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SPATIAL-TEMPORAL CHANGE IN INFANT MORTALITY AND ITS DETERMINANTS IN BIHAR, INDIA

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ABSTRACT

It is well known that Bihar is one of the demographic backward state having relatively high rates of poverty and malnutrition, and this has been suggested as the reason for the high fertility and infant mortality observed across the district. However, the study attempt to examine spatial-temporal change in infant mortality and its determinants in Bihar. The district level estimates of IMR manifests that all districts have still high infant mortality. The infant mortality is higher in rural areas than that of urban areas over the period. Similar differences are observed across the educational groups. Infant mortality also varied largely across the economic groups, i.e. the poorest has higher IMR than richest. All most all background characteristics have experienced decline in IMR, while only schedule caste has experienced increased in IMR. The Cox proportional hazard risk is used to understand the significant predictors of IMR. Results evidenced that once again socio-economic variables such as education of mother and household economic status emerged as key predictors in case risk of infant mortality.

INTRODUCTION

Mortality analysis is one of the most-useful inputs to the developmental programs such as education, reproductive and child health services, population stabilization and human development at both the national and sub-national levels. The National Population Policy launched in 2000 has a medium term objective to achieve the replacement level fertility by 2010. This also envisages states to bring their policies, giving priority to local issues in coherence with the goals and objectives prescribed in the national policy. Henceforth, several states have brought out their policies to attain the below 35 infant death per thousand live birth within a rational time frame and the prevailing socio-economic status of the people. Accordingly, many of the state achieved this goal, but the condition is worse in Bihar. Moreover, infant mortality rate also varies substantially across the districts of Bihar. However, to achieve such an objective one needs to understand the variations in Infant Mortality within the state and socio-demographic and maternal care determinants of infant mortality. Therefore, the district level IMR estimates and determinant factors are not only appropriate, but also necessary to execute any policy or program effectively.

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Determinants of Infant Mortality

Socio-economic factors such as place of residence, women's education, and economic condition known as powerful determinants of infant and child mortality. Bhattacharya (1999) discussed socio-economic factors, which influence child survival in less developed countries, which include the proximate determinants, like infection, food intake, nutritional status, disease control, maternal factors, and injury. Bhuiya & Streatfield (1991) have investigated about the positive effect of mother's education on child survival. Educated mother is better able to judge the gravity of an illness, to understand the capabilities of modern medicines and therefore to seek appropriate care for a sick child at the right time which has a significant negative effect on child mortality (Caldwell, 1979). Mortality levels are found to be higher in rural areas than urban not only by reason of their economic condition but also by their access to medical and education facilities (Jain, 1985; Mahy, 2003). Religion and caste are known to affect many aspects of life in India and are likely to affect levels of infant and child mortality as well. Effect of religion and caste arise due to the difference in the lifestyle based on tradition and beliefs (Pandey *et al*., 1998). Membership of the head of the household to an SC/ST is known to affect many aspects of the life of their families, particularly survival of the newborn.

Such effects reflect differences in lifestyle based on traditions or beliefs and practices related to childbearing, childbirth, child feeding and health care. However, between caste groups, the differences in adjusted mortality rates are much smaller than the difference between the unadjusted mortality rates (Pandey *et al*., 2005). In India, the explanatory power of per capita income as a determinant of cross-state differences in child mortality is weak because there are other factors, not necessarily correlated with income, that have significant effects on child mortality (Murthi *et al*., 1995). Also, Indian studies used household data found a small but significant effect of wealth index on infant mortality (Kishor & Parasurman, 1998). An association has been observed between maternal age at birth and infant mortality, with elevated risks of child loss for teenage and older mothers (Bicego and Ahmad 1996; Manda 1998). A plausible explanation for this association is that very young mothers tend to be socially and economically disadvantaged and they use antenatal services less frequently (Geronimus and Korenman 1993). Elevated mortality risks for births to older mothers are thought to be a result of complications associated with high parity and low use of obstetric services (Magadi *et al*., 2000).

The complex relationship between birth order and mortality is not well understood. In general, mortality is higher among first birth, which is usually explained by the observation that many mothers have their first child before having reached physical and reproductive maturity (Sullivan, 1994). Another studies found that the birth order of child has strong effect on the survival of first year of life but the effect diminished there after (Kabir *et al*., 1995).Other explanations for death clustering within families are: parenting competence (Das Gupta 1997; Pebley *et al*., 1996); feeding practices (Madise and Mpoma 1997) including breastfeeding patterns (Sastry 1997); and the use of health services (Steele *et al*., 1996; Matthews and Diamond 1997). In this study, we use tetanus immunization, antenatal visits and postnatal visits to assess the impact of prenatal care on the reduction of infant mortality

Data

The present paper is base on the secondary data obtained from census of India and second and third round of District Level Household Survey. An attempt has been made to understand the spatial-temporal change in infant mortality in Bihar. To trend analysis of infant mortality rate at districts level estimates of Registrar General of India for 1981 and 2001 is used. Census of India provides district level total numbers of woman, children ever born and total birth of last year; this information are used to estimate the infant mortality rate for 1991(Registrar General of India 1997). District Level Household Survey provides the information son and daughter at home; son and daughter live elsewhere and the total number of death boys and girls. This information used to estimate for children ever born and children survive then have estimated to infant mortality rate. All these information are used to examine spatial-temporal change in infant mortality.

MATERIALS AND METHODS

Mortality estimation: Most of the indirect estimates of IMR and child mortality are based on this method. Brass was the first to develop the procedure to convert proportion dead of children ever born by women in age groups 15-19, 20-24, etc. into estimation of the probability of dying before attaining certain exact childhood ages. The basic data required for this method are:

a. The number of children ever born, classified by sex and by five year age group of women39
b. The number of children surviving (or the number of children dead), classified by sex and by five year age groups of women
c. The total number of women (irrespective of marital status), classified by five year age groups

As a first step, average parity per woman is computed as

$$P(i) = CEB(i)/FP(i)$$

Where CEB (i) is the children ever borne by women in age group i and FP (i) is the total number of women in age group i. In the second step the proportion of dead children for each age group of mother is defined as

$$D(i) = CD(i)/CEB(i)$$

or

$$D(i) = 1\text{-}CS(i)/CEB(i)$$

Where CD (i) is the number of children dead reported to women in age group i. The multiplier k (i) is calculated for non mortality factors determining the value of D(i)

The equation of $k(i)= a(i)+ b(i)\,(P(1)/P(2))+c(i)(P(2)/P(3))$

The probability of dying is calculated as

$$q(x)= k(i)* D(i).$$

The data required are mean CEB and mean CS by five year age groups, mean age at child bearing and month and year of survey. The demographic package MORTPAK, developed by the United Nation is used for such an exercise. The main data source of such estimates is the national census as well as the large scale household surveys. (Note: This method used by MORTPAK4.)

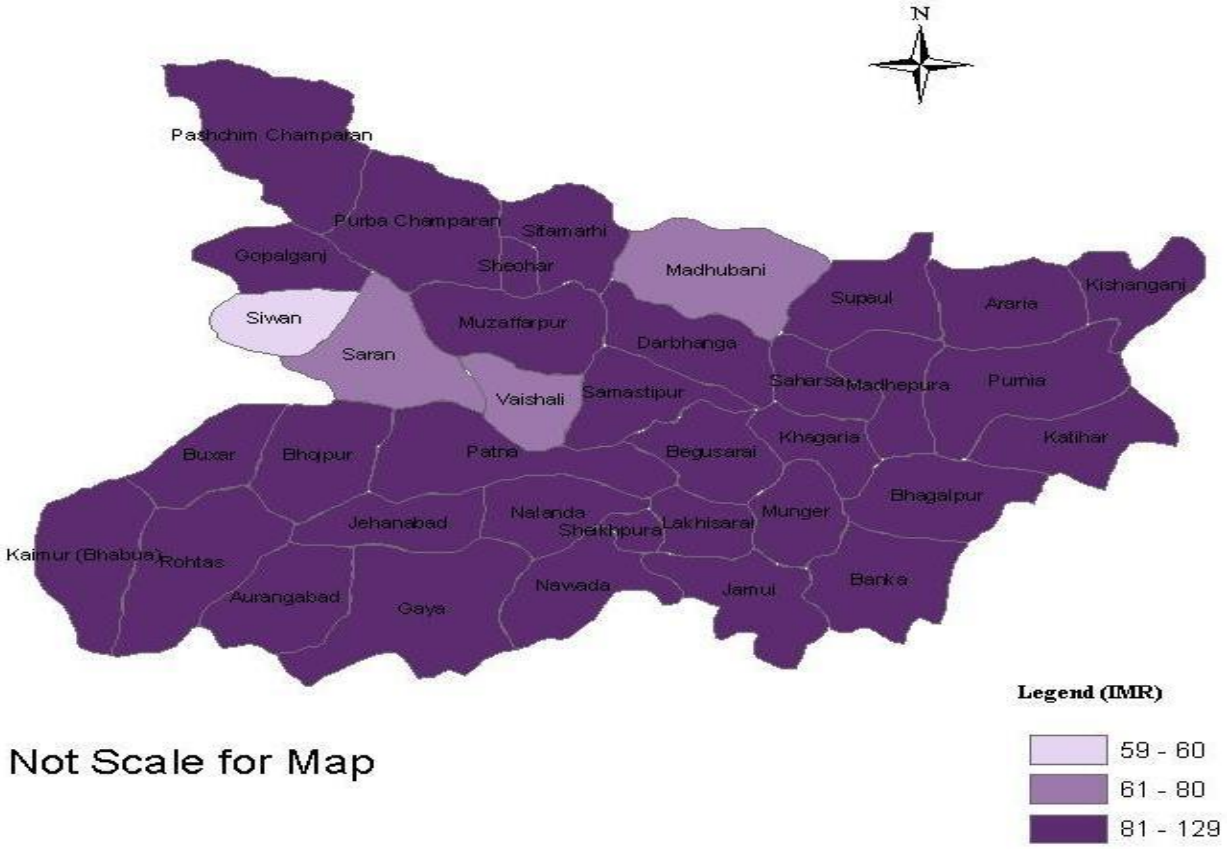
Determinants of infant mortality: To know the relative risk to survival of infants by Scio-economic and heath care utilization and bio demographic variables, proportion hazard model (Cox, 1972) has been fitted. The proportionally assumption has been tested using appropriate statistical techniques. The function from of the method may be given as below;

$$h(t, x)=h_o(t)\, e^{Xi\beta}$$

Where $h_o(t)$ is the baseline hazard function. 'Xi's are the covariates taken in to the model. The results in this paper are shown in terms of relative risk.

Dependent variable: Child is alive or not alive (create the dummy 0 alive and 1 not alive) and time variable is age in month.

District-wise Infant Mortality Rate in Bihar,1981



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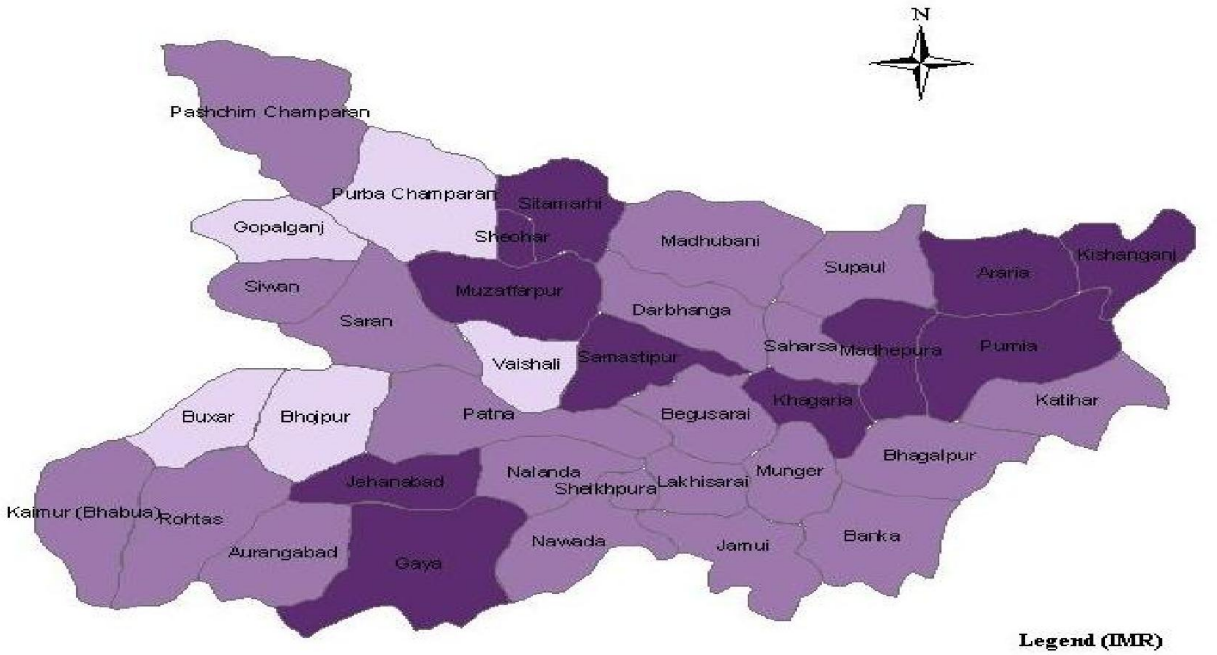
District-wise Infant Mortality Rate in Bihar, 1991



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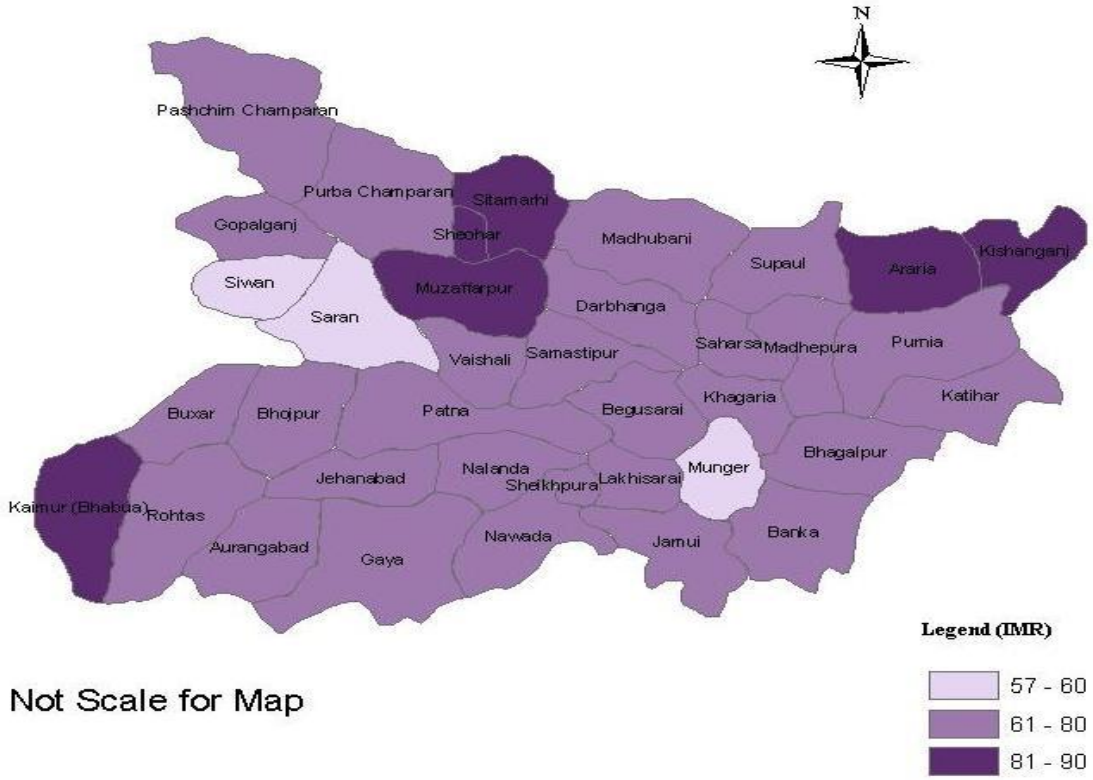
District-wise Infant Mortality rate in Bihar 2001



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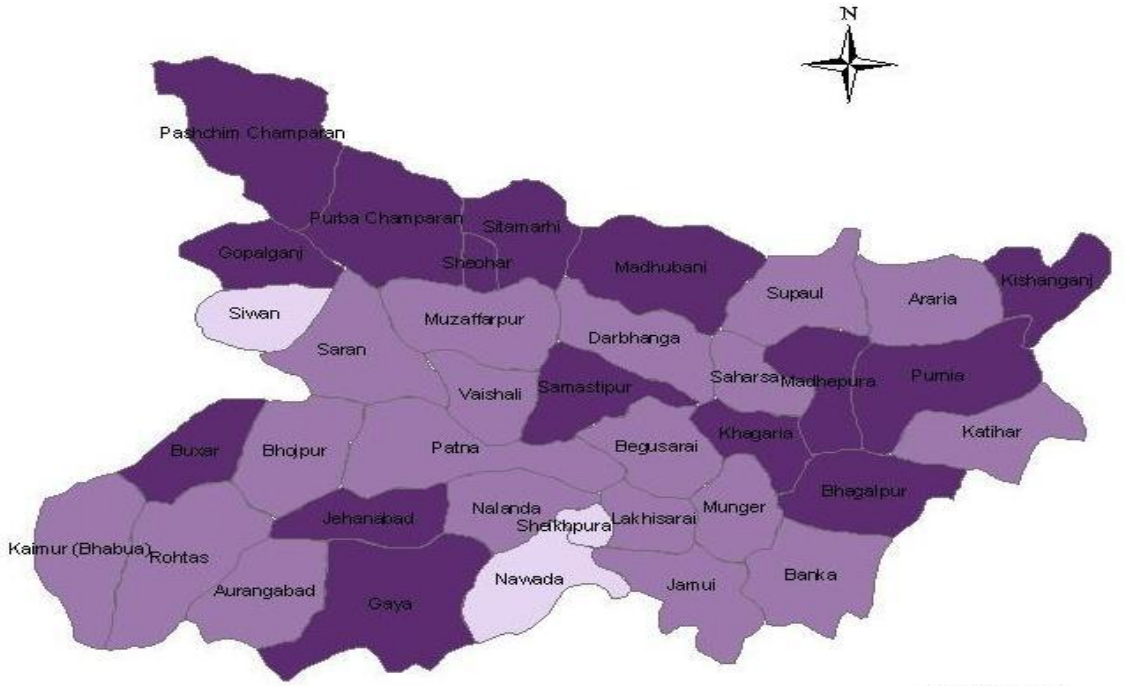
District-wise Infant Mortality Rate in Bihar, 2002-04



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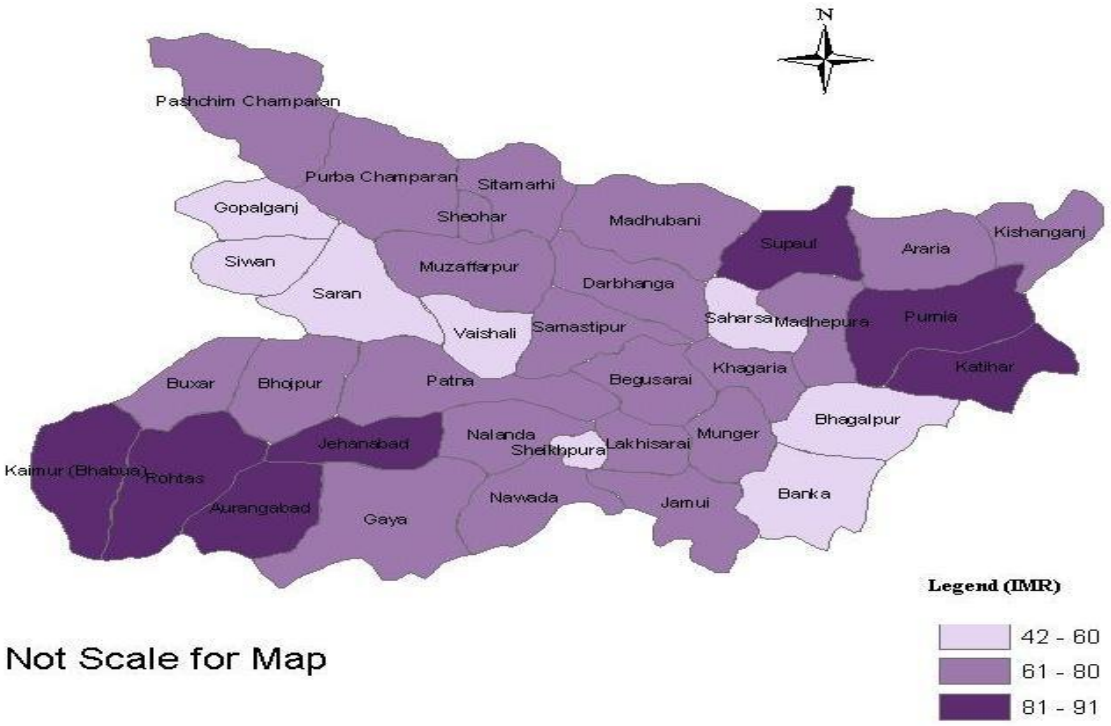

Map 1. Infant Mortality Rate of district in Bihar, 1981 to 2008

Independent variable: The demographic, healthcare, socioeconomic, and cultural variables used as independent variables are: mother age at birth, birth order, mother age at birth of child, antenatal check-up, TT injection at least one, safe delivery, postnatal, check-up, children check-up within 24 hours after birth, and children received colostrums/khees, place of residence, education of mother and father, religion, caste and wealth status. Many of the independent variables were categorically variable. For example, the variable perceived like to have mother age at birth, birth order, education of mother and father, religion, caste, and wealth status

RESULTS

Level of Infant Mortality Rate of Districts

Map 1 show that district wise Infant Mortality Rate of Bihar according to census 1981. It is clear from the map only Siwan had IMR less 60 deaths per 1000 live births, and three districts (Saran, Vaishali, and Madhubani) had between 60-80 infant deaths per 1000 live birth. However, all most all district had very high IMR (more than 80 deaths per 1000 live births). In 1991, 5 districts (Gopalganj, Purba champaran, Buxer, Bhojpur, and Vaishali) came down to below 60 deaths per 1000 live births. While the IMR drastically increased in Siwan. Moreover, IMR was more than 80 deaths per 1000 live births in 11 districts namely – Gaya, Jehanabad, Sitamarhi, Sheohar, Muzaffarpur, Samastipur, Khagaria, Madhepura, Purnia, Araria, and Kishanganj. According to 2001, census, among 3 districts - Siwan, Saran, and Munger, IMR was more than 80 deaths per 1000 live births. Moreover, Sitamarhi, Seohar, Muzaffarpur, Araria, Kishanganj, and Kaimur had IMR ranging from 60-80 deaths per 1000 live births. The estimated IMR based on DLHS-2 shows that there were three districts namely - Siwan, Nawada, and Seikhpura, where IMR was more than 80 deaths per 1000 live births. Moreover, it is observed that among 14 districts (Kishanganj, Samastipur, Khagaria, Gaya, Jehanabad, Sitamarhi, Sheohar, Madhubani, Pachim chmparan, Purba champaran, Bhagalpur, Gopalganj, Buxer, Purnia, and Madhepura, IMR was more than 80 deaths per 1000 live births. Thus, half of districts of Bihar had IMR 60-80. Estimates of IMR based on DLHS-3 data shows that currently there are eight districts namely - Gopalganj, Siwan, Saran, Vaishali, Saharsa, Bhagalpur, Banka, and Seikhpura, where IMR are below 60 deaths per 1000 live births. But in districts of Supauul, Purnia, Katihar, Kaimur, Rohtas, Aurangabad, and Jehanabad, estimated IMR is more than 80 deaths per 1000 live births.

Changes in infant mortality rate of district

Figure 1 shows the percentage changes in IMR across the districts in of Bihar. It can see that during 1981 to 1991, only among two districts - Araria and Sitamarhi, IMR has not changed while; among the rest of the districts it has declined between 20-40 percent. However among few district namely – Begusarai, Samastipur, Rohtas, Navada, Darbhanga, Khagaria, Madhubani, and Saran had experienced lowest (below 20 percent) decline in IMR. Vaishali had experienced highest (43 percent) change in IMR. IMR has drastically increased only in Siwan over the period. During 1991 to 2001, IMR had increased among 9 districts namely - Purba champaran, Vaishali, Gopalganj, Bhojpur, Aurangabad, Bhagalpur, Pachim champaran, Kathar, and Madhubani. Highest decline in IMR observed in Purba champaran percentage (25 percent). In last 20 years (1981-2001), all most all districts have

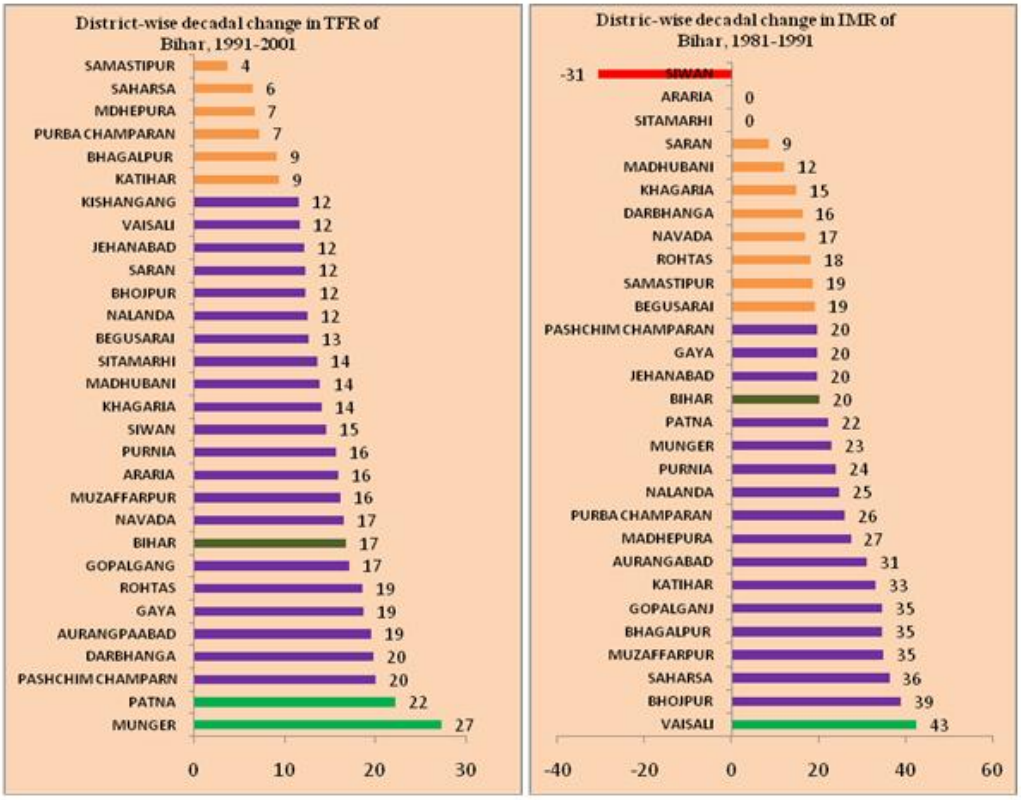

Figure 1. Percentage changes in infant mortality rate of district in Bihar

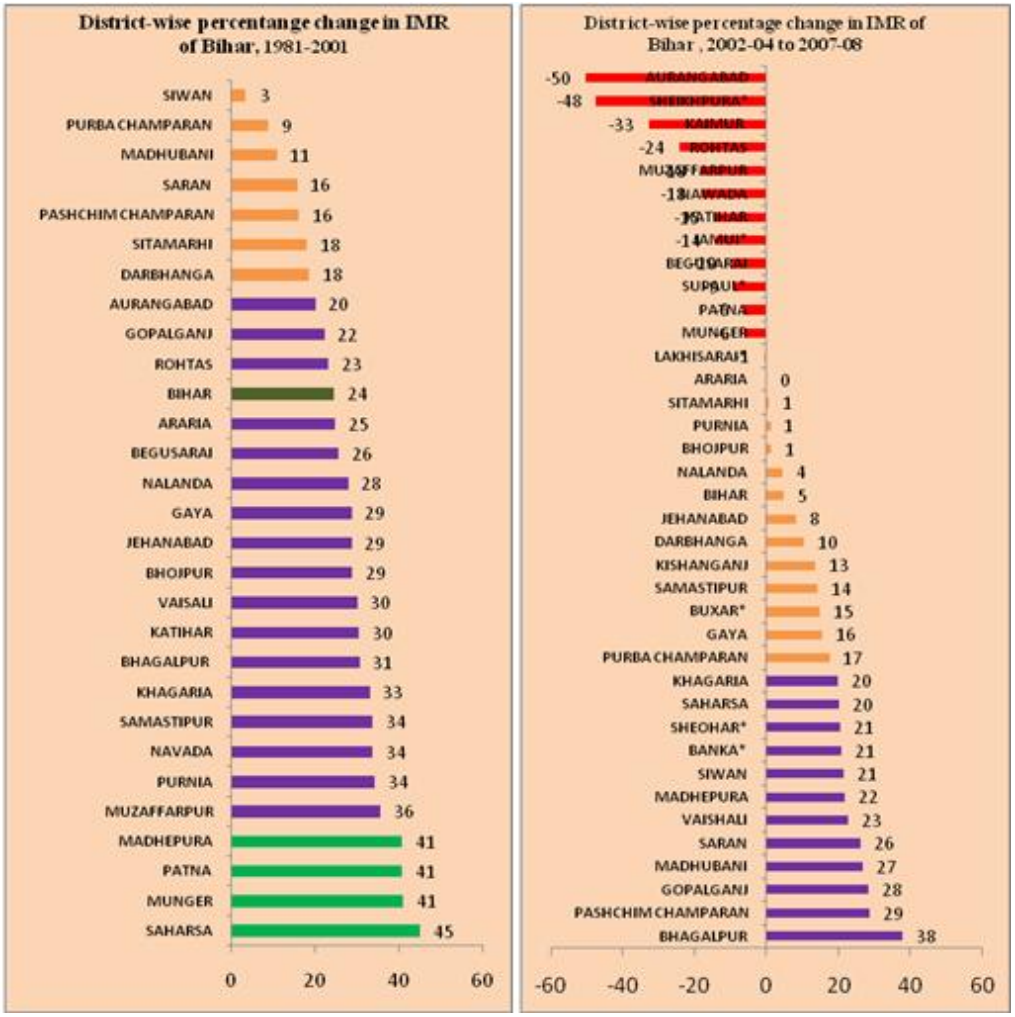

Figure 2. Percentage changes in infant mortality rate of district in Bihar

experienced decline in IMR. 17 districts experienced parentage of decline between 20-40 percent in IMR and 7 districts (Darbhanga, Sitamarhi, Pachim champaran, Saran, Madhubani, Purba champaran, and Siwan experienced below 20 percent decline in IMR. Moreover Saharsa, Munger, Patna, and Mdhepura, show that highest (more than 40 percent) decline in IMR. The estimated IMR based on DLHS shows that percentage changes in IMR during 2002-04 to 2007-08. It can see that 13 districts have exprienced drastically increased in IMR. For instance, Aurangabad, Seikhpura, Katihar, Rhtas, Muzaffarpur, Nawada, Kaimur, Jamui, Begusarai, Saran, Patna, Munger, and Lakhisarai during 2002-04 and 2007-08. Moreover, only among 12 districts IMR has declined between (20-40 percent) during the period. But IMR has remained unchanged in Araria

Differential of Infant Mortality

Table 1 shows the differentials in IMR across selected background characteristics. Result shows that IMR has declined by all background characteristics like place of residence, year of schooling and wealth index in during DLHS-2 to DLHS-3. But the Schedule Tribe shows 15 percent increase in IMR from DLHS-2 (80 infant deaths per 1000 live birth) to DLHS-3 (92 infant deaths per1000 live birth). The poorest quintile shows high IMR and the richest quintile

Table 1. Differential in IMR by background characteristics of Bihar, DLHS-2 and 3

Background characteristics	DLHS-2	DLHS-3
Residence		
Rural	79	72
Urban	65	61
Religion		
Hindu	75	71
Muslim	76	71
Education		
Illiterate	87	62
0-9	59	45
10+	42	25
Caste		
SC	90	82
ST	80	92
OBC	74	70
Other	59	54
Wealth index		
Poorest	91	88
Second	79	73
Middle	64	60
Forth	54	48
Richest	36	30

shows low IMR among all background characteristics. The decline in IMR is higher (40%) in 10+ years of schooling and lower (3%) in poorest than rest of background characteristics over the periods.

Determinants of Infant Mortality

The result of Cox regression shows that the significant effect of the caste (other), wealth index (second and richest), mother education (5-9 years of schooling and 10 or more years) antenatal check-up (ANC), TT injection received, safe delivery, mother age at birth (21-35 years), birth order, children check-up within 24 hours after birth, and children received colostrums on infant mortality

Socio-economic and cultural factors

Place of residence and religion has not statically significant. Moreover, in case of caste that belong to other caste have 0.774 times less chance of dying than infant of schedule caste. It observed that infants belonging to household of the highest quintile have 0.633 times higher survival chance as compared to infants belonging to the poorest quintile of households. It can see that mother schooling 5-9 years and 10 or more years have statically significant impact on child survival.

Table 2. Relative risks of infants dying under age 1 year by socio-economic and demographic characteristics, Bihar, DLHS (2007-08)

Characteristics	Exp(B)	Sig.	95.0% CI for Exp(B)	
			Lower	Upper
Place Of Residence				
Rural@	1			
Urban	0.854	0.240	0.656	1.112
Religion		0.796		
Hindu@	1			
Muslim	1.041	0.674	0.863	1.256
Other	0.586	0.596	0.081	4.237
Caste		0.052		
Schedule Caste@	1			
Schedule Tribes Caste	1.329	0.157	0.896	1.971
OBC	0.902	0.183	0.774	1.050
Other	0.774	0.040	0.607	0.988
Wealth Index		0.155		
Poorer@	1			
Second	0.929	0.326	0.801	1.076
Middle	0.778	0.024	0.627	0.967
Fourth	0.792	0.138	0.582	1.078
Richest	0.633	0.095	0.369	1.083
Education		0.003		
Non Literate@	1			
0-5 Years	0.959	0.728	0.757	1.215
5-9 Years	0.742	0.009	0.593	0.929
10 Or More Years	0.556	0.001	0.392	0.789
Education		0.097		
Non Literate@	1			
0-5 Years	1.084	0.452	0.879	1.336
5-9 Years	0.834	0.039	0.702	0.991
10 Or More Years	0.941	0.547	0.770	1.148
Antenatal Check-Up				
No@	1			
Yes	1.633	0.018	1.086	2.455
TT Injection				
No@	1			
Yes	0.836	0.085	0.682	1.025
Safe Delivery				
No	1			
Yes	1.324	0.001	1.126	1.556
Postnatal Check-Up				
No@	1			
Yes	0.915	0.466	0.720	1.162
Mother Age At Birth		0.011		
Below 20 Years@	1			
21-35 Years	0.801	0.013	0.673	0.954
35 Above Years	1.010	0.953	0.737	1.383
Birth Order		0.000		
Birth Order 1st@	1			
Birth Order 2nd	0.601	0.000	0.494	0.731
Birth Order 3rd	0.593	0.000	0.472	0.744
Birth Order 4th	0.670	0.000	0.547	0.822
Children Check-Up Within 24 Hours Of Birth				
No@	1			
Yes	1.410	0.005	1.112	1.788
Children Received Colostrums/Khees				
No@	1			
Yes	0.875	0.050	0.766	1.000

Note: @= Reference category
001 <1%; 005<5%; 01<10% level of significance

The higher education of the mother has 0.556 times less in relative risk of infant mortality as compared to infants of non-literate. Our finding shows that those fathers complete 10 or more years completed schooling have 0.941 times less chance of dying than infants of non-literate.

Maternal and child health care factors

It is interesting finding that the mother who received antenatal check-up (ANC) has 1.633 times increase relative risk of infant mortality than who mother was receiving not ANC. It could be one of the reason that who women go to ANC, who have experienced problem during the gestation period. It observed that those mothers received TT injection has 0.836 times less chance of dying than infants of no received TT injection. Moreover, it is noticed that mother get safe deliveries have 1.324 time high relative of infant mortality. It could be one of reason that institutional deliveries and with skilled person deliveries are component of safe deliveries. On the other hand generally mother who experienced problem during delivery, go to institutional deliveries or call to skilled persons. Further, post-natal check-up is not statically significant. Mother age at birth plays an important role in infant mortality. Mother age at birth also has the significant effect on child survival. Those Children born through mother age at birth less than 20 years and above 35 years have the higher risk of dying than those children born to mother's age 22-35 years. It observed that birth orders are most statically significant than other variables. (Sullivan, 1994) found that infant mortality different levels by birth order, starting high, then falling and rising again. Our result is similar; birth order 2nd has 0.601 times less chance of dying than infants of 1st birth order, and birth order 4+ have 0.670 times less relative risk of infant mortality than infants of 3rd birth order. It observed that children check-up within 24 hours after birth has statically significant. Who children check-up within 24 hours after birth have 1.410 times higher relative risk of infant mortality than counterpart. It could be one of the reasons that mostly who children go to checkups within 24 hours after birth, who experience problem. Also, children received colostrums have the significant effect on survival of the infant. Here who baby received colostrums is experiencing 0.875 times less relative risk of infant mortality than their counterpart.

Conclusion

The district level estimates of IMR manifests that all districts have still high infant mortality. It indicates that the performance of government's interventions has not been satisfactory among districts of the state. The government of Bihar needs to implement a policy of extensive decentralization of development, such as building infrastructure on health, education, and income-generating activities and need to re-look and monitor of all program for reproductive health and population stabilization. The analysis of the determinant of shows that the study might be useful for researcher and policy maker to take appropriate strategies to reduce infant mortality as it identified the segment of the population where the mortality was high. The existing heath care facilities need to be extending and strengthening as the study identified that the infant mortality reduced significantly after availing such facilities. Appropriate measures should be undertaken to ensure that health personnel would be available at healthcare centers. Mass media campaign is required for strengthening the awareness of people about the demerits of not taken TT injection, demerits of early age pregnancy, demerits of not check-up of child after birth, and demerits of consecutive births, advantage of antenatal cares during pregnancy and after delivery, advantage of safe delivery and check-up of child after birth and beneficial effect of colostrums/khees and breastfeeding.

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