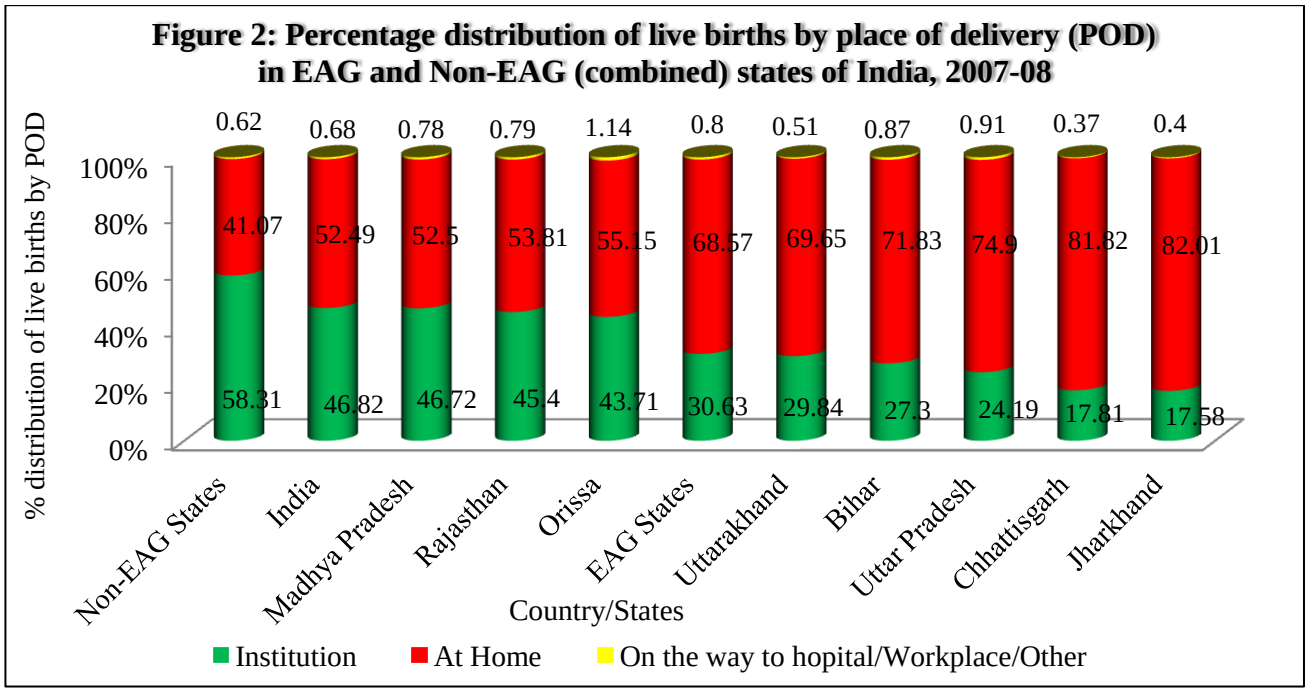
Model 2 of Table 2 presents the results of ordinary least square regression in terms of adjusted proportion of neonatal mortality rate in different EAG states as well as in India. Adjusting for Pre-Post NRHM, institutional delivery was a significant predictor of neonatal mortality rate except for the state of Jharkhand. For example, the adjusted percentage decline in neonatal mortality rate of India had been observed to be 19% for each additional unit increase in institutional delivery and for Non-EAG states, it was 31%. Among the EAG states of India, the adjusted percentage decline in neonatal mortality rate was maximum for Odisha (34%) and minimum for Bihar (11%). The decline for the state of Rajasthan had been observed to be 15% for each additional unit increase in institutional delivery. Similarly, pre-post NRHM period was a significant predictor of neonatal mortality rate but only for the state of Bihar. The adjusted regression coefficient with respect to Post-NRHM period (2005-12) was -3.12 for Bihar indicating that a significantly lower risk of neonatal mortality was found during Post-NRHM period compared to Pre-NRHM period. In this model also, 96 per cent of the variation in the neonatal mortality rate had been explained by the institutional delivery as well as

Pre-Post NRHM period and the remaining 4 per cent can be attributed to unknown, lurking variables or inherent variability.

Distribution of live births across EAG States of India by Place of Delivery

Figure 2 presents the insights into the percentage distribution of live births by place of delivery across different EAG states of India. Around 52% of the deliveries in India were conducted at home, 47 % in institutions and the remaining 1% of the deliveries took place on the way to hospital/workplace/some other place. In case of EAG states, majority of the deliveries (68%) were conducted at home and the contribution of the institutional delivery was only 31%. Of the total live births in the EAG States, Uttar Pradesh had the highest proportion of births (32%) followed by Bihar (18%), Madhya Pradesh (14%) and lowest by Uttarakhand (4%). But the percentage of home deliveries was highest in the state of Jharkhand (82%) followed by Chhattisgarh (81.82%), Uttar Pradesh (75%), Bihar (72%), Uttarakhand (70%), Orissa (55%), Rajasthan (54%) and lowest in Madhya Pradesh (53%).

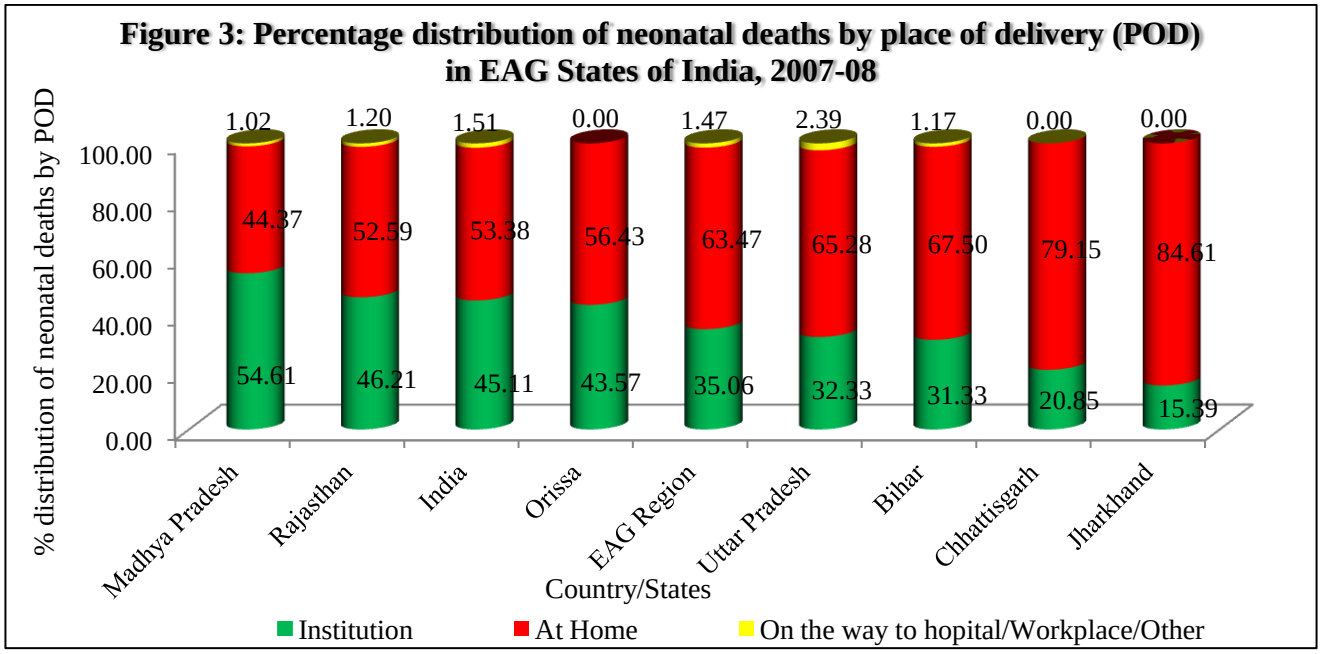
Madhya Pradesh topped the rank among all EAG states in the number of deliveries being conducted in institutions (47%) followed by Rajasthan (45%), Orissa (44%), Uttarakhand (30%), Bihar (27%), Uttar Pradesh (24%) and the minimum by Chhattisgarh and Jharkhand (18%). A very insignificant percentage of deliveries were observed to be conducted on the way to hospital/workplace/some other place. The situation gets reversed in case of Non-EAG states of India. These states have performed better in terms of the place of delivery compared to EAG states with around 58% of the deliveries happening in institution and 41% at home.



Source: DLHS-3 (2007-08)

Distribution of neonatal deaths across EAG States of India by Place of Delivery

Figure 3 presents the percentage distribution of neonatal deaths by place of delivery in EAG states of India. In India, more than 50% neonatal deaths were observed among the live births delivered at home compared to 45% among those delivered in institution.



Source: DLHS-3 (2007-08)

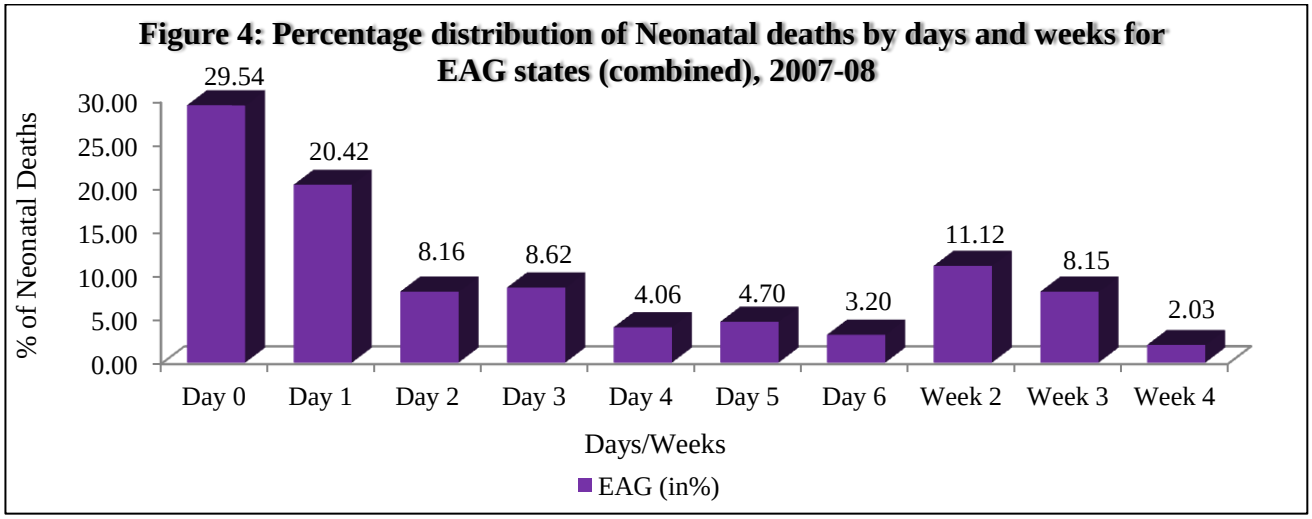
The EAG region needs priority focus due to its high percentage (63%) of the neonatal deaths among those delivered at home than 35% of the neonatal deaths among those delivered in institution. This might be due to the unskilled assistance provided by birth attendants for deliveries at home. The state of Jharkhand topped the rank in maximum number of neonatal deaths occurring at home due to its highest percentage of live births accounting for home deliveries. The percentage of neonatal deaths occurring at home for the state of Chhattisgarh is 79% followed by Bihar (68%), Uttar Pradesh (65%), Orissa (56%), Rajasthan (53%) and the minimum was for Madhya Pradesh (44%) among the EAG states due to its low level of home deliveries. 15% of the neonatal deaths in the state of Jharkhand were institutional while the maximum percentage was accounted by Madhya Pradesh (55%).

A very negligible percentage of neonatal deaths were happening on the way to hospital/workplace/some other place with the maximum percentage being contributed by the state of Uttar Pradesh (2%) out of all EAG states of India.

Neonatal Deaths by days and weeks

Figure 4 presents the percentage distribution of neonatal deaths by days and weeks for EAG states (combined) of India. The maximum neonatal deaths were observed before the completion of the first day or within 24 hours (30%) followed by the first day (20%). However, it was observed that with increase in duration of the neonatal, a substantial decline was observed among the neonatal deaths. EAG states have shown quite a high percentage of neonatal deaths during the second week (11%) compared to third (8%) and fourth (2%) week. These demographically lagging states contribute

around 67% of the neonatal deaths followed by Non-EAG states (33%). India contributes around 61% of neonatal deaths to the under-five mortality.



Source: DLHS-3 (2007-08)

Determinants of Neonatal Mortality in EAG states of India

Table 3 presents the results of unadjusted and adjusted hazard ratio of neonatal mortality using Cox Proportional Hazard Regression Model for EAG states of India. Among the combined effect of place of delivery and type of delivery attendants, those who delivered in institution with the assistance of health personnel were taken as a reference category. Although insignificant, but among the various combinations of place of delivery and type of delivery attendants, results suggested that the risk of neonatal mortality was reduced by 6% among those children whose mothers delivered at home with the assistance of health personnel, the risk increased insignificantly by 44% among those children whose mothers delivered at home without any assistance. However, a significantly reduced risk of 10% was evident among mothers delivered at home with the help of dai. Among those mothers who delivered at home with the assistance of relatives/friends, the risk of neonatal mortality in EAG states increased significantly by 17% and by more than two times among those delivered on the way to hospital/workplace/other and assisted by no one.

Amongst the various socio-economic variables, maternal education, wealth index, place of residence and working status of the mother had a significant impact on neonatal mortality. With respect to maternal education, the risk of neonatal mortality reduced by 57% among children born to mothers with higher education, 39% among those born to mothers with secondary education and 8% among those born to mothers with primary education. The risk of neonatal mortality involved in EAG states reduced significantly by 35% among children for richest wealth index mothers and by 11% for children of mothers belonging to middle class. However, children born in urban areas of EAG states had a significantly reduced hazard of mortality compared with rural areas. In settings where the mother of the new born was employed, the children were associated with an increased risk of 14%.

With respect to various bio-demographic factors, our analysis found that female births had a comparatively lower hazard of neonatal mortality compared with male births. Children of second birth order were associated with a significantly reduced risk of 35% compared to children of first birth order. Similarly, the risk was lowered significantly by 33% and 15% among children of third birth order, and fourth and above birth orders respectively. The protective effect of maternal age at childbirth was evident in our analysis for EAG states. Children born to mothers of age-group 25-29 had the maximum reduced risk of 16%. In situations where the maternal age during childbirth was less than 19 years and 34-49, an increased hazard of 32% and 30% respectively was observed. The results were found to be statistically significant.

Among the various constituents of health care variables, only ANC checks during delivery was found to have a significant impact on neonatal mortality in EAG states. Neonatal mortality was lowered by 18% among children whose mothers received ANC checks during pregnancy. Although insignificant, an increased risk of 6% was observed among children whose mothers were confronted with delivery-related complications. Statiscally significant effect on neonatal mortality was witnessed during post-NRHM period and among children of mothers who received assistance under JSY scheme. The mortality among children was declined by 95% during post-NRHM period as well as by 29% among those children whose mothers were associated with JSY scheme.

Adjusted neonatal mortality of EAG states for place of delivery and type of delivery attendants indicates that the mortality was reduced significantly by 32% among those children whose mothers delivered at home with the help of dai and by 22% among those whose mothers delivered at home with the assistance of health personnel compared with mothers who delivered in institution and the delivery was assisted by health personnel.

Among the socio-economic factors, maternal education and marital status emerged as strong and significant determinants of neonatal mortality. The risk was lowered by 48% among children whose mothers received higher education compared to mothers without any formal education. Risk associated with neonatal mortality increased by more than two times among children born to separated/deserted/divorced women compared to women belonging to widowed category. The sex of the child, birth order and maternal age at childbirth varied largely and had a significant effect on neonatal mortality. Female births had a reduced risk of 12% compared to male births in EAG states of India. Children of second birth order experienced the maximum decline of 27% risk associated with neonatal mortality, followed by 24% decline among third birth order children and minimum reduction of 15% among fourth and above birth order children. A decline of 13% risk was observed among the infants borne by mothers of age-group 25-29 years concomitant by 20% increased risk among children of mothers less than 19 years.

The protective role of ANC checks was evident amongst infants born to mothers who received these checks. The risk of neonatal mortality was significantly reduced by 14% among infants whose mothers attended these ANC services. However, in case of delivery-related complications, a significantly increased risk of 12% was observed among children whose mothers faced complications. The significant effect of NRHM in EAG states brought about a 94% decline in neonatal mortality during post-NRHM period. Neonatal mortality was significantly lowered by 37% among children whose mothers received benefits of JSY.

Discussion

The theoretical foundation of the study before assessing empirically the relationship between institutional delivery and neonatal mortality revealed that children whose mothers delivered outside health institutions experience higher odds of neonatal mortality than those delivered within health institutions. Institutional delivery is considered as a keystone in reducing the neonatal mortality and improving the overall health of the newborns under Janani Suraksha Yojana (JSY). This safe motherhood intervention was initiated with a priority focus on low performing states especially eight EAG states. Moreover, it was felt that the financially weak sector of the society aspire to get well-equipped treatment especially when it comes to women's reproductive rights of safe delivery but not at the high cost charged by the health institutions which they are incapable of incurring. Considering this, the need was felt to examine the role of institutional deliveries in improving neonatal survival specifically in Empowered action Group (EAG) States of India.

The increase in institutional delivery was prodigious during the period 2001-12 in India. However, the decline in neonatal mortality rate was slow and showed borderline variations. This implies that the sharp decline in infant mortality rate was largely due to decline in post neonatal mortality. The percentage decline in neonatal mortality rate was maximum during the period 2009-12 which highlights the intensification of NRHM during this period. The relationship of neonatal mortality rate and institutional delivery at state level suggested that the institutional delivery was a significant factor in reducing neonatal mortality rate in both EAG and Non-EAG states. However, controlling for institutional delivery, we observed that the decline was significant only in the state of Bihar during post-NRHM period. The improved governance in Bihar since last few years has led to an increased investment on health care infrastructure, better health facilities and greater emphasis on educational aspect (SPIP 2012-13).

The state of Jharkhand has shown lowest institutional delivery as well as minimum decline in neonatal mortality rate during post-NRHM (2005-12) period. There is a need for effective, efficient and strengthened health promotion programmes particularly in rural and remote areas of Jharkhand that could work both at community as well as individual level to create awareness regarding the need for institutional delivery. The maximum significant decline with each additional unit increase in

institutional delivery was found in Chhattisgarh followed by Odisha and Uttar Pradesh. However, controlling for pre-post NRHM period, Odisha has shown the maximum decline in neonatal mortality with each additional unit increase in institutional delivery. A significantly lower risk of neonatal mortality was found only in the state of Bihar during Post-NRHM period compared to Pre-NRHM period.

The findings of DLHS-3 indicated that around 47% deliveries in India were conducted at home, 52% in health institutions and 1% on the way to hospital/workplace /other. However, the demographically lagging EAG states revealed that more than two-thirds of the deliveries were conducted at home and 31% in health institutions. Nevertheless, the neonatal mortality rate of institutional deliveries for EAG states was quite high compared to neonatal mortality rate in case of home deliveries. On the other hand, the comparison of neonatal mortality rate for institution and at home in case of Non-EAG states did not reveal much difference. The rise in neonatal deaths among institutional deliveries in EAG states could be due to the fact that pregnancies resulting in complications from prolonged labour and prematurity are often referred to medical institutions. However, lack of well-equipped infrastructure to respond to crisis, non-availability of obstetric emergency care, lack of transportation facilities to deal with emergency cases add to the loss of lives in health institutions.

Madhya Pradesh experienced the maximum institutional delivery coverage (47%), and minimum by Chhattisgarh and Jharkhand each having 18% coverage. About 55% of the institutional deliveries in Madhya Pradesh were confronted with neonatal mortality. This indicates poor quality of care received by a newborn after childbirth even at health centres. Home-delivered children in Chhattisgarh and Jharkhand were seen to have high neonatal mortality due to their more than 80% of the births being delivered at home. Neonatal mortality in EAG states accounted for 67% of total under-five mortality with the maximum deaths occurring within 24 hours of delivery.

In EAG states, it was observed that delivering at home with the assistance of dai was associated with a significantly lower risk of neonatal mortality compared to delivering in health institutions with the assistance of health personnel. The analysis of unit data from District Level Household Survey-3 did not support the state level analysis done using Sample Registration System data which confirmed institutional delivery as a significant determinant in reducing neonatal mortality. On the other hand, the reduction in neonatal mortality post 2005 period was confirmed in our study.

Among the various EAG states, it was found that the risk of neonatal mortality was reduced significantly by 59% only in the state of Uttarakhand controlling for other variables. Our analyses provided further understanding of the extent of reduction in neonatal mortality among females compared to males as well as among second birth order children and the differences were statistically significant. Among the various socio-economic factors, maternal education emerged as a powerful determinant of neonatal mortality in the EAG states due to the reason that higher education of a

woman is associated with better utilisation of maternal-child health care services. The protective cover of ANC was evident in our analyses. We have observed that JSY through its financial assistance incentive for delivery care has made a notable impact in reducing neonatal mortality.

Women face different barriers in achieving timely and efficient health care services which might prevent the loss of maternal and new-born lives. Three delays exist that handicap women to avail the required health care services: delay in decision to seek care, delay in reaching care and delay in receiving adequate health care. These delays might result in reporting of institutional neonatal deaths.

Mobile clinics with medically sound treatment should come up towards a move for reducing neonatal mortality. The availability, accessibility and affordability of the emergency obstetric care services in both rural and urban areas should be given a top-notch priority so that women in need receive a timely medical attention. There is a need to strengthen the Information, Education and Communication (IEC) system particularly in EAG states so that women are aware and sensitized on the essentials of institutional delivery. There is a need to undertake primary care research within institutions to understand the quality of care provided to mothers and new-borns so that any pregnancy terminating in death could be avoided. Moreover, the improved quality of care would improve the neo-natal survival and achieve health related millennium development goals.

Conclusion

Based on our analyses, we conclude that though the institutional deliveries have increased significantly in EAG states, it is not resulting in decline of neonatal mortality. On the other hand, there are no differences in neonatal mortality rate among deliveries in institutions and at home of Non-EAG states. Accordingly, it is suggested to improve the quality of new-born care in health centres so as to improve the neo-natal survival and achieve health related millennium development goals. More precisely, investment on newborn care in Empowered Action Group States is called for.

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Table 1: Institutional Delivery (ID), Neonatal Mortality Rate (NMR) and Infant Mortality Rate (IMR) in Pre-NRHM (average of 2001-04) and Post-NRHM (average of 2005-12) period in India

State	ID (in %)		NMR per 1000 live births		% change	
	Pre-NRHM (2001-04)	Post-NRHM (2005-12)	Pre-NRHM (2001-04)	Post-NRHM (2005-12)	ID	NMR
India	29	52	38.50	34.00	78.08	-11.69
EAG States						
Bihar	17	35	35.75	30.75	99.14	-13.99
Chhattisgarh	23	39	43.00	38.50	72.96	-10.47
Jharkhand	12	23	26.00	27.88	96.53	7.21
Madhya Pradesh	18	46	51.00	46.25	158.61	-9.31
Odisha	20	46	52.00	45.63	133.46	-12.26
Rajasthan	13	51	45.00	41.00	299.61	-8.89
Uttar Pradesh	11	30	48.00	43.50	186.00	-9.38
Non-EAG States						
Andhra Pradesh	46.18	73.95	38.25	31.63	60.15	-17.32
Assam	22.20	43.86	40.50	32.63	97.58	-19.44
Delhi	61.30	73.23	20.00	19.00	19.45	-5.00
Gujarat	40.40	69.95	38.75	33.88	73.14	-12.58
Haryana	26.98	51.59	33.25	32.63	91.24	-1.88
Himachal Pradesh	26.83	48.73	34.75	31.00	81.64	-10.79
Jammu & Kashmir	46.20	61.98	38.00	35.88	34.15	-5.59
Karnataka	51.73	74.80	33.50	25.38	44.61	-24.25
Kerala	97.55	99.34	8.00	7.88	1.83	-1.56
Maharashtra	50.78	74.99	27.50	22.88	47.69	-16.82
Punjab	23.75	58.34	31.75	26.25	145.63	-17.32
Tamil Nadu	67.3	85.76	30.25	19.75	27.39	-34.71
West Bengal	38.5	58.39	29.75	25.50	51.66	-14.29

Source: SRS 2001-12

Table 2: Result of Ordinary least square regression analysis of Infant Mortality in EAG and Non-EAG states of India

Country/State	Model 1				Model 2				
	α_1	α	R^2	N	α_1	α_2	α	R^2	N
India	-.44 (14.36)***	73.96 (51.20)***	0.95	12	-.40 (10.04)***	-1.79 (1.33)	73.54 (51.54)***	0.96	12
Non-EAG States	-.51 (15.26)***	73.23 (34.16)***	0.61	150	-.54 (14.65)***	3.64 (2.03)**	72.77 (34.10)***	0.62	150
EAG States									
Bihar	-.49 (13.61)***	69.48 (61.30)***	0.95	12	-.49 (10.37)***	0.15 (0.11)	69.47 (58.07)***	0.95	12
Chhattisgarh	-.38 (12.87)***	69.91 (58.70)***	0.96	9	-.40 (12.57)***	1.57 (1.11)	69.00 (48.36)***	0.97	9
Jharkhand	-.35 (10.05)***	52.73 (60.54)***	0.94	9	-.35 (8.84)***	-0.53 (0.37)	53.11 (38.24)***	0.94	9
Madhya Pradesh	-.46 (11.91)***	89.26 (55.20)***	0.93	12	-.38 (10.68)***	-5.34 (3.57)***	89.72 (81.32)***	0.97	12
Odisha	-.61 (11.25)***	94.43 (42.41)***	0.93	12	-.50 (8.34)***	-5.92 (2.63)**	94.30 (53.41)***	0.96	12
Rajasthan	-.36 (12.12)***	78.57 (57.66)***	0.94	12	-.32 (7.99)***	-3.03 (1.40)	79.08 (58.53)***	0.94	12
Uttar Pradesh	-.54 (9.45)***	81.46 (50.89)***	0.90	12	-.45 (7.74)***	-4.65 (2.47)**	82.51 (60.29)***	0.94	12

Figures in parentheses are t-statistics. Source: SRS 2001-12

*** p< 0.01; ** p< 0.05; * p<0.1

Table 3: Hazard Ratio (HR) of neonatal mortality by socio-economic, bio-demographic, health care, and time and programme determinants for EAG States (combined) of India: the results of multivariate analysis, DLHS-3 (2007-08)

Variables	N	Unadjusted			Adjusted		
		HR	p value	(95% CI)	HR	p value	(95% CI)
Socio-economic Variables							
Maternal Education	73581						
No Formal Education ®		1.00			1.00		
Primary education		0.92	0.072*	(0.839-1.008)	0.91	0.132	(0.802-1.029)
Secondary Education		0.61	0.000***	(0.525-0.714)	0.63	0.000***	(0.516-0.779)
Higher education		0.43	0.000***	(0.307-0.608)	0.52	0.001***	(0.350-0.780)
Marital Status	73601						
Widowed ®		1.00			1.00		
Currently Married		0.76	0.332	(0.435-1.324)	1.54	0.287	(0.694-3.429)
Separated/ Deserted/ Divorced		1.58	0.206	(0.777-3.232)	2.37	0.087*	(0.882-6.360)
Wealth Index	73602						
Poorest ®		1.00			1.00		
Poorer		0.94	0.244	(0.849-1.043)	0.90	0.164	(0.784-1.042)
Middle		0.89	0.058*	(0.796-1.004)	0.97	0.680	(0.830-1.129)
Richer		0.90	0.103	(0.794-1.022)	1.05	0.585	(0.884-1.245)
Richest		0.65	0.000***	(0.551-0.762)	0.92	0.507	(0.729-1.169)
Place of Residence	73602						
Rural ®		1.00			1.00		
Urban		0.86	0.013**	(0.756-0.967)	0.97	0.728	(0.829-1.140)
Working Status	49624						
Not worked in last 12 months ®		1.00			1.00		
Worked in last 12 months		1.14	0.072*	(0.989-1.303)	1.07	0.375	(0.925-1.229)
Bio-demographic factors							
Sex of the child	73594						
Male ®		1.00			1.00		
Female		0.82	0.000***	(0.756-0.890)	0.88	0.013**	(0.792-0.973)
Birth Order	73589						
First ®		1.00			1.00		
Second		0.65	0.000***	(0.585-0.733)	0.73	0.000***	(0.630-0.844)
Third		0.67	0.000***	(0.594-0.766)	0.76	0.003***	(0.640-0.913)
Fourth and above		0.85	0.001***	(0.771-0.938)	0.85	0.067*	(0.706-1.012)
Maternal Age at birth of the child	73602						
20-24 ®		1.00			1.00		
Less than 19		1.32	0.000***	(1.178-1.486)	1.20	0.017**	(1.034-1.391)
25-29		0.84	0.001***	(0.752-0.928)	0.87	0.061*	(0.755-1.007)
30-34		0.99	0.824	(0.863-1.124)	0.85	0.113	(0.687-1.041)
35-49		1.30	0.001***	(1.118-1.513)	1.18	0.171	(0.932-1.492)
Health Care Services							
Antenatal Care during pregnancy	73591						
Not Received ®		1.00			1.00		
Received		0.82	0.000***	(0.755-0.889)	0.86	0.008***	(0.767-0.962)
Delivery-related complications	73579						
Not Experienced ®		1.00			1.00		
Experienced		1.06	0.194	(0.970-1.159)	1.12	0.051*	(1.000-1.261)
Place of Delivery and Type of Delivery Attendants	73588						
Mother delivered in institution and assisted by health personnel ®		1.00			1.00		
Mother delivered at home and assisted by health personnel		0.94	0.510	(0.790-1.124)	0.78	0.036**	(0.623-0.984)

Table 3: Continued

Variables	N	Unadjusted			Adjusted		
		HR	p value	(95% CI)	HR	p value	(95% CI)
Mother delivered at home and assisted by dai		0.90	0.024**	(0.814-0.986)	0.68	0.000***	(0.587-0.784)
Mother delivered at home and assisted by relatives/friends		1.17	0.004***	(1.051-1.309)	0.91	0.269	(0.774-1.074)
Mother delivered at home and assisted by no one		1.44	0.188	(0.837-2.477)	0.90	0.798	(0.388-2.071)
Mother delivered on the way to hospital/workplace/other and assisted by someone		1.67	0.003***	(1.194-2.333)	1.13	0.614	(0.710-1.788)
Mother delivered on the way to hospital/workplace/other and assisted by no one		2.22	0.242	(0.584-8.448)	2.76	0.123	(0.761-9.988)
Time and Programmes							
NRHM	73602						
Pre NRHM ®		1.00			1.00		
Post NRHM		0.05	0.000***	(0.049-0.062)	0.06	0.000***	(0.0477-0.066)
Janani Suraksha Yojana	73593						
Not Received ®		1.00			1.00		
Received		0.71	0.000***	(0.620-0.807)	0.63	0.000***	(0.529-0.760)

® Reference Category

***p<0.01; **p<0.05; *p<0.1