Current Research Journal of Biological Sciences 1(3): 83-88, 2009
ISSN: 2041-0778

Submitted Date: June 27, 2009 Accepted Date: August 17, 2009 Published Date: October 20, 2009

Effects of Health Related Factors on Neonatal, Post Neonatal, Infant and Child Mortality

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Abstract: The purpose of this study is to determine health related factors that affect neonatal, post neonatal, infant and child mortality. For this, the data is collected using multistage sampling technique and direct method of mortality estimation, contingency analysis and logistic regression procedure has been applied. The results show post-neonatal mortality rate (PNNMR) is higher for the children who are not immunized at all (e.g., PNNMR is 250.00 per 1000 live births). The infant of the house gets treatment facility from traditional sources considerably have higher mortality and also respondents who have not taken medical check up, while lower in mothers' child who get sufficient medical check up (e.g. child mortality rate (CMR) is 6.13 per1000 live births). The Chi-square (χ^2) test result implies that immunization, treatment place and medical check up during pregnancy are highly significantly associated with neonatal, post neonatal, infant and child mortality. Multivariate analysis results designate immunization, types of delivery, medical check up duration of pregnancy and health check up for child have crucial influence on mortality of post-neonatal period but in infant and child period, immunization practices and treatment place of women have significant effects on mortality. Therefore, women are required to bring in cycle of women-child health awareness based programme and community health system to reduce infant and child mortality in Bangladesh.

Key words: Neonatal, post-neonatal, infant and child mortality rate, health related characteristics, chi-square (χ^2) test and logistic regression analysis

INTRODUCTION

A healthy and sound grown up generation can lead a nation to the way of prosperity and vision. In Bangladesh, the last few decades have brought significant improvements in infant and child health. According to Population and Development Indicators for Asia and the Pacific Report, 2008, ESCAP (United Nations, 2008), in 2008 SAARC countries' infant and under five mortality rates (156 and 234 per 1,000 live births respectively) is highest in Afghanistan and lowest in Sri Lanka (infant and under five mortality rates are 11 and 13 per 1,000 live births respectively). In Bangladesh, infant and under five mortality rates are 52 and 68 per 1,000 live births respectively in 2008.

Bangladesh has designed grassroots based service delivery infrastructure all over the country. At national level there are one Institute of Post Graduate Medicine and Research, one Maternal and Child Health Institute (MCHI), one Institute of Child and Mother Health (ICMH), 13 Government Medical College Hospitals, 57 District hospitals, 90 Mother and Child Welfare Centers (MCWC) situated at the District, Upazila and Union level, 397 Upazila health complexes, 3,200 Union Health and Family Welfare Centers (UH and FWC), about 30,000 "satellite clinics" in the country providing antenatal care, postnatal care; Expanded Programme of Immunization (EPI), childcare etc. About 23 thousand Family Welfare Assistants and 15 thousand Health Assistants are working at the grass root level for basic health and family planning service delivery. Besides this, at present many Non-Government Organizations (NGOs) and private sectors have special program and facilities for providing antenatal care and safe delivery care. In spite of these progress made in health sector, Bangladesh has been identified as one of 57 countries with a critical shortage of the health workforce (doctors, nurses and midwives number below 2.28 per 1000 population). The nurses to population ratio of 0.14 per 1000 and nurses to doctors' ratio of 1:1.85 are among the lowest in the world (World Health Organization, 2007).

The total health expenditure constitutes 3.2% of the national Gross Domestic Product (GDP) (National Health Accounts (NHA), 2003). The sectoral share of the GDP of the health sector (at 2000-01 prices) has increased only marginally from 0.71% in 1998-1999 to 0.83% in 2004-2005 (Public Expenditure Review (PER), 2003-2004). Health expenditure in Bangladesh, at US$ 12.16 per person per year (National Health Accounts (NHA), 2003), is far below the minimum expenditure for scaling up a set of essential health interventions in the country. The government's health expenditure is only around US$ 4 per capita per annum (National Health Accounts (NHA), 2003) and prospects for its substantial increase are limited.

A large part of the health services are financed and provided for privately. Over 70% of the expenditure and nearly 80% of the health-care contacts are in the private

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sector (World Bank, 2006). Facility utilization rates in the public sector are low, and there has been increasing demand for services provided by the private sector and non-governmental organizations in Bangladesh and involved increasingly in providing primary health care and Information Education and Communication (IEC) programs.

One of the important reasons for high rate of infant and child mortality is limited use of health care services by mothers (Kabir and Amin, 1993). A number of other factors related to infant and child mortality such as poor quality health care services, inadequate nutrition and low use of oral dehydration therapy as well as breast-feeding pattern and immunization. Poor medical attention and hygienic conditions during delivery can reduce the risk of infections and facilitate management of complications that can cause death or various illnesses for the mother or the newborn child (Mitra *et al*., 1997).

This research study conveys special importance from the various angles of vision. It is strongly believed that this research will be helpful and will play an important role for the policy makers, demographers and other researcher for further study. Therefore the fundamental objective of this study is to identify the existing bifurcated health related causes of infant and child mortality.

Data and Sources of Data: A study on infant and child mortality was conducted from November to December 2007 among reproductive aged women (aged 15-49 years) of Natore sadar upazila in Natore district of Bangladesh. All eligible reproductive aged women were requested to participate in the study after being given a brief description of the purpose and procedures of the study. To investigate health related information on women, 796 women were selected as the study population through using multi-stage sampling devise. A structured questionnaire was developed to explore the determinants of infancy and childhood mortality, after a long discussion with an expert group in this area. A personal interview approach was followed for the purpose of data collection. Women were directly interviewed and the information was collected with the questionnaire. The data were analyzed by using Statistical Package for Social Sciences (SPSS), version 10.0.

MATERIALS AND METHODS

Contingency Analysis: A contingency analysis was used to test for association between the different phenomena on the basis of classification of variables or attributes by applying the Chi-square (χ^2) test, in which $\chi^2 = \sum \frac{O_{ij}}{E_{ij}} - N$, follows a χ^2 distribution with (r−1)(c−1) degrees of freedom.

Logistic Regression Analysis: A logistic regression analysis was performed in order to observe the effects of the independent variables (X) on the dependent variable (Y). The logistic function can be written as:

$$E(Y/Z=z) = \frac{e^{Z}}{1+e^{Z}}$$

where, $z = \beta_0, \beta_1 X_1, \beta_2 X_2, \beta_3 X_3, \beta_4 X_4, \beta_5 X_5, \text{ and } \beta_6 X_6$ and β_0, β_1, β_2, β_3, β_4, β_5 and β_6 are regression parameters to be determined from the data.. For the predicted variable

For Model 1: $Y == \begin{cases} 1, \text{if neonata mortality occures,} \\ 0, \text{otherwise.} \end{cases}$

For Model 2: $Y == \begin{cases} 1, \text{if post neonatal mortality occures,} \\ 0, \text{if it dose not occur.} \end{cases}$

For Model 3: $Y == \begin{cases} 1, \text{if infant mortality occures,} \\ 0, \text{Otherwise} \end{cases}$

For Model 4: $Y == \begin{cases} 1, \text{if child mortality occures,} \\ 0, \text{if it does not occur.} \end{cases}$

And for the explanatory variables

X_1 = Immunization = $\begin{cases} 0, \text{if not at all,} \\ 1, \text{if full} \\ 2, \text{if partial} \end{cases}$

X_2 = Treatment place = $\begin{cases} 1, \text{if hospital \& clinical,} \\ 0, \text{otherwise.} \end{cases}$

X_3 = Presence of M.B.B.S doctor in delivery period = $\begin{cases} 1, \text{if yes,} \\ 0, \text{otherwise.} \end{cases}$

X_4 = Types of delivery = $\begin{cases} 1, \text{if normal} \\ 0, \text{otherwise.} \end{cases}$

X_5 = Medical checkup during pregnancy = $\begin{cases} 1, \text{if yes,} \\ 0, \text{otherwise.} \end{cases}$

X_6 = Health checkup for child after delivery = $\begin{cases} 1, \text{if yes,} \\ 0, \text{otherwise.} \end{cases}$

In multivariate approach, four logistic models have been built for health related variables and presented in Table 4.

RESULTS AND DISCUSSION

Health Related Characteristics of the Respondents: The immunization of children is an important factor that contributes to children's chances of survival. The

information of health related characteristics is shown in Table 1, 84.2% children have totally immunized 9.4% partially and 6.4% children have not immunized at all. The major portion of infant and children treatment place is hospital 29.3%. The remaining 25.8%, 24.6%, 10.7% and 7.2% are pallichikithshak, clinic, M.B.B.S doctor and kobiraji respectively. Percentage of mother took help of MBBS doctor duration of pregnancy period is only 17.5% and the majority portion 82.5% did not take help of MBBS doctor duration of pregnancy period. Most of mother's delivery process is normal 90.8% and 9.2% is caesarian in the study area. 71.6% women have taken medical check up and 28.4% have not taken medical check up duration of pregnancy period. Health checks up of mother and children after delivery may reduce the risk of dying and in the study 50.8% children have taken health checkup and 49.2% have not taken health check up after delivery.

Neonatal Mortality Rate (NNMR), PNNMR, IMR and CMR by Some Selected Health Related Characteristics: The NNMR, PNNMR, IMR and CMR by selected health related characteristics are shown in Table 2 and this section is examined their differentials. In this analysis, immunization, treatment place, presence of M.B.B.S doctor in delivery time, types of delivery, medical check up duration of pregnancy, health check up for mother after delivery and health check up for child are considered as health related variables. Table 2 indicates NNMR, PNNMR, IMR and CMR by selected health related characteristics.

Rahman *et al.* (2005) analyzed that immunization practice of children has highly significant effects on infant and child mortality. In Table 2, it is shown that the differentials in NNMR, PNNMR, IMR and CMR by immunization of children. Mortality rates are higher for the children who are not immunized at all (e.g., NNMR is 334.13, PNNMR is 250.00, IMR is 584.13 and CMR is 571.43 per 1000 live births) while lower for the children who are totally immunized (e.g., PNNMR is 20.41, IMR is 20.41 and CMR is 5.76 per 1000 live births)

Hong (2006) showed that levels of infant and child mortality in many developing countries remain unacceptably high, and they are disproportionably higher among high-risk groups such as newborn and infant of multiple births, particularly in countries where advanced medical cares are available only at regional referral levels with limited access by the rural poor women and children. Table 2 shows that the children of the household have taken treatment from traditional sources considerably have higher mortality (e.g., NNMR is 75.00, PNNMR is 100.00, IMR is 175.00 and CMR is 48.78 per 1000 live births).

Proper medical attention and hygienic conditions during delivery can reduce the risk of infections and facilitate management of complications that can cause death or various illnesses for the mother and/or the newborn child (Mitra *et al.*, 1997). Recent reviews on neonatal health as well as experiences from India, Nepal and Bangladesh suggest that other community-based interventions such as health education to improve neonatal care practices and care-seeking for illness and creating demand for skilled care can be used to improve neonatal survival (Darmstadt *et al.*, 2007). While lower mortality rate for the children of the household have taken treatment from clinic and M.B.B.S doctor (e.g., NNMR is 34.48, PNNMR is 34.48, IMR is 68.97 and CMR is 7.35 per 1000 live births). In this study the Table 2 shows the children for which there has been absence of M.B.B.S doctor at the time of birth have higher mortality (e.g., NNMR is 44.12, PNNMR is 74.33 and IMR is 117.65 per 1000 live births). There are higher NNMR, PNNMR, IMR and CMR for the child born through scissorian (e.g., NNMR is 134.13, IMR is 134.13 and CMR is 55.56 per 1000 live births).

Chowdhury (1982) conducted an experiment that showed that the declines in IMR are attributed to the introduction of improved public health measures and access to maternal and child health care services. Table 2 confirms NNMR, PNNMR, and IMR and CMR are higher in mothers group who have not taken medical check up during pregnancy (e.g., NNMR is 200.00, PNNMR is 334.13, IMR is 534.13 and CMR is 127.66 per 1000 live births) while lower in mothers group who have taken medical check up during pregnancy (e.g., NNMR is 13.16, PNNMR is 13.16, IMR is 26.32 and CMR is 6.13 per 1000 live births).

Health check up of child after delivery has impact on NNMR, PNNMR, IMR and CMR. It is observed that NNMR, PNNMR, and IMR and CMR are higher for child who have not taken health check up after delivery (e.g., NNMR is 107.14, PNNMR is 142.86, IMR is 250.0 and CMR is 30.30 per 1000 live births) while lower child group who have taken health check up (e.g., NNMR is 15.87, PNNMR is 31.75, IMR is 47.62 and CMR is 16.6 per 1000 live births).

The Test Results with Health Related Attributes: The test results with health related attributes are presented in Table 3. With regard to health related factors, neonatal mortality is significantly associated with immunization, type of delivery and medical check up during pregnancy. Therefore, level of neonatal mortality is influenced by the above health related factors. With these mortality levels post-neonatal mortality is statistically significant with immunization, treatment place, type of delivery and medical check up during pregnancy. Hence, the above health related factors have greater influence on post-neonatal mortality level. Infant mortality is statistically significantly associated with immunization, treatment place, medical check duration of pregnancy and health check up for child after delivery. Thus from statistical point of view, mortality level of infant mortality is influenced by the above health related factors. Child mortality is statistically significant with immunization, treatment place and medical check during pregnancy. Therefore, mortality level of child is influenced by the

Table 1: Percentage of women aged 15-49 years according to the selected health related characteristics of Natore Sadar Upazila in Natore District, Bangladesh, 2007

Health related characteristics	Number of cases	Percentages	Health related characteristics	Number of cases	Percentages
Immunization			**Types of delivary**		
Not at all	593	6.4	Normal	65	9.2
Total	66	84.2	Caesarian	639	90.8
Partial	45	9.4	**Medical check up in pregnancy period**		
Treatment place					
Hospital	233	29.3	No	226	28.4
Clinic	196	24.6	Yes	570	71.6
MBBS doctor	85	10.7	**Health checkup for mother**		
Homeopathic	12	1.5			
Kobiraji	57	7.2	No	390	49.0
Pallichikithshak	205	25.8	Yes	406	51.0
Others	8	1.0	**Health checkup for child**		
Presence of M.B.B.S doctor in delivery time					
			No	392	49.2
No	581	82.5	Yes	404	50.8
Yes	123	17.5			

Table 2: NNMR, PNNMR, IMR and CMR by some selected health related characteristics of Natore Sadar Upazila in Natore District, Bangladesh, 2007

Characteristics	NNMR (per 1000 live births)	PNNMR (per 1000 live births)	IMR (per 1000 live births)	CMR (per 1000 live births)
Immunization				
Not at all	334.13	250.00	584.13	571.43
Total	–	20.41	20.41	5.76
Partial	–	66.67	66.67	104.26
Treatment place				
Traditional	75.00	100.00	175.00	48.78
Hospital	–	45.45	45.45	8.77
Clinic and M.B.B.S. doctor	34.48	34.48	68.97	7.35
Presence of M.B.B.S doctor in delivery time				
No	44.12	74.33	117.65	19.29
Yes	44.28	44.28	86.96	32.26
Types of delivery:				
Normal	26.32	78.95	104.26	17.80
Scissorian	134.13	–	134.13	55.56
Medical checkup duration of pregnancy				
No	200.00	334.13	534.13	127.66
Yes	13.16	13.16	26.32	6.13
Health checkup for child				
No	107.14	142.86	250.00	30.30
Yes	15.87	31.75	47.62	16.60

above health related factors. Especially immunization, treatment place and medical check up during pregnancy, which has a great influence on the survival of young children.

Logistic Regression Analysis: In the logistic regression analysis, the dependent variables are neonatal, post neonatal, infant and child mortality. The value is used to identify the significant effects and to assess the relative importance of some selected health related variables on neonatal, post neonatal, infant and child mortality in the models. The estimates of logistic co-efficient, significance probability and relative odds calculated for each category of the categorical variables are demonstrated in Table 4.

Model 1: From Table 4, it is observed that Model 1 of logistic regression includes the neonatal mortality as the dependent variable and the entire selected health related characteristic as the independent variables. According to the fitted model, there does not exist any variable out of 6 independent variables that are statistically significant. Therefore the discussion of this model is kept out in this study.

Model 2: Model 2 considers the post-neonatal mortality as the dependent variable and the some selected health related characteristic as the independent variables. According to the fitted model, 4 variables out of 5 independent variables are statistically significant. The significant predicators of post-neonatal mortality are immunization, types of delivery, medical check up duration of pregnancy and health check up for child. It is evident that immunization practices have substantial effects on post-neonatal mortality. The odds ratio for full and partial immunization practices is 0.042 and 0.566 respectively. The results reveal that the experience of

Table 3: Results of contingency analysis according to health related factors with Neonatal, Post-natal, Infant and Child Mortality in Natore Sadar Upazila, Bangladesh

Attributes	Neonatal mortality				Post-natal mortality			
	Cal. χ^2	Df.	Asy Sig (ρ)	Sig	Cal. χ^2	Df.	Asy Sig (ρ)	Sig
Immunization	68.926	2	0.000	Sig*	29.664	2	0.000	Sig*
Treatment place	2.617	1	0.106	Insig	5.754	1	0.016	Sig**
Presence of M.B.B.S doctor in delivery period	0.161	1	0.688	Insig	0.002	1	0.964	Insig
Types of delivery	8.441	1	0.004	Sig*	4.516	1	0.034	Sig**
Medical checkup duration of pregnancy	7.689	1	0.006	Sig*	15.083	1	0.000	Sig*
Health checkup for mother after birth	1.743	1	0.187	Insig	0.145	1	0.703	Insig
Health checkup for child	1.760	1	0.185	Insig	1.467	1	0.226	Insig
Attributes	**Infant mortality**				**Child mortality**			
	Cal. χ^2	Df.	Asy Sig (ρ)	Sig	Cal. χ^2	Df.	Asy Sig (ρ)	Sig
Immunization	78.654	2	0.000	Sig*	34.877	2	0.000	Sig*
Treatment place	4.915	1	0.027	Sig**	5.191	1	0.023	Sig**
Presence of M.B.B.S doctor in delivery period	0.047	1	0.828	Insig	0.319	1	0.572	Insig
Types of delivery	1.596	1	0.206	Insig	2.645	1	0.104	Insig
Medical checkup duration of pregnancy	22.190	1	0.000	Sig*	15.108	1	0.000	Sig*
Health checkup for mother after birth	1.267	1	0.260	Insig	0.074	1	0.786	Insig
Health checkup for child	3.133	1	0.077	Sig***	0.201	1	0.654	Insig

Notes: Significance at p<0.01 ** Significance at p<0.05 ***Significance at p<0.10
Tab χ^2_{10}= 2.705 with 1 d.f.; Tab χ^2_{10}= 4.605 with 2 d.f.;
Tab χ^2_{05}= 3.841 with 1 d.f.; Tab χ^2_{05}= 5.991 with 2 d.f.;
Tab χ^2_{01}= 6.635 with 1 d.f.; Tab χ^2_{01}= 9.210 with 2 d.f.

Table 4: Logistic regression estimates for the effects of health variables with Neonatal, Post neonatal, Infant and Child Mortality as the Dependent Variables

Health related characteristics	Model 1 for neonatal mortality		Model 2 for post-neonatal mortality		Model 3 for infant mortality		Model 4 for child mortality	
	Coefficient (β)	Odds ratio	Coefficient (β)	Odds ratio	Coefficient (β)	Odds Ratio	Coefficient (β)	Odds ratio
Immunization								
Not at all ®	…	1.000	…	1.000	…	1.000	…	1.000
Full	-32.522	0.000	-3.168***	0.042	-4.171*	0.015	-3.080**	0.046
Partial	-33.912	0.000	-0.569**	0.566	-1.458*	0.233	-0.807*	0.446
Treatment Place								
Traditional ®	…	1.000	…	1.000	…	1.000	…	1.000
Hospital & clinical	-21.188	0.000	-2.576	0.076	-1.542**	0.214	-2.311**	0.099
Presence of M.B.B.S doctor in delivery period			–	–	–	–		
No ®	…	1.000					…	1.000
Yes	1.290	3.632					0.654	1.924
Types of delivery								
scissorian ®	…	1.000	…	1.000	…	1.000	…	1.000
Normal	-21.793	0.000	-1.864**	0.155	-1.107	0.331	-1.426	0.240
Medical checkup during pregnancy								
No ®	…	1.000	…	1.000	…	1.000	…	1.000
Yes	1.895	6.651	-2.567***	0.077	-1.381	0.251	-2.349	0.095
Health checkup for child								
No ®	…	1.000	…	1.000	…	1.000	…	1.000
Yes	-10.153	0.000	-1.026**	0.358	0.362	1.436	1.593	4.918
Constant	19.596	32382792 2.11	0.230	1.259	0.269	1.309	-0.179	0.836

* Significance at p<0.01 ** Significance at p<0.05 ***Significance at p<0.10 (R) Reference category.

post-neonatal death is less if children have fully immunized (95.8%) while if the child have not fully immunized, that is, partially immunized then they have (43.4%) lower risk than none immunized children

Considering the scissorian delivery of mother as reference category, it is observed that normal delivery has negative significant effects on post neonatal mortality. Regression coefficient for normal delivery is -1.864 and the odds ratio for normal delivery is 0.155 that indicate the risk of post neonatal mortality for normal delivery have 0.155 times lower risk than that of scissorian delivery. Medical check up duration of pregnancy is an influential factor on post-neonatal mortality. The post-neonate born by mother who has taken medical check up duration of pregnancy has 0.077 times lower risk than the post-neonate born by the mother who has not taken medical check up duration of pregnancy (reference category). The post-neonate has been taken medical check up after birth has 0.358 times lower risks than the post-neonate has not been taken medical check up after birth (reference category).

Model 3: According to the fitted model for infant mortality, only 2 independent variables out of 5 variables are significant. Significant predicators for infant mortality are immunization and treatment place of women. It is evident that immunization practices have substantial effects on infant mortality. The odds ratio for full and partial immunization practices is 0.015 and 0.233 respectively. The results reveal that the experience of infant death is less if children have fully immunized 0.015 times while if the child have not fully immunized, that is, partially immunized then they have 0.233 times lower risk than none immunized children. Treatment place of infant with hospital and clinic have 79.6% less likely to die before reaching one year of age than traditional treatment place of infant. It is surprising to notice that the mortality risk of infant is low if the infant is born government hospital/ clinic as compared to the infant born at home. One possibility is that the high-risk pregnancies may not be getting admitted to the government hospitals.

Model 4: According to the fitted model for child mortality, immunization and treatment place of child are statistically significant. It is observed that immunization practices have substantial effects on child mortality. The odds ratio for full and partial immunization practices is 0.046 and 0.446 respectively. The results reveal that the experience of child death is less if children have fully immunized 0.046 times while if the child have not fully immunized, that is, partially immunized then they have 0.446 times lower risk than none immunized children. Treatment place of child with hospital and clinic have 90.1% less likely to die before reaching one year of age than traditional treatment place of children.

CONCLUSION AND RECOMMENDATIONS

Reducing infant and child mortality has long been a goal of population policy in Bangladesh. The Ministry of Health and Family Welfare, the main stakeholder in the health and population sector, and the development partners have worked with a shared vision for this goal. In the study area, poor quality health care services and absence in immunization program, lacking medical attention and unhygienic conditions during delivery are the crucial causes of infancy and childhood mortality. So, the following recommendations can be suggested on the basis of the present study may help planners and policy makers to take appropriate decision to reduce infant and child mortality not only of the study area but also in Bangladesh.

Government should decentralize service delivery (Through satellite clinics and EPI out reach centers at the grass- root level).

IEC programs should range from informing mothers about some simple items such as the importance of personal hygiene and cleanliness for children and houses till the more complicated items such as how to know symptoms of different diseases, drugs needed and quick check-up in case of emergency. These IEC programs could play a very effective role in saving life of many children in the study area as well as in Bangladesh.

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