Infant Mortality Situation in Bangladesh in 2007: A District Level Analysis

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Infant Mortality Situation in Bangladesh in 2007: A District Level Analysis

Mazbahul Golam Ahamad[1*]
Kaniz Tasnima[2]
Nafisa Khaled[3]
Subir Kanti Bairagi[4]
Uttam Kumar Deb[5]

Abstract

District level trend of infant mortality rate (IMR) per thousand live births in Bangladesh influenced by some assorted form of socio-demographic determinants such as individual, household and community level factors. This paper examines the trend and annual rate of reduction from 1998-2007 time periods and correlates causal factors based on different data from Statistical Yearbook of Bangladesh 2008 and Sample Vital Registration System 2007. Seven explanatory variables are considered and the log-log specified ordinary least square and simultaneous quantile regression models are employed to investigate and compare the stochastic impacts of these predictors on changing infant mortality. Infant immunization is the most effective factor that reduces infant mortality especially at lower quantile districts. Most notably, lower poverty line implies increasing trend with upper quantile, indicates that districts with low infant mortality rate has low effect for any positive rate of change of it. The least square as well as simultaneous quantile regression result disclose that share of population lived in electricity accessed houses, road density, no. of female per family planning personnel has potential and statistically significant impacts on infant mortality rate that is -0.25%, -0.22% and -0.58% respectively. Likewise, infant mortality decreased with the increased percentage of household having television by 0.08%, on average. As infant mortality is an outcome from a variety of socio-economic disparity; reduction strategy should address the degree of severity of the risk factors on infant mortality, prioritizing the most effective reducing factors such as infant immunization and controlled population growth rate as well.

Keywords: Infant Mortality Rate, Socio-demographic Determinants, Annual Rate of Reduction, Log linear Regression, Simultaneous Quantile Regression.

1.0 Introduction

Children are considered as the future of a nation. So, the health of a nation depends on the health of its children. To have an efficient nation with healthy citizens in 2021, it is very necessary to ensure survival and healthy improvement of all children (Goal 4) (Bangladesh Vision 2021, CPD 2007). In addition to this, the present Awami League-led government has proposed to reduce the Infant Mortality Rate to 15 per thousand live births by 2021 in its election manifesto named 'A Charter for Change'.

Infant Mortality Rate (IMR) is defined as the chance of a live born child dying before its first birthday and is consisted of mortality in the post neonatal early days or hours

[*]The authors are respectively a Programme Associate[1,2], Senior Research Associate[3], Research Associate[4], and Head, Research Division[5] of the 'Centre for Policy Dialogue (CPD)', Dhaka-1209, Bangladesh. The views expressed in this paper are those of the authors alone and do not necessarily reflects the views of CPD.

of life, early neonatal during the first week, late fetal or stillbirths, and perinatal period (Masuy-Stroobant and Gourbin 1995). It is considered as one of the most important indicators of the development of the socio economic and health status of a community. One of the important targets in the Millennium Development Goals (MDG) is to reduce child mortality rate by two-thirds between 1990 and 2015 (UNICEF 2006) and IMR is one of the indicators of reaching the target. According to SVRS the infant mortality rate in Bangladesh was 94 per thousand live births in 1990, which should reduce by 67 per cent between 1991 and 2015. Thus, the MDG (Indicator 14 of Target 4 under Goal 4) target of IMR is 31 per thousand live births. The actual rate of reduction was 53 per cent during 1991-2007 and the target will be reached by more two years at this rate (Planning Commission, GoB (n.d.)).

In Bangladesh, the decline in infant mortality forms a major challenge in attaining the MDG on child survival (i.e. under-five mortality) as it accounts for a significant part of the later (about 71.67 per cent in 2007). The IMR in Bangladesh is 43 per thousand live births in 2007, which is 45 for male and 41 for female (SVRS 2007). That means, on an average, 1 in every 23 children dies before reaching its first birthday.

1.1 Objective

This paper attempts to examine the district wise variation in IMR and to identify the factors which are affecting these variations of IMR in Bangladesh. It also intends to suggest some feasible strategies to narrow down these district level differences in IMR to achieve MDG by 2015 and to make a healthy nation for 2021.

1.2 Literature Review

There are a lot of studies, which have discussed about the determinants of infant mortality. Caldwell (1979), Debpuur et al. (2005), Hosseinpoor et al. (2005), Madise and Diamond (1995) have found a significant relationship between various socioeconomic factors, demographic factors and infant-child mortality by analysing various countries' survey and census data.

To find out the inter-district variation in infant mortality in Sri Lanka, a study has been carried out by Chaudhury et al. (2006). The findings of multiple regression analysis show that the availability of public health midwife is the single most significant determinant of inter-district variation in infant mortality followed by access to safe drinking water, low birth weight and registration status of pregnant women .

A similar analysis of Kapoor (2009) has allowed deciding in which districts of India, the affect of promoting more target policies would result in the greatest decrease in infant mortality. Using district-level data for the year 1991 and 2001 of the Census of India, he has found out that the increase in female literacy and labor force participation considerably reduces infant mortality at the district level.

The study of Ssewanyana and Younger (2007) has observed that in Uganda district-level vaccination rates, particularly for childhood diseases and mothers' educational achievement have turned out to be key determinants of infant mortality. In the study on Zambia, Derose and Kulkarni (2005) have also identified that full immunization significantly increases the possibility of infant survival.

A report of Planning Commission, Government of Bangladesh (GoB) and UNDP Bangladesh has showed that the infant mortality rate in Bangladesh is higher for the mothers who are less than 18 years or over 34 years of age at the time of delivery. Birth spacing is negatively associated to infant mortality rate and birth order is positively related with infant mortality rate. The sex of the children, place of residence, and number of children in a family has also impact on infant mortality. Stephen, K. (1989) found similar results in a study in Lesotho but sex of the children was not a significant determinant in his study.

By analyzing the secondary data of Kenyan Demographic and Health Survey (KDHS) for children, Mustafa and Odimegwu (2008) have found that biological and demographic factors like breastfeeding, ethnicity and sex of the child, including fertility factors such as birth order and intervals in rural areas are significant determinants of infant mortality in Kenya, where mother's occupation and her highest level of education are the least significant factors. They have concluded that social and economic empowerment of women and breastfeeding promotion should be encouraged to achieve the MDG on child and infant mortality.

Rahman and Sarkar (2009), using data from Bangladesh Health and Demographic Survey (BDHS) 1999-2000 , have decided that urban-rural residence, education of father and mother, preceding birth interval, family size, toilet facility, delivery place and antenatal care are the major determinants of infant and child mortality in Bangladesh.

Mondal et al. (2009) have shown that the risk of child mortality is 78.20 per cent lower among the immunized children in Rajshahi. Moreover, according to their findings, as the risk of child mortality decreased with increased female education and better access to safe treatment places, they have suggested to pay more attention to female education and expansion of public health system in order to reduce the risk of infant and child mortality.

Dixit et al. (2006) have suggested to increase the number of health care institutions by five per cent and percentage of households visited by a health worker in the last three months should be doubled to decrease the infant mortality in the Indian Thar desert as in their study they have observed that the number of health institutions and percentage households visited by a health worker in the last 3 months are the most significant factors that influence the infant mortality in the locality greatly.

In a study Pandey et al. (1998) have found that children born to young aged mothers have more chance to be premature, have low birth weights and suffering from problems at delivery time.

The study by Hong and Ruiz-Beltran (2007) has observed that the children of mothers who did not receive prenatal care during pregnancy have more than double risk of dying during infancy than the children whose mothers received prenatal care during pregnancy, implying that expansion of prenatal care services at the community level is the key to improving child survival in Bangladesh. Terra De Souza et al. (1999) have found that breastfeeding and prenatal care up-to-date are significantly and inversely associated with differences in infant mortality among municipalities of the State of Ceará, Brazil.But Zacharia et al. (1994) have shown that medical attention at

the time of delivery and antenatal care are significant factors for the survival chance of the new born.

The meta-study by Charmarbagwala et al. (2005) has found that, though there can be little suspicion that household income is an important determinant of child health, it appears that income is not a key factor in determining infant mortality in most of the cases.

Other studies like Hobcraft et al. (1985), Forste (1994), Gyimah (2002) etc., conducted to find out the determinants of infant and child mortality have advocated the significant influence of some biological and demographic indicators. Recently, Omariba et al. (2007) have supported the influence of demographic factors.

The review of different literatures on infant mortality shows that a number of factors are influencing infant mortality. However, the determinants of district level difference in infant mortality are changing day by day as the awareness among people regarding child health care is gradually increasing.

1.3 Determinants of Infant Mortality

To develop policy supports in reducing district level variation in infant mortality, it is important to know the factors which are accountable for the decline in mortality. There are number of empirical studies which have discussed the determinants of infant mortality. Several socioeconomic factors and health related characteristics like immunization, access to electricity, access to television, average household size, poverty, better road connectivity, belonging to the lower poverty line, availability of the family planning personnel are considered as the main determinants of infant mortality. The importance of these factors is discussed briefly in below:

Immunization and IMR: Tetanus, whooping cough, measles etc contribute significantly to high the IMR, which can be prevented through immunization practice. Immunization coverage in 2007 for 1-year-old children against polio (OPV3 vaccine), DPT3 and measles (MCV1 vaccine) are 96 per cent, 90 per cent and 88 per cent respectively (WHO 2008). Immunization is an important determinant of district level variations in infant's probability of survival.

Access to electricity and IMR: Lack of electricity refers to the case, where a household is not reaching modern amenities of the present world. So, IMR in those households are generally higher than households having access to electricity. About 50.72 per cent of the households in Bangladesh are provided with the electricity facility. Moreover, there are wide district level variations in access to electricity. About 96 per cent households in Dhaka are electrified whereas only 8.8 per cent households in Lalmonirhat district have access to electricity. Thus, it is a key factor that determines the district level variations in IMR.

Access to television and IMR: Television is the most powerful electronic media at present. The households having television sets have better awareness about child health as it broadcasts some programmes related to public health care. An illiterate or semi-literate person becomes conscious about the importance of child health care by watching these programmes which will lead to the reduction district level variation in IMR. But in Bangladesh on an average only less than 1 per cent households have the

access to TV sets. Moreover there are district level differences in access to TV. It is 0.74 per cent in Dhaka while only 0.01 per cent in Meherpur. Thus, access to TV will be a good indicator of district level differences in IMR.

Average household size and IMR: Average household size determines the quality of facilities obtained by the household members, especially, the children. If the average household size increases, then per capita facilities received by the members decreases. So, in that case, IMR is generally high. In Bangladesh, average household size is 4.9. In district level; it varied from 4 to 7 persons in 2001.This variation may explain the district level differences in IMR. So, it is an important factor in determining the deviation that exists in district level IMR in Bangladesh.

Poverty and IMR: The probability of IMR is expected to be higher in poor families. As the households that live in the lower poverty line, have lower access to health care facilities and belong to lower nutritional status, the children of those households have more chance of death at an early age. In Bangladesh, about 29 per cent people live in the lower poverty line; the lowest is 5 per cent in Feni and the highest is 55 per cent people in Nilphamari. This huge gap among districts with respect to poverty may clarify the district level differences in IMR.

Better road connectivity and IMR: When a district has access to better road connectivity, then automatically it gets some advantages like better health care facility which helps to reduce IMR. But in Bangladesh, there is a wide variation among districts regarding road connectivity facilities. In Chuadanga total length of road is only 92 km, whereas in Comilla the total length of road is 708.51 km. Road density can be a good proxy indicator of road connectivity facility, which shows a large divergence for the districts of Bangladesh. This divergence may define the district wise variation in IMR.

Availability of the female family planning personnel and IMR: The availability of female family planning personnel represents the admission of health care system of a locality. There is large divergence among the districts of Bangladesh in availability of the family planning personnel, acts as a proxy for availability of health care facilities. It is only 89 in Bandarban, but in Mymenshing it is 790. The differences in IMR may be well explained by this wide variance in the district level availability of family planning personnel.

2.0 District-wise Trend Analysis of Infant Mortality Rate of Bangladesh: 1998-2007

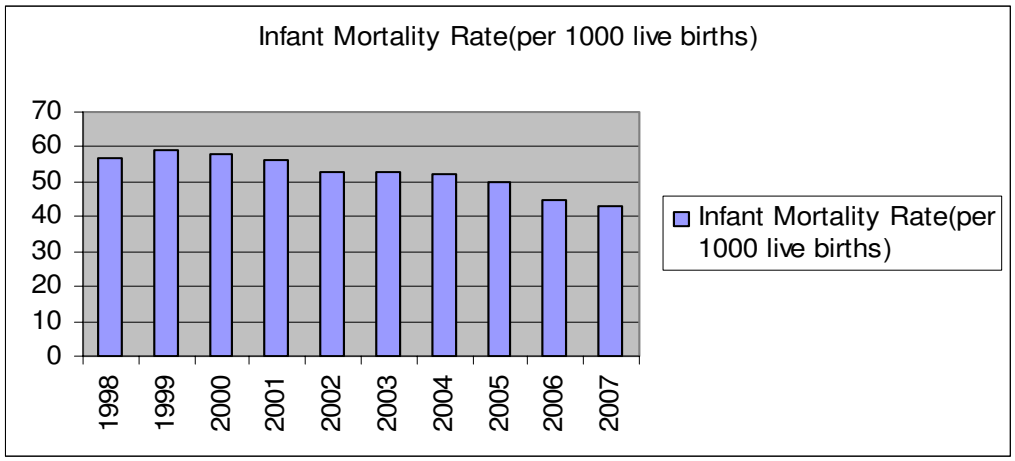
The country has made an impressive progress in decreasing the IMR during 1998-2007 (Figure 1). In 1998, it was 57 per thousand live births, which has reduced to 43 per thousand live births in 2007.So, if it follows the same trend then, it may not be difficult to reduce IMR to the targeted level by 2015 (31 per thousand live births as required in MDG).

2.1 Distribution and Trend of IMR

If we look at the district level situation of IMR in Bangladesh in 2007, then it can be observed that some of the districts in the country are showing an optimistic situation (See Annex 1).It shows that 20 districts have low IMR in 2007, where 20 districts for male and 24 districts for female are showing low IMR. But still 27 districts are in the

category of very high IMR. The highest IMR is in Kurigram (99.4 per 1000 live births) and the lowest is in Kushtia (6.7 per 1000 live births). Thus, the district level data for 2007 show that there is significant variation in the status of infant mortality in the country, which can create an obstacle to achieve the targets of MDG and 'A Charter for Change'. One way to achieve these targets is to decrease the district level variation in infant mortality, which differs widely across districts.

Figure 1: Trends in Infant Mortality in Bangladesh: 1998-2007



Source: Sample Vital Registration System (SVRS), BBS, 2007.

In 2007, IMR is very high (48 or above per 1000 live births) in twenty seven districts (Barisal, Gaibandha, Kishoreganj, Lalmonirhat, Magura, Meherpur, Nilphamari, Noakhali, Panchaghar, Satkhira, Brahmanbaria, Faridpur, Lakshmipur, Pabna, Rangpur, Cox'sbazar, Feni, Gopalganj, Jamalpur, Jhalokati, Kurigram, Madaripur, Maulvibazar, Shariatpur, Sirajganj, Sunamganj, Dhaka); moderately high(32 to 47 per 1000 live births) in seventeen districts (Mymenshing, Narayanganj, Thakurgaon, Nawabganj, Bogra, Sherpur, Netrakona, Gazipur, Narsingdi, Manikganj, Rajbari, Chuadanga, Pirojpur, Barguna, Chittagong, Bagerhat, Naogaon) and low (less or equal to 31 per 1000 live births)in twenty districts (Bandarban, Bhola, Chandpur, Comilla, Dinajpur, Joypurhat, Khagrachhari, Khulna, Kushtia, Munshiganj, Narail, Natore, Patuakhali, Habiganj, Jhenaidah Rajshahi, Rangamati, Sylhet, Tangail, Jessore) (See Annex 2).

2.2 Dynamics of Infant Mortality Rate

The district level trend show that fourteen districts (Barisal, Cox'sbazar, Gopalganj, Jamalpur, Jhalakati, Kishoreganj, Kurigram, Lakshimpur, Maulvibazar, Nilphamari, Noakhali, Rangpur, Sirajganj, Sunamganj) show an increasing trend and 50 districts show decreasing trend during 1998-2007(See Annex 3).The districts with increasing trend can be a serious concern for the country's overall IMR situation in future.

The district level rate of change in IMR during 1998-2007 shows that reduction rate is very high(more than 10 per cent) in sixteen districts (Barguna, Bandarban, Comilla, Chandpur, Feni, Sylhet, Munshiganj, Khulna, Jhenaidah, Narail, Kushtia, Rajshahi, Rangamati, Natore, Joypurhat, Bhola); high (5 per cent to 10 per cent) in twenty one districts (Barisal, Patuakhali, Khagrachhari, Chittagong, Brahmanbaria, Habiganj,

Narayanganj, Narsingdi, Madaripur, Shariatpur, Netrokona, Tangail, Bagerhat, Jessore, Magura, Chuadanga, Meherpur, Naogaon, Sirajganj, Bogra, Dinajpur); medium (1 per cent to 5 per cent) in twenty districts (Pirojpur, Cox'sbazar, Noakhali, Lakshmipur, Maulavibazar, Dhaka, Gazipur, Manikganj, Faridpur, Rajbari, Gopalganj, Sherpur, Mymenshing, Kishoreganj, Nawabganj, Pabna, Rangpur, Nilphamari, Panchaghar, Thakurgaon); and low (up to 1 per cent) in two districts (Gaibandha, Lalmonirhat), while the rate is positive i.e. IMR is increased in five districts(Satkhira, Jamalpur, Kurigram, Sunamganj, Jhalokati) (See Annex 4 and 5).

3.0 Econometric Estimation and Data

3.1 The Model

To determine the factors which affect infant mortality rate (IMR) in Bangladesh and to test empirically, ordinary least square (OLS) regression and simultaneous quantile regression is used to estimate in the following way.

$$\textbf{(1) } \ln IMR_i = \alpha + \ln \beta X_i + e_i$$

Where,
$\ln IMR_i$ = Log of district (i) level infant mortality rate as dependent variable
X_i = Vector of district (i) level socio-economic factors as independent variables
e_i = Error term.

The socio-economic determinants, which are operating through proximate (population based data) determinants, are grouped into different broad categories such as individual level, household level (income, housing condition) and community level (physical infrastructure like roads, electricity, healthcare) (Masuy-Stroobant 2001). To find out the impacts of these variables, equation (1) can be rewrite as equation (2) and (3), that given below.

$$\textbf{(2) } \ln IMR_i = \alpha + \ln X_i\beta_1 + \ln X_i\beta_2 + \ln X_i\beta_3 + \ln X_i\beta_4 + \ln X_i\beta_5 + \ln X_i\beta_6 + \ln X_i\beta_7 + e_i$$

$$\textbf{(3) } \ln\_imr_i = \alpha + \ln\_iir\ \beta_1 + \ln\_pleah\ \beta_2 + \ln\_lpl\ \beta_3 + \ln\_hhtv\ \beta_4 + \ln\_ahs\ \beta_5 + \ln\_pclor\ \beta_6 + \ln\_nffpp\ \beta_7 + e_i$$

3.2 Model Variables

Table 1 shows the variables of econometric model where variable name description and sources also explained.

Table 1: Variables used for Econometric Analysis

Variable	Variable Name	Data Source
Dependent Variable		
ln_imr	Log of Infant Mortality Rate	Sample Vital Registration System 2007 (p. 76)
Independent Variables		
ln_iir	Log of Infant Immunization Rate	Progotir Pathey
ln_pleah	Log of Percentage of Population lived in Electricity Accessed House	Sample Vital Registration System 2007 (p. 168)
ln_lpl	Log of Lower Poverty Line	VAM Report 2009

Variable	Variable Name	Data Source
ln_hhtv	Log of No. of Household having Television (Ratio of No. of Household to No. of Television)	Statistical Yearbook of Bangladesh 2008 (p. 33, 277)
ln_ahs	Log of Average Household Size	Statistical Yearbook of Bangladesh 2008 (p. 33)
ln_pclor	Log of Per capita Length of Road (Ratio of Length of Road (Km.) to Total Population)	Statistical Yearbook of Bangladesh 2008 (p. 258, 33)
ln_nffpp	Log of No. of Female per Family Planning Personnel (Ratio of No. of Female Person to No. of Family Planning Personnel (National, Female))	Statistical Yearbook of Bangladesh 2008 (p. 33, 508)

Source: Authors' compilation.

4.0 Result and Discussion of Econometric Estimation

4.1 Descriptive Statistics of Econometric Model Variables

Table 2 shows the descriptive statistics of the variables that are being used in the econometric models for both OLS and simultaneous quantile regression.

Table 2: Descriptive Statistics of the Model Variables

Category Variable	Frequency	Mean	Std. Dev.	Min.	Max.
Imr	64	42.40	19.73	6.7	99.4
Iir	64	91.75	3.09	82.1	95.5
Pleah	64	45.51	19.71	8.8	98.22
Lpl	64	27.85	12.07	4.78	55
Hhtv	64	1751.00	1644.24	120.54	8618.81
Ahs	64	4.92	0.50	4.1	7
Pclor	64	0.0015	0.0014	0.0001	0.0109
Nffpp	64	2745.85	953.97	273.04	7181.28

Source: Author's calculation.

4.2 Econometric Model

4.2.1 Estimation of Logarithmic OLS Model

Ordinary least square (OLS) regression of infant mortality rate (IMR) on a set of independent variables (i.e. infant immunization rate, percentage of population lived in electricity accessed house, lower poverty line, no. of household having television, average household size, per capita length of road, no. of female per family planning personnel (national, female)) can generally reflects the theoretical framework of the study. The double logarithmic (log-log, also known as constant elasticity model) form postulates a more statistically significant linear relationship between the log of the dependent variable and the log of independent variables. The slope coefficients measures the percentage change in regressand variable for a given (small) percentage change in regressors. The category variables retained in the regression (OLS and simultaneous quantile) model considered by the inclusion criteria, explained better understanding (R^2=*0.41*) about the variation in IMR. The log linear estimates of IMR on the set explanatory variables are shown in Table 3.

Infant immunization rate: Infant immunization rate is the most influential factor in differentiating the infant mortality rate (IMR) at district level although it effect is not statistically significant. Table 3 show that infant immunization rate has negative impact on IMR and it gives the rate of change that is 2.21%, which means that if the infant immunization rate goes up by 1%, on average; IMR goes down by about 2.21%.

Percentage of population lived in electricity accessed houses: Houses with electricity access is a near proxy of socio-economic condition of the respective household, and also another important casual factor in determining the district level variation of IMR. The coefficient sign is negative and significant at 5% level which shows a strong negative relationship with the rate of change of IMR that is 0.25%. The rate of change of IMR decreased by 0.25% for a 1% rate of change in percentage of population lived in electricity accessed houses.

Lower poverty line: Lower poverty line has a small impact on IMR with a rate of change by 0.12%, although it is statistically insignificant in the model. It represents the household's economic condition in terms of monetary income and empirical evidence has found that income poor people hardly to access the essential things for their newborn babies.

Table 3: OLS and Simultaneous Quantile Regression Results for Infant Mortality Rate (IMR), 2007

Category Variables	OLS		Quantile					
			.30		.60		.90	
	Coef.	B. Std. Err.	Coef.	B. Std. Err.	Coef.	B. Std. Err.	Coef.	B. Std. Err.
ln_iir	-2.21	2.62	-3.68	4.68	-3.43	3.63	-0.43	2.88
ln_pleah	-0.25*	0.13	-0.32	0.29	-0.16	0.19	-0.37**	0.16
ln_lpl	0.12	0.19	0.08	0.37	0.32	0.26	0.22	0.19
ln_hhtv	0.08	0.10	0.16	0.18	-0.03	0.12	-0.14	0.12
ln_ahs	1.07	0.73	0.86	0.99	0.72	0.95	0.81	1.18
ln_pclor	-0.22*	0.14	-0.07	0.27	-0.23	0.15	-0.07	0.22
ln_nffpp	0.58***	0.19	0.52**	0.27	0.61**	0.28	0.44	0.36
Constant	5.80	12.28	13.90	21.36	11.55	16.99	2.48	14.40
N	64		63		63		63	
R-squred	0.43		0.23†		0.18†		0.19†	
Prob > chi2	0.0000							

Note: Dependent variable: ln_imr.
***, **, *: Significant at 1%, 5% and 10% level.
†Psedu R-square for quantile regression.
Source: Authors' calculation.

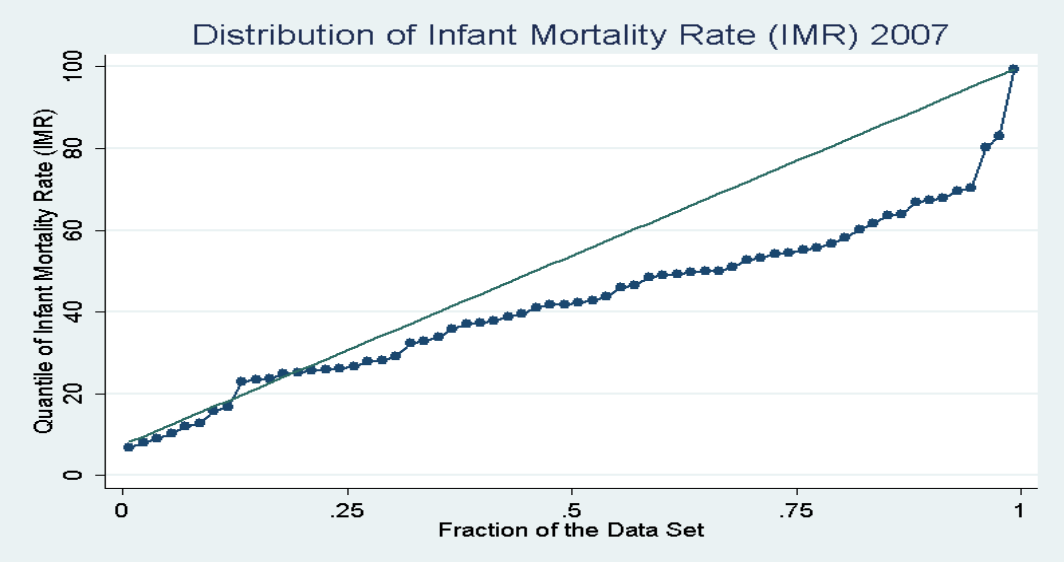
No. of household having television: Television (black and white, color) is assumed a proxy indicator for of people's access of information. Government and respective non-government organization try to inform people about the child health care facility across the country. Result shows a small contribution (rate of change is 0.08%) of ln_hhtv to reduce IMR in 2007, but evidently it has a significant impact in the long run.

Average household size: Previous empirical study revealed that household with more family members, especially in low income groups has reduced capability to ensure the child feeding and health basics. The estimated result of the district level IMR analysis reflects this view. Coefficient value of ln_ahs shows that a 1% increase of average household size leads to 1.07% rises of IMR.

Per capita length of road: The ratio of length of road to total population is another important influencing (reducing) factor of IMR. Road density is a good proxy variable to represent the connectivity like as access and time required to get health (e.g. hospital, clinic) facilities. Table 3 shows the statistically significant (at 10% level), positively associated road density*[†] with IMR. A 1% rate of change in road density decreases IMR by 0.22%.

No. of female per family planning personnel (national, female): Infant mortality rate is directly related with mother's health status and mother health status also depends on the number of female family planning personnel at different districts in Bangladesh. The result of the study indicates a very significant (at 1% level) positive (0.58%) impact of ln_nffpp on IMR.

Figure 2: Distribution of Infant Mortality Rate (IMR), 2007



Source: Authors' compilation.

4.2.2 Simultaneous Quantile Regression of Log linear Model

For specific policy analysis to be effective, it would be more logical to estimate the effect of the model covariates at different levels of the infant mortality distribution (Kapoor 2009). Quantile regression minimizes the sum of asymmetrically weighted absolute residuals, also called least absolute value (LAB) model; estimates the median of the dependent variable. The term 'quantile' means to one of the class of the value of a variate that divides the total frequency of a sample or population into a given number of equal proportions[‡]. It also refers the points taken at regular intervals from the cumulative distribution function (CDF) of a random variable[§]. On the contrary,

[†] ***p<0.01, **p<0.05, *p<0.10
[‡] Source: http://www.dictionary.com, accessed at 21 January 2010.
[§] Frohne, I.; Hyndman, R.J. (2009). *Sample Quantile.*

OLS estimators minimize the sum of squared residuals and estimate a conditional mean function. So, quantile regression analysis is to determine the factor's impact on infant mortality over OLS is more logical, because it allows estimating the model for conditional median function with conditional quantile functions.

And hence, simultaneous quantile regression estimation (Koenkar and Hallock 2001) of logarithmic IMR equation at three assorted points of its conditional distribution (i.e. 30% 60% and 90%) also address the issue of heterogeneity in the district level data. These three different points are low (national target as well as MDG indicator), moderately high and high (Millennium Development Goals: Bangladesh Progress Report 2008, p. 38) infant mortality rate (IMR) that represents approximately 30%, 60% and 90% cumulative distribution respectively. Figure 1 shows the distributional graph of IMR of district levels.

Stochastic error term of respective percentile (i.e. quantile) is probably affected by heteroscadasticity that causes biasness of estimated variances. To eliminate the non-constant error term; bootstrap estimates of the asymptotic variances of respective quantile coefficients are calculated with 50 replications with asymptotic t-ratios.

The sequential quantile regression results found important variations at three different points of district level IMR distribution. The effect of infant immunization rate (ln_iir) decreases as the IMR distribution increases. This states that infant immunization is more effective in districts with low IMR than with comparatively worse off (moderately high and high [**]) IMR districts. Though, the effect of infant immunization rate is highest in magnitude, it is less significant at low IMR districts because of some unexplained factors such as female literacy rate, per capita household income, economic and environmental constraints (seasonal unemployment, flood affected chars and mainland). Table 3 also portrays that infant immunization is the distinctive determining (reducing) factor for the lower 30 and 60 percentiles.

No. of household having television (ln_hhtv), on the contrary, had a strong and decreasing negative impact on IMR as the quantile increases. And hence, districts lie in moderately high and high quantile had a much lower impact on reducing IMR than the lower IMR district. Percentage of population lived in electricity accessed houses represents same (0.16, -0.03 and -0.14 for 30^{th}, 60^{th} and 90^{th} quantile respectively) and statistically significant coefficient. Per capita length of road (-0.07, -0.23 and -0.07 for 30^{th}, 60^{th} and 90^{th} quantile respectively) is another reducing factor that reacts same as before.

Infant immunization rate (ln_iir) and average household size (ln_ahs) are two major contributing factors that affect reducing IMR at every quantile. Moreover, lower poverty level (ln_lpl) has fluctuating impacts at low (0.08%), medium (0.32%) and high (0.22%) quantile. Important relationship is that ln_hhtv has very low but positive (0.16%), negative (-0.03%) and negative (-0.14%) relationship with IMR for three consecutive quantile. The higher the quantiles, the stronger is the negative impact of

[**] District-wise data for 2007 shows that about 20 (31.25%) districts have already achieved national target (IMR less than 31). Another 17 (26.56%) districts with moderate IMR are expected to achieve the national target by 2015. Districts with high IMR (42.19%) may not cross the target line by 2015. Source: SVRS, BBS 2007.

household having televisions on reducing IMR. So, access of information for the low IMR districts on health and medicare are more effectives than better IMR's.

5.0 Policy Implications and Conclusion

The study has some limitations as it uses district level data of 2007 for regression analysis without considering panel study of intra-district or household level data to interpret the determinant factors of infant mortality. This certainly places a constriction on the analysis and on the explanation of the findings. Even if, the estimated results are limited in scope to uncover the overall influencing factors, yet it clearly find out the relationships among model variables. This reveals the relative consequence of the category variables in explaining the variations of IMR.

The results of the multivariate log linear and simultaneous quantile regression analysis verify the theoretical relationship between infant mortality and model variables. These explain that immunization is the most significant and influential factor on infant mortality. To achieve Millennium Development Goals (MDG's) on infant and under-five child mortality, immunization programme must be tune up under various healthcare development initiatives.

Household with electricity access has negative influence on infant mortality; is a proxy indicator reflecting living standard. But due to current production constraints of electricity, it may be very hard to distribute electricity across the regions. So production of electricity must be stable with increasing growth. Moreover, lower poverty line is positively associated with infant mortality. Graduation from lower line is a time consuming process and it takes more time to influence infant mortality. So, policy makers should take sustainable strategies addressing short run and long run as well.

Average household size, is the second most important factor affecting infant mortality. The higher the average household size, the more the infant mortality rate, as household size is significantly positive with infant mortality rate. In the long run, comprehensive policy should take to reduce population growth rate and accelerates the implementations process; continued with required modifications of ongoing development programmes.

Nonetheless a restricted set of determinant factors have been examined, consideration of immunization and average household size will be vital policy imperative. Seven of the factors examined here directly affect infant mortality that accounts for about 59%[††] of the deaths per thousand live births in Bangladesh. In order to ensure a quick response, necessary reducing strategies should be taken on this observation. Hence, the national target, 31 or less per thousand live births (SVRS, BBS 2007) will be captured by 2015, and simultaneously MDG's.

[††] Source: https://www.cia.gov/library/publications/the-world-factbook/geos/bg.html, accessed at 21 January 2010.

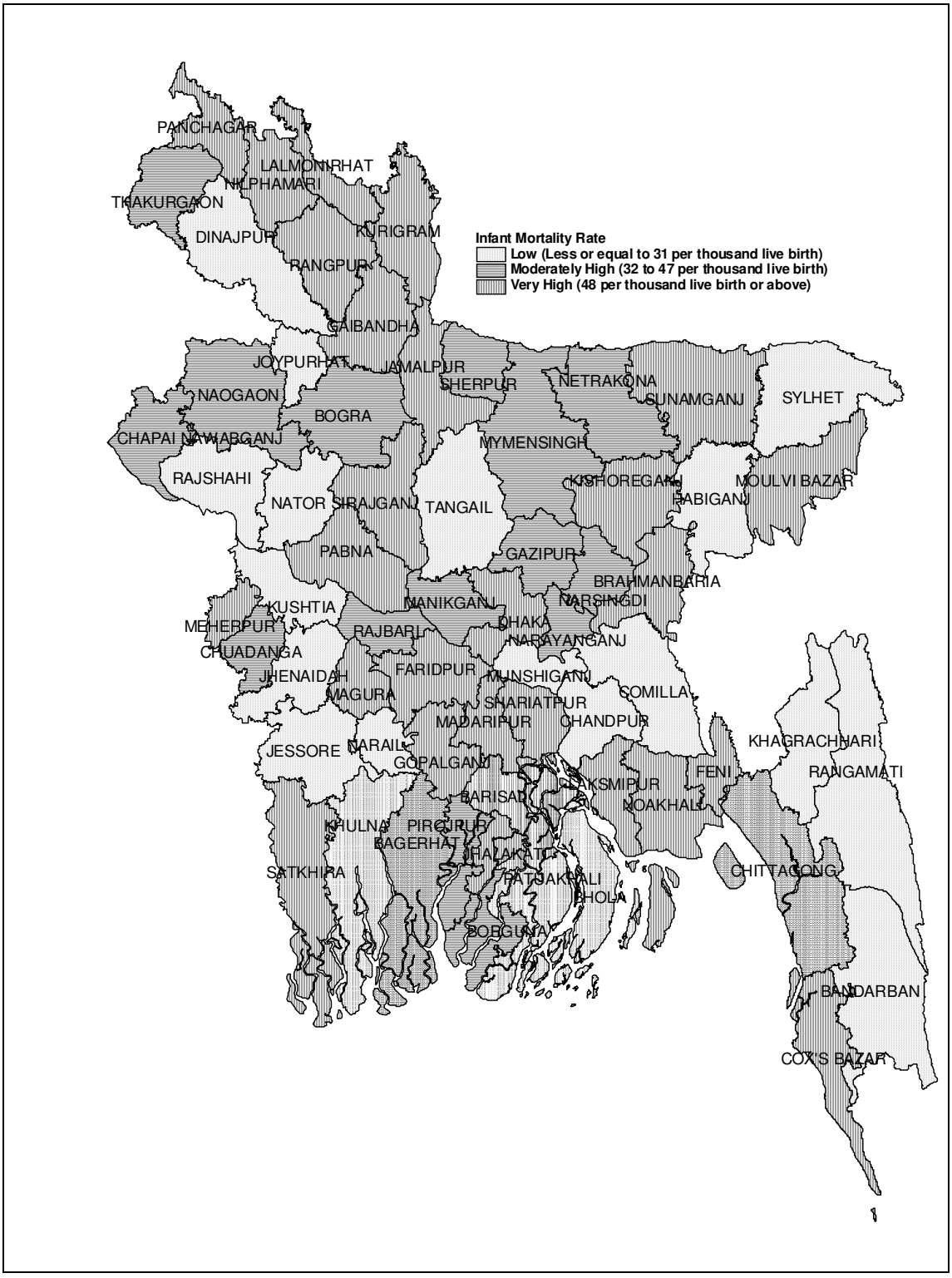
Annex 1: Infant Mortality Situation at the District Level, 2007

Category‡‡	Male	Female	Both Sex
Low (<31 per 1000 live births)	Rangamati, Kushtia, Joypurhat, Rajshahi, Narail, Habiganj, Khulna, Narsingdi, Natore, Munshiganj, Jhenaidah, Chandpur, Tangail, Bhola, Chuadanga, Bandarban, Rajbari, Netrokona, Bogra, Comilla (20 Districts)	Natore, Bagerhat, Narail, Kushtia, Bhola, Jhenaidah, Patuakhali, Rangamati, Sylhet, Comilla, Joypurhat, Khagrachhari, Rajshahi, Dinajpur, Shariatpur, Bandarban, Nawabganj, Chuadanga, Mymenshing, Narayanganj, Feni, Pirojpur, Naogaon, Jessore (24 Districts)	Bandarban, Bhola, Chandpur, Comilla, Dinajpur, Joypurhat, Khagrachhari, Khulna, Kushtia, Munshiganj, Narail, , Natore, Patuakhali, , Habiganj, Jhenaidah Rajshahi, Rangamati, Sylhet, Tangail, Jessore (20 Districts)
Moderately High (32-47 per 1000 live births)	Khagrachhari, Dinajpur, Chittagong, Naogaon, Gazipur, Patuakhali, Sherpur, Sylhet, Barguna, Manikganj, Dhaka, Jessore (12 Districts)	Tangail, Khulna, Sherpur, Munshiganj, Barisal, Barguna, Lalmonirhat, Thakurgaon, Madaripur, Manikganj, Satkhira, Sirajganj, Habiganj, Netrokona, Gaibandha, Magura, Meherpur, Chandpur, Chittagong, Narsingdi, Gopalganj, Gazipur (22 Districts)	Mymenshing, Narayanganj, Thakurgaon, Nawabganj, Bogra, Sherpur, Netrakona, Gazipur, Narsingdi, Manikganj, Rajbari, Chuadanga, Pirojpur, Barguna, Chittagong, Bagerhat, Naogaon (17 Districts)
Very High (>48 per 1000 live births)	Mymenshing, Lakshmipur, Pabna, Brahmanbaria, Rangpur, Faridpur, Noakhali, Thakurgaon, Narayanganj, Satkhira, Magura, Pirojpur, Panchaghar, Barisal, Meherpur, Kishoreganj, Nilphamari, Gaibandha, Nawabganj, Lalmonirhat, Jhalokati, Madaripur, Jamalpur, Feni, Bagerhat, Cox'sbazar, Maulavibazar, Gopalganj, Sirajganj, Shariatpur, Sunamganj, Kurigram (32 Districts)	Bogra, Pabna, Maulavibazar, Panchaghar, Cox'sbazar, Noakhali, Dhaka, Rajbari, Brahmanbaria, Faridpur, Jamalpur, Nilphamari, Sunamganj, Kishoreganj, Rangpur, Lakshmipur, Kurigram, Jhalokati (18 Districts)	Barisal, Gaibandha, Kishoreganj, Lalmonirhat, Magura, Meherpur, Nilphamari,Noakhali, Panchaghar, Satkhira, Brahmanbaria, Faridpur, Lakshmipur, Pabna, Rangpur, Cox’sbazar, Feni, Gopalganj, Jamalpur, Jhalokati, Kurigram, Madaripur, Maulvibazar, Shariatpur, Sirajganj, Sunamganj , Dhaka (27 Districts)

Source: Sample Vital Registration System (SRVS), BBS, 2007.

‡‡ The categorization is based on Planning Commission, GoB.,

Annex 2: District-wise Distribution of IMR in 2007



Source: Authors' compilation, based on data from SVRS, BBS, 2007.

Annex 3: Trends in Infant Mortality Rate at the District Level: 1998-2007

Name of District	1998	2007	Change	Name of District	1998	2007	Change
Bagerhat	57.06	43.81	Decreased	Madaripur	68.89	56.7	Decreased
Bandarban	62.2	23.6	Decreased	Magura	58.69	49.9	Decreased
Barguna	58.13	38.9	Decreased	Manikganj	41.87	41.0	Decreased
Barisal	46.91	48.6	Increased	Maulvibazar	54.68	63.5	Increased
Bhola	55.21	16.7	Decreased	Meherpur	55.66	50.9	Decreased
Bogra	54.61	37.9	Decreased	Munshiganj	53.41	25.7	Decreased
Brahmanbaria	58.61	55.1	Decreased	Mymensingh	52.39	37.3	Decreased
Chandpur	58.83	29.0	Decreased	Naogaon	59.6	32.9	Decreased
Chittagong	63.11	39.5	Decreased	Narayanganj	53.41	42.8	Decreased
Chuadanga	49.54	43.8	Decreased	Narail	58.48	10.2	Decreased
Comilla	54.54	24.9	Decreased	Narsingdi	53.41	32.3	Decreased
Cox'sbazar	43.7	63.9	Increased	Natore	48.08	12.0	Decreased
Dhaka	58.62	50.0	Decreased	Nawabganj	55.53	45.9	Decreased
Dinajpur	57.21	27.8	Decreased	Netrokona	62.56	33.9	Decreased
Faridpur	61.07	58.1	Decreased	Nilphamari	60.73	66.9	Increased
Feni	63.11	52.8	Decreased	Noakhali	53.95	55.6	Increased
Gaibandha	57.0	53.3	Decreased	Pabna	53.48	48.9	Decreased
Gazipur	45.88	41.9	Decreased	Panchagarh	54.69	54.4	Decreased
Gopalganj	60.85	61.7	Increased	Patuakhali	68.82	25.2	Decreased
Habiganj	55.45	26.6	Decreased	Pirojpur	64.5	43.2	Decreased
Jamalpur	52.29	70.3	Increased	Rajbari	59.32	41.7	Decreased
Jessore	44.19	23.0	Decreased	Rajshahi	42.85	12.8	Decreased
Jhalakati	50.85	80.3	Increased	Rangamati	62.31	8.1	Decreased
Jhenaidah	57.2	15.8	Decreased	Rangpur	54.47	67.3	Increased
Joypurhat	66.47	9.1	Decreased	Satkhira	56.09	49.2	Decreased
Khagrachhari	60.09	26.2	Decreased	Shariatpur	66.13	49.7	Decreased
Khulna	60.46	23.4	Decreased	Sherpur	55.87	35.9	Decreased
Kishoreganj	57.27	69.5	Increased	Sirajganj	54.06	60.1	Increased
Kurigram	54.26	99.4	Increased	Sunamganj	48.64	82.9	Increased
Kushtia	54.46	6.7	Decreased	Sylhet	53.06	28.1	Decreased
Lakshimpur	59.39	67.8	Increased	Tangail	50.71	25.9	Decreased
Lalmonirhat	55.24	54.2	Decreased	Thakurgaon	58.64	46.6	Decreased

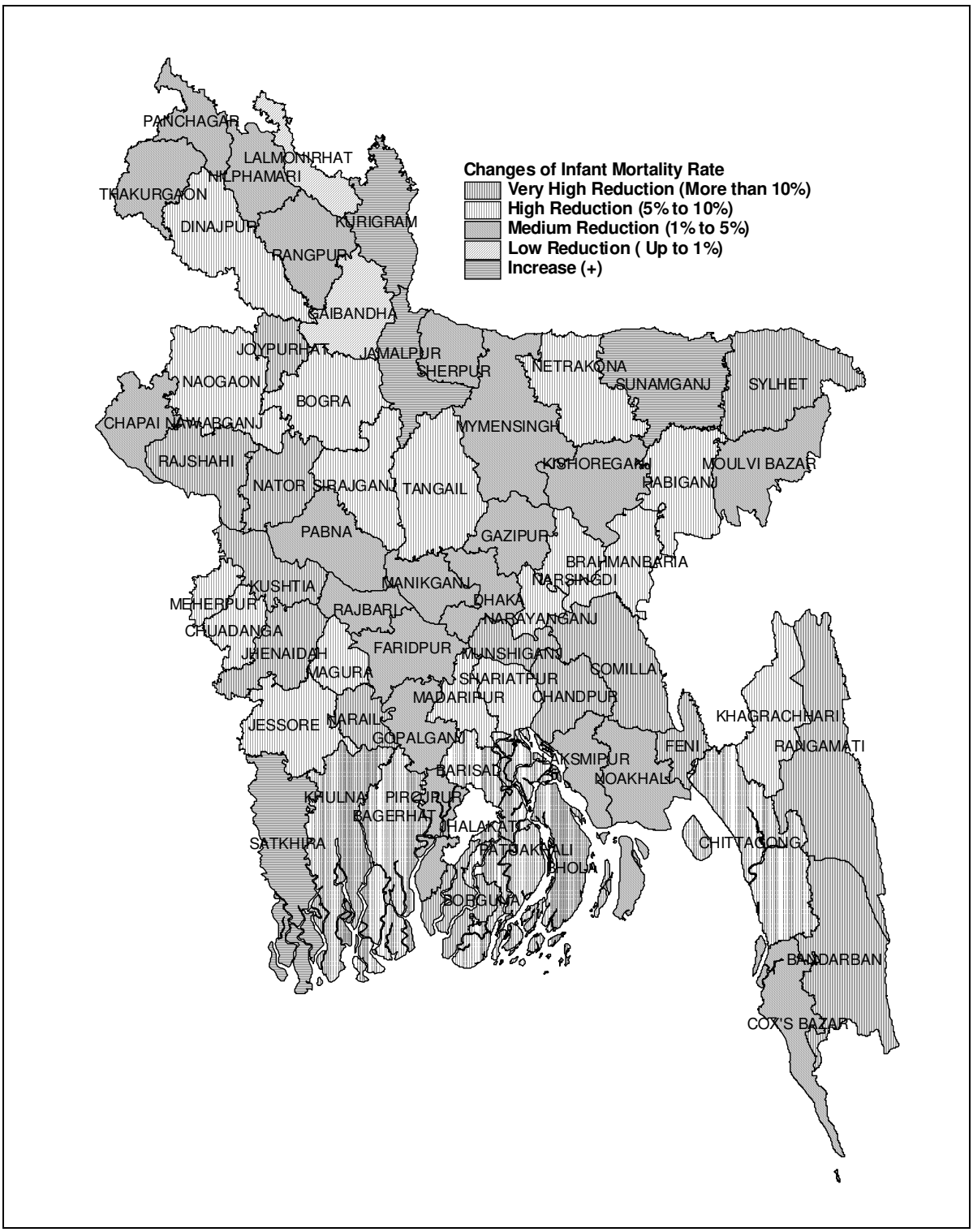
Source: Sample Vital Registration System (SRVS), BBS, 2007.

Annex 4: Dynamics of Infant Mortality Rate

Category of Change	Districts
Increased	Satkhira, Jamalpur, Kurigram, Sunamganj, Jhalokati. (5 Districts)
Low Reduction (Up to 1%)	Gaibandha, Lalmonirhat. (2 Districts)
Medium Reduction (>1 %-< 5%)	Pirojpur, Cox'sbazar, Noakhali, Lakshmipur, Maulavibazar, Dhaka, Gazipur, Manikganj, Faridpur, Rajbari, Gopalganj, Sherpur, Mymenshing, Kishoreganj, Nawabganj, Pabna, Rangpur, Nilphamari, Panchaghar, Thakurgaon. (20 Districts)
High Reduction (≥5 %-< 10%)	Barisal, Patuakhali, Khagrachhari, Chittagong, Brahmanbaria, Habiganj, Narayanganj, Narsingdi, Madaripur, Shariatpur, Netrokona, Tangail, Bagerhat, Jessore, Magura, Chuadanga, Meherpur, Naogaon, Sirajganj, Bogra, Dinajpur. (21 Districts)
Very High Reduction (≥10%)	Barguna, Bandarban, Comilla, Chandpur, Feni, Sylhet, Munshiganj, Khulna, Jhenaidah, Narail, Kushtia, Rajshahi, Rangamati, Natore, Joypurhat, Bhola. (16 Districts)

Source: Authors' calculation, based on data from SVRS, BBS, 2007.

Annex 5: District-wise Distribution of IMR Changes in 1998 – 2007



Source: Authors' compilation, based on data from SVRS, BBS, 2007.

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