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Risk Factors Accessing of Infant Mortality: Cox Proportional Hazard Model vs. Cox Frailty Model

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Abstract:

Introduction:

Infant (0-11 months) nutritional, health and mortality status is a very concerning issue in Bangladesh. This study aims to find out the risk factors of infant mortality by the application of survival models according to Bangladesh Demographic Health Survey-2014.

Methods:

The study utilized the information on 1503 infants that were born in the five years preceding the survey, 42 did not survive and 1461 were still surviving. To access the risk factors of infant mortality, Cox proportional hazard model was employed and for testing the unobserved heterogeneity among children, Cox frailty model has been considered.

Results:

Mother's working status, number of antenatal care visits, multiplicity of birth and numbers of living children are significantly associated as the cause of the infant's death and variability is 0.002401.

Conclusion:

Study results recommended that to improve antenatal care utilization, facilities in the job sector for women and newborn care.

Key Words: infant mortality-cox proportional hazard model-cox frailty model

Introduction:

Infant mortality is one of the most important sensorial indicators of the socio-economic and health status of a country. In moderate and high mortality populations, childhood deaths may constitute half of all deaths and differences in levels of child survival between developing and developed countries are very marked, more so than for any other age group (Preston, 1980; Kathryn and Amin, 1992). Child and infant mortality are a widely used indicator of the health status of all population as well as the level of development of a country; also reflects social, economic and environmental conditions in which children (and others in society) live including their health care." (Reidpath & Allotgey, 2003; Alderman & Behrman, 2004). Like other South Asian countries, Bangladesh has a high risk of infant mortality. According to UNICEF-2018, the infant mortality rate of Bangladesh is 26.9 deaths per 1,000 live births in 2017 (Table 1) [1].

	Bangladesh	India	Pakistan	Bhutan	Nepal	Srilanka	Maldives	Afganistan
1990	99.7	88.4	106.2	89.5	97.9	17.9	68.1	120.2
1991	95.9	86.2	104.4	85.9	93.4	18	65.1	116.4
1992	92.1	84	102.6	82.4	89.1	18	62.2	112.9
1993	83.3	82	100.8	79.1	85	18	59.2	109.5
1994	84.5	79.9	99.1	75.8	81	18	56.1	106.3
1995	80.8	77.8	97.3	72.6	77.2	17.8	52.9	103.3
1996	77.2	75.6	95.5	69.4	73.6	17.3	49.6	100.5
1997	73.7	73.4	93.6	66.3	70	16.8	46	97.9
1998	70.3	71.1	91.7	63.4	66.7	16.1	42.4	95.4
1999	67	68.8	89.9	60.4	63.4	15.4	38.7	93.1
2000	64	66.6	88.1	57.6	60.3	14.7	35	90.8
2001	61	64.3	86.3	54.9	57.4	14.1	31.3	88.4
2002	58.2	62	84.7	52.4	54.6	13.7	27.8	86.1
2003	55.6	59.9	83.1	49.8	52.1	13.4	24.6	83.6
2004	53.1	57.7	81.7	47.4	49.6	13.1	22.3	81.1
2005	50.6	55.7	80.3	44.9	47.3	15.6	19.2	78.5
2006	48.2	53.7	78.9	42.6	45.1	12.3	17.1	76
2007	45.8	51.6	77.6	40.4	43.1	11.7	15.3	73.4
2008	43.5	49.6	76.3	38.3	41.1	11.1	13.8	70.8
2009	41.3	47.6	75	36.2	39.2	10.1	12.5	68.2
2010	39.1	45.5	73.6	34.4	37.4	9.7	11.3	65.7
2011	37	43.5	72.2	32.7	35.7	9.3	10.3	63.3
2012	35	41.6	70.7	31.3	34.1	9.1	9.5	61
2013	33.2	39.7	69.1	30	32.5	8.8	8.7	58.8
2014	31.4	37.9	67.3	28.8	31	8.5	8.2	56.8
2015	29.7	36.2	65.7	27.8	29.6	8.3	7.7	54.9
2016	28.2	34.6	64.2	26.8	28.4	8	7.3	53.2
2017	26.9	32	61.2	25.6	27.8	7.5	6.8	51.5

Table 1: Infant mortality rate (per 1,000 live births) in South Asian countries (1990-2017), UNICEF-2018.

The early childhood mortality rates obtained for the five years preceding the DHS surveys conducted in Bangladesh since 1993-1994 confirm a declining a trend in infant mortality and a Bangladeshi infant was around two times more likely to die before reaching his/her first birthday in the early 1990s than in 2014 (Figure 1) [2].

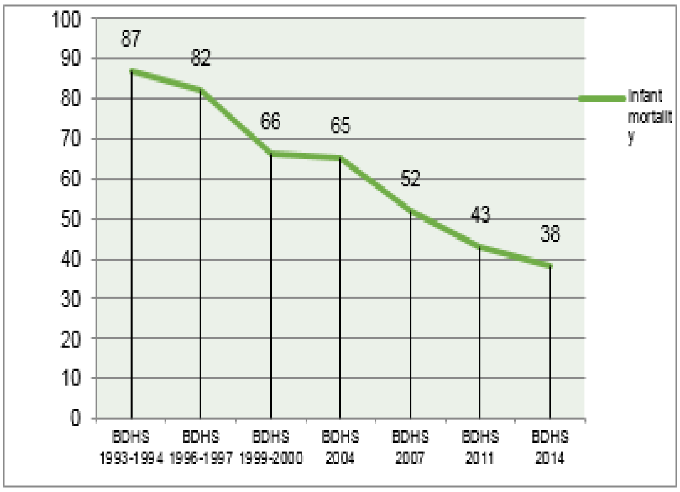


Figure 1: Trends in infant (0-11 months) mortality rates per 1000 live births, BDHS (1993-1994)-BDHS 2014

Bangladesh as a member of the World Health Organization (WHO) and as a signatory of the Alma-Ata declaration in 1978 is executed to achieve the goal of health care as the key approach. In recent years, Bangladesh's health and family planning program has successfully implemented a wide array of fertility and mortality reduction interventions. In 1993, GOB (Government of Bangladesh) started a phase implementation of the Acute Respiratory Infection (ARI) control program. In 2015, when the world began working targeted Millennium Development Goals (MDGs), then to seeking to achieve the early childhood mortality to at least as low as 25 death per 1,000 live births by 2030 is referred as the “Third Sustainable Development Goals (SDGs3)”[3]. Over 46 years, after independence in 1971 the health system of Bangladesh has gone through several reforms and established an extensive health infrastructure in the public and private sectors. Also, the Government of Bangladesh (GOB) has been following the sector-wide approach in the health sector of the country from 1998 and presenting the 4th program- Health, Population and Nutrition Sector Program (HPNSP) (2017-2022) is being implemented. The program is comprised of three components; namely, governance- stewardship of the sector, strong health system and health services to achieve health, population, and nutrition sector targets and health-related SDGs. However, despite all the efforts, health care facilities in

Bangladesh remain limited and inadequate. In 2017, 4.1 million infant deaths occurred within their first year of life and have declined from 8.8 million in 1990 globally4. Many socioeconomic factors such as, paternal-maternal education, income status of family etc; some proximate factors like, maternal age at marriage and first birth, birth spacing pattern, total children born to mother, parity, size of child at birth, place of delivery, mode of delivery, ANC (Antenatal care) visits, vaccination are associated with infant mortality. Also, environmental and household factors (region, type of place of residence, type of toilet facility, source of drinking water) can be related to cause of infant deaths. The purpose of this work is to find out the risk factors of infant mortality by survival models; Cox proportional hazard model and Cox-frailty model.

Materials and Methods:
Source of data and variables:

The data used for this study is a secondary data obtained from the Bangladesh Demographic Health Survey- 2014 (BDHS-2014), which is the seventh DHS survey conducted in Bangladesh under the authority of the National Institute of Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare (MHFW) and implemented by Mitra and Associates of Dhaka; which is freely available online and contains information on a wide range about socioeconomic, demographic, hygienic and household variables of the population nationwide2. The BDHS survey has been conducted approximately every five years since 1993-1994. A two-stage cluster sampling was utilized to determine the sample size and included a household survey of ever-married women age 15-49 by conducting face-to-face interviews on 18,000 residential households; expected number of completed interviews was 17,886. In the study, 1503 infant's survival information obtained from the birth history data of BDHS-2014. The dependent variable of the study was infant (0-11months) mortality; i.e., probability of dying before reaching his/her the first birthday (<12 months). For this study, child age in month has been computed by subtracting "Date of birth (CMC)" from "Date of interview (CMC)". The survival status of infant coded as "0= Death" and "1= Alive". The risk factors/ independent variables/ covariates were recited into three categories; socio-economic factors, demographic/ proximate factors, hygienic and household factors. (Table 2)

Background Characteristics	Categories	Total N (%)	No. of deaths within 5 years of survey (%)	Log-rank test (Mantel-Cox) χ^2	d.f	p-value
Region	1= Dhaka	264 (17.6)	3 (1.1)	8.752	6	0.188
	2=Chittagong	282 (18.8)	5 (1.8)			
	3= Barisal	193 (12.8)	5 (2.6)			
	4=Khulna	174 (11.6)	7 (4.0)			
	5=Rajshahi	187 (12.4)	7 (3.7)			
	6=Rangpur	173 (11.5)	4 (2.3)			
	7=Sylhet	230 (15.3)	11 (4.8)			
Type of place of residence	1=Urban	484 (32.2)	8 (1.7)	3.284	1	0.070*
	2=Rural	1019 (67.8)	34 (3.3)			
Religion	1=Islam	1387 (92.3)	41 (3.0)	1.754	1	0.185
	2=Non-islam	116 (7.7)	1 (1.0)			
Mother's educational level	0=No education	201 (13.4)	9 (4.5)	5.492	3	0.114
	1=Primary	408 (27.1)	15 (3.7)			
	2=Secondary	699 (46.5)	16 (2.3)			
	3=Higher	195 (13)	2 (1.0)			
Mother's working status	0=No	1246 (83)	30 (2.4)	2.954	1	0.086*
	1=Yes	257 (17)	12 (4.7)			
Father's educational level	0=No education	306 (20.4)	15 (4.9)	11.065	3	0.011**
	1=Primary	470 (31.3)	17 (3.6)			
	2=Secondary	488 (32.5)	8 (1.6)			
	3=Higher	239 (16)	2 (0.8)			
Father's occupation	1= Agricultural worker	321 (21.4)	11 (3.4)	0.609	2	0.738
	2=Non-agricultural worker	128 (8.5)	3 (2.3)			
	3= Others	1054 (70.1)	28 (2.7)			
Wealth status of family	1=Poor	610 (40.6)	23 (3.8)	3.772	2	0.152
	2=Middle	286 (19)	7 (2.4)			
	3=Rich	607 (40.4)	12 (2.0)			
Mother's age at first birth	1= Age 12-17 years	626 (41.7)	15 (2.4)	0.953	2	0.621
	2= Age 18-29 years	866 (57.6)	27 (3.1)			
	3= Age 30+ years	11 (0.7)	0 (0)			
Number of ANC visits	0=No visit	281 (18.7)	18 (6.4)	14.770	1	0.000***
	1= At least once	1222 (81.3)	24 (2.0)			
Place of delivery	1=Home	864 (57.5)	24 (2.8)	0.202	1	0.653
	2=Any other medical facilities	639 (42.5)	18 (2.8)			
Number of living children	1= 1 or 2 children	1147 (76.3)	39 (3.4)	6.291	1	0.012***
	2= 3 or more	356 (23.7)	3 (1.0)			
Total children ever born	1= 1 child	625 (41.6)	18 (2.9)			

	2= 2 or 3 children	698 (46.4)	20 (2.9)	0.329	2	0.848
	3= 4 or more	180 (12)	4 (2.2)			
Preceding birth interval	1= 1st child	633 (42.1)	23 (3.6)			
	2=Interval < 48 months	344 (22.9)	7 (2.03)	3.302	2	0.192
	3= Interval >= 48 months	526 (35)	12 (2.2)			
Currently breastfeeding	0=No	77 (5.1)	42 (54.5)	723.451	1	0.000***
	1=Yes	1426 (94.9)	0 (0)			
Birth order number	1=1st birth order/rank	629 (41.8)	20 (3.1)			
	2=2nd birth order /rank	466 (31.0)	13 (2.8)	1.014	2	0.602
	3= 3rd order or more	408 (27.1)	9 (2.2)			
Multiplicity of birth	1=Single birth	1483 (98.7)	38 (2.6)			
	2=Multiple birth	20 (1.3)	4 (20)	120.881	1	0.000***
Child size at birth	1=Average/Large	1408 (93.7)	36 (2.6)			
	2=Very small (<= 2.5 kg)	95 (6.3)	6 (6.3)	4.247	1	0.039**
Sex of child	1= Male	794 (52.8)	26 (3.3)			
	2= Female	709 (47.2)	16 (2.3)	1.791	1	0.181
Exposure to mass media	0=No	757 (50.4)	26 (3.4)	2.087	1	0.149
	1=Yes	746 (49.7)	16 (2.1)			
Sex of household head	1=Male	1383 (92)	41 (3)			
	2=Female	120 (8)	1 (0.8)	1.738	1	0.187
Source of drinking water	1= Tube-well water	1142 (76)	34 (3)			
	2= Piped water	110 (7.3)	2 (1.8)	0.356	2	0.837
	3= Others	251 (16.7)	6 (2.4)			
Type of toilet facility	1= Pit-toilet latrine	673 (44.8)	17 (2.5)			
	2= Flush toilet	243 (16.2)	5 (2.1)	1.896	3	0.594
	3=No facility	32 (2.1)	1 (3.1)			
	4=Others	555 (37)	19 (3.4)			

[Note: ANC: Antenatal care; * p<0.10, **p<0.05 and ***p<0.01]

Table 2: Summary statistics of infant according to selected variables and Log-rank test (Mantel-Cox) for infant mortality, BDHS-2014

Methods:

Kaplan-Meier estimate, Log-rank test, Bonferroni correction and Log-minus-log plot

The Kaplan-Meier procedure (1958) is used to analyze data based on the survival time. It is a most common method used in survival data analysis and also known as product limit method. The K-M (Kaplan-Meier) estimate of survival time t is shown as, $\widehat{S(t)} = \prod_{t_j<t, j=1}^{k}\left(\frac{n_j-d_j}{n_j}\right)$; j=1, 2, 3, ……. , k.

Where, t_j = Total set of failure times recorded.

n_j = The number of observations/individuals at risk at the survival time t.

d_j= Number of failures or deaths at time t_j .

Also, the hazard function $h(t)$ is defined as the event/failure/death rate at time t conditional or surviving up to or beyond time t.

The Log-rank test is the most popular test for testing the equality of survival or hazard functions. Then the hypothesis will be,

$H_0: h_1(t) = h_2(t) = \cdots = h_k(t)$; for all $t \leq T$

Or, H_0= All survival functions are the same.

The Cox-Mantel Log-rank test statistic is, $\chi^2_{CM} = \sum_{j=1}^{k}\frac{(O_j-E_j)^2}{E_j} \sim \chi^2_{(G-1)}$.

Where, G is the number of groups of individuals.

$O_j = d_{oj}$= Number of deaths observed for the group 0 at the j-th death time.

$E_j = \frac{d_j n_{oj}}{n_j}$ = Number of deaths expected for the group 0 at the j-th death time.

And, j=1, 2, 3, ……., k.

The Bonferroni correction is an adjustment made to p-values when several dependent or independent statistical tests are being performed simultaneously on a single data set. To perform a Bonferroni Correction, divide the critical p-value ($\boldsymbol{\alpha}$) by the number of comparisons (k) being made. i.e, $\frac{\alpha}{k}$.

For Cox proportional hazard model, the first thing is to check that the variables meet the proportional hazard assumption or not and can be test by Log-minus-log (LML) plot, when the covariates are dichotomous/categorical. An LML plot is the plot of the logarithm of the negative logarithm of the estimated survivor function. If the curves of the categories of a variable are not crossing each other, then that variable considered as a covariate of the Cox proportional hazard model.

Cox proportional hazard model and Cox frailty model:

The Cox proportional hazard model (1972) is the most commonly used semi-parametric survival model to access the importance of various covariates in the survival times of observations through the hazard function h(t). It is a favorable used model for providing hazard ratio to compare survival times of two or more population groups. The Cox proportional hazard model has the form as:

$$h(t; X) = h_0(t)\exp(X^T B)$$

Where, $h_0(t)$ is the baseline hazard function depends on survival time

$X^T = [X_1, X_2, X_3, \dots\dots\dots, X_n]$ is the covariates vector

$B = [\beta_1, \beta_2, \dots\dots, \beta_n]$ is the regression parameters vector

The measure of the effect of covariates on survival time is given by the hazard ratio denoted as HR. The hazard ratio for two groups (X=1, X=0) is defined as:

$$HR = \frac{h\,(t;X=1)}{h\,(t;X=0)} = \exp(\beta)$$

When, HR=1; it implies that the individuals in the categories have same risk of getting the event. HR>1; implies that the individuals in the first group (X=1) are at high risk of getting the event. And, HR<1; implies that lower risk of getting event than the other.

In the Cox proportional hazard model, only observed homogeneity among individuals are considered. But in survival analysis, some of the individuals exposed to getting event than the others in the survival time. It may bring due to the unobserved causes of some individuals. The Cox frailty model considers both observed and unobserved effects of observations. Cox proportional hazard has entered as random effects in the Cox frailty model.

For the presence of unobserved components, the Cox frailty model can be expressed as: $h(t; X, U) = h_0(t) \exp(X^T B + U)$

$$= h_0(t) \exp(U) \exp(X^T B)$$
$$= Z\, h_0(t)\ \exp(X^T B)$$

Where, $Z = \exp(U)$ is the frailty term; which follows several distributions as, Gamma distribution, Log-normal distribution etc. The Gamma distribution is the most frequently used in the frailty model, due to the following reasons:

- The Gamma distribution takes on positive random variables, since the frailty term is also positive random variable.
- The Gamma frailty is conjugate to the hazard model thus simplifying the computational procedure.

Now recall the Cox frailty model,

$$h\,(t; X, U) = Z\, h_0(t)\ \exp(X^T B)$$

The frailty term Z follows Gamma distribution with mean E(Z)= 1 and variance $Var(Z) = \frac{1}{\alpha} = \theta$ (For the purpose of model identifiability) and the probability density function of Z is; $f(z) = \frac{z^{\frac{1}{\theta}-1} e^{-\frac{z}{\theta}}}{\Gamma(\frac{1}{\theta})\theta^{\frac{1}{\theta}}}$

The value of θ represents the variability among individuals.

Results:

The descriptive statistics of the independent variables selected for the study are described in Table 2 that a total of 42 deaths about 1503 infants according to BDHS-2014. Among 1503 infants, the more were from the Chittagong division. Also, in the Sylhet division, 4.8% died before celebrating their first birthday which was the highest percentage of death as compared to other categories of the region. From the birth history data, among 1503 infants 1.7% and 3.3% of deaths have occurred in urban and rural area respectively. Also, 3.0% and 1% of deaths have observed on Muslim and non-Muslim family respectively. During the survey, 4.5% infant has died whose mothers are illiterate; which is the highest amount than the other categories of mother's educational level. About 4.7% of infant deaths attributed to mothers who were doing a job outside of the home. It is also found that 15(4.9%) infant deaths are prevalent among the fathers having no educational qualification and 3.4% of deaths have occurred whose fathers are agricultural workers. About 3.8% of infant death occurred in a poor family. Among mothers, who gave birth 1st children at the age of 18-29 years, those 3.1% of infant deaths have occurred before reaching his/her first birthday. About 6.4% of infant deaths have occurred whose mothers did not get antenatal care (ANC) visits during pregnancy. It is also observed that 39(3.4%) infant deaths have occurred for the category "1 or 2 children" of the variable number of living children. Also, all of the infant deaths 42 reported for the category "No" of the variable currently breastfeeding. Out of the 20-multiple born 20% had died before the age of one. Of the total live births, 2.6% and 6.3% of infant death have occurred among the baby born with average/large size and very small size (<=2.5 kg) respectively.

From the Kaplan-Meier survival plots and hazard plots in Figure 2indicated that the probability of infant surviving and at risk on a specific month of survival time respectively according to independent factors. After Bonferroni correction father's educational level is significant at 5% and 10% level of significance, Then, for testing proportional hazard assumption by LML plot in Figure 3, 7 variables; type of place of residence, father's educational level, mother's educational level, mother's working status, multiplicity of birth, number of ANC visits, child-size at birth, number of living children are taken as covariates of the Cox Model. Table 3 shows that, estimate B- coefficients, standard error of B, exponential of B (i.e., hazard ratio, HR), 95% confidence interval (CI) of HR and p-value for the covariates of the Cox proportional hazard model.

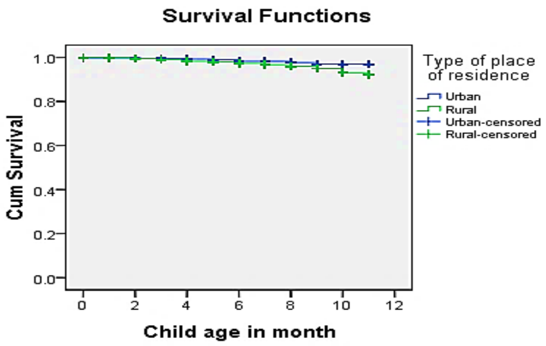
Covariates	Cox proportional hazard model				Cox frailty model			
	B coefficients [SE(B)]	Hazard ratio, HR	95% CI of HR	p-value	B [SE(B)]	Hazard ratio, HR	95% CI of HR	p-value
Type of place of residence								
Urban (rc)		1.000				1.000		
Rural	0.311 [0.410]	1.366	(0.611, 3.048)	0.448	0.312 [0.409]	1.366	(0.612, 3.052)	0.445
Father's educational level								
No education (rc)		1.000				1.000		
Primary	-0.075 [0.380]	0.928	(0.440, 1.954)	0.843	-0.077 [0.380]	0.925	(0.438, 1.950)	0.838
Secondary	-0.738 [0.476]	0.478	(0.188, 1.215)	0.121	-0.747 [0.476]	0.473	(0.186, 1.204)	0.116
Higher	-1.293 [0.791]	0.274	(0.058, 1.663)	0.104	-1.301 [0.790]	0.272	(0.057, 1.281)	0.100

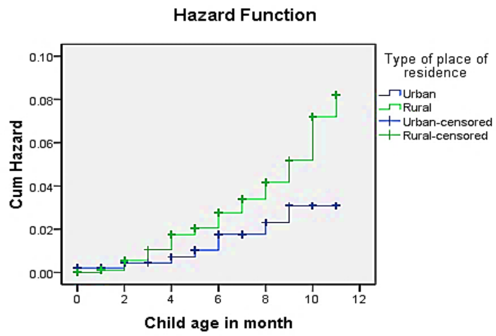
Mother's working status								
No (rc)		1.000				1.000		
Yes	0.790 [0.352]	2.204	(1.106, 4.393)	0.025**	0.807 [0.353]	2.242	(1.123, 4.476)	0.022**
Number of ANC visits								
No visits (rc)		1.000				1.000		
At least once	-0.662 [0.346]	0.516	(0.226, 1.016)	0.056*	-0.659 [0.346]	0.517	(0.262, 1.018)	0.056*
Child size at birth								
Average/Large (rc)		1.000				1.000		
Very small (less than 2.5 kg)	-0.161 [0.546]	0.852	(0.292, 2.484)	0.769	-0.178 [0.548]	0.836	(0.286, 2.449)	0.744
Multiplicity of birth								
Single birth	-2.604 [0.475]	0.074	(0.029, 0.188)	0.000***	-2.658 [0.477]	0.070	(0.027, 0.178)	0.000***
Multiple birth (rc)		1.000				1.000		
Number of living children								
1 or 2 children (rc)		1.000				1.000		
3 or more	-1.590 [0.606]	0.204	(0.062, 0.670)	0.009**	-1.598 [0.606]	0.202	(0.061, 0.663)	0.008**
n= 1503 Number of events = 42	Value of chi-square= 146.747 Degrees of freedom= 9 Level of significance= 0.01 p-value= 0.000				Value of chi-square= 58.98 Degrees of freedom= 9 Variance of frailty term= 0.002401 Level of significance= 0.01 p-value= 0.000			

[Note: ANC= Antenatal care. CI= Confidence interval rc = Reference category. * p<0.10, ** p<0.05 and *** p<0.01]

Table 3: Estimated hazard ratios obtained from both Cox proportional hazard model and Cox frailty model of infant (0-11 months) mortality, BDHS-2014

From the Cox model, the mother's working status, number of ANC (antenatal care) visits, the multiplicity of birth and number of living children is found to be significant for infant mortality. The Cox proportional hazard model is significant (p-value= 0.000) at 1% level of significance and the value of chi-square for the likelihood test is 146.747 with 9 degrees of freedom. The infant has 2.204 times (HR= 2.204, 95% CI; 1.106, 4.398) more likely to die whose mothers doing the job outside of the home. A significant difference was found for the categories of ANC (antenatal care) visits; the infant has 49% (HR= 0.516, 95% CI; 0.226, 1.016) lower risk of dying whose mothers get at least one visits for ANC to qualified doctor/ hospital/ clinic during the gestational period. Singleton birth infants had approximately 93% lower risk of dying than the multiple birth infant (HR= 0.074, 95% CI; 0.029, 0.188). The number of living children in the household has also affect on infant mortality. The number of living children in the household where the status infant lived, "3 or more" has 90% lower risk of dying than the other category "1 or 2 children" (HR= 0.204, 95% CI; 0.062, 0.670). For checking the unobserved heterogeneity among infant during their 0 to 11 months of life for risk of dying; the Cox frailty model is significant at 1% level of significance (p-value= 0.000) with the value of chi-square 58.98 on 9 degrees of freedom and the variance of frailty term is 0.002401. In the Cox frailty model, the Cox proportional hazard model entered as a random effect. As well as the same variables were found to be significant with a slight change in parameter estimate, standard error, hazard ratio (HR) and 95% CI of HR.





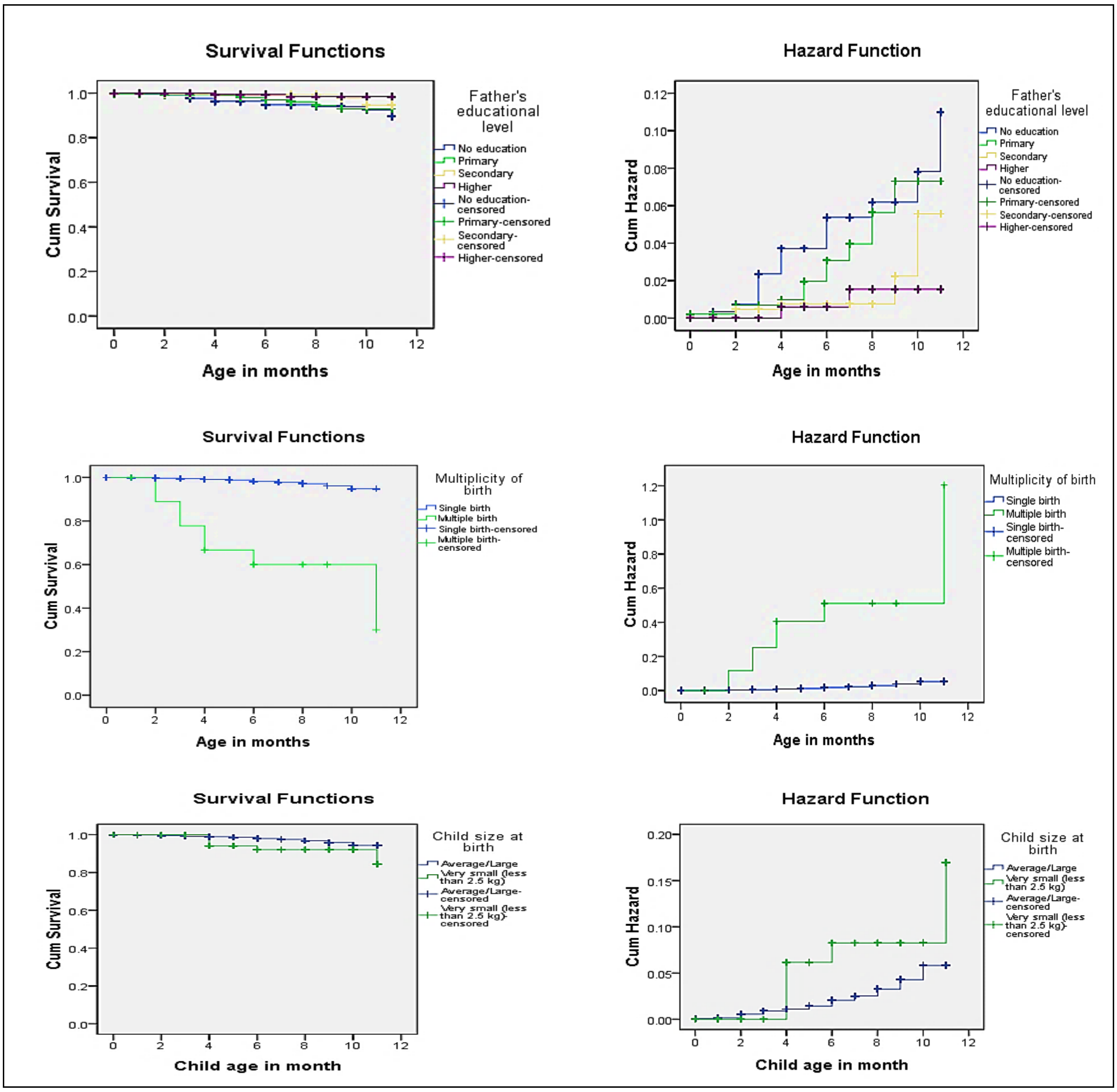
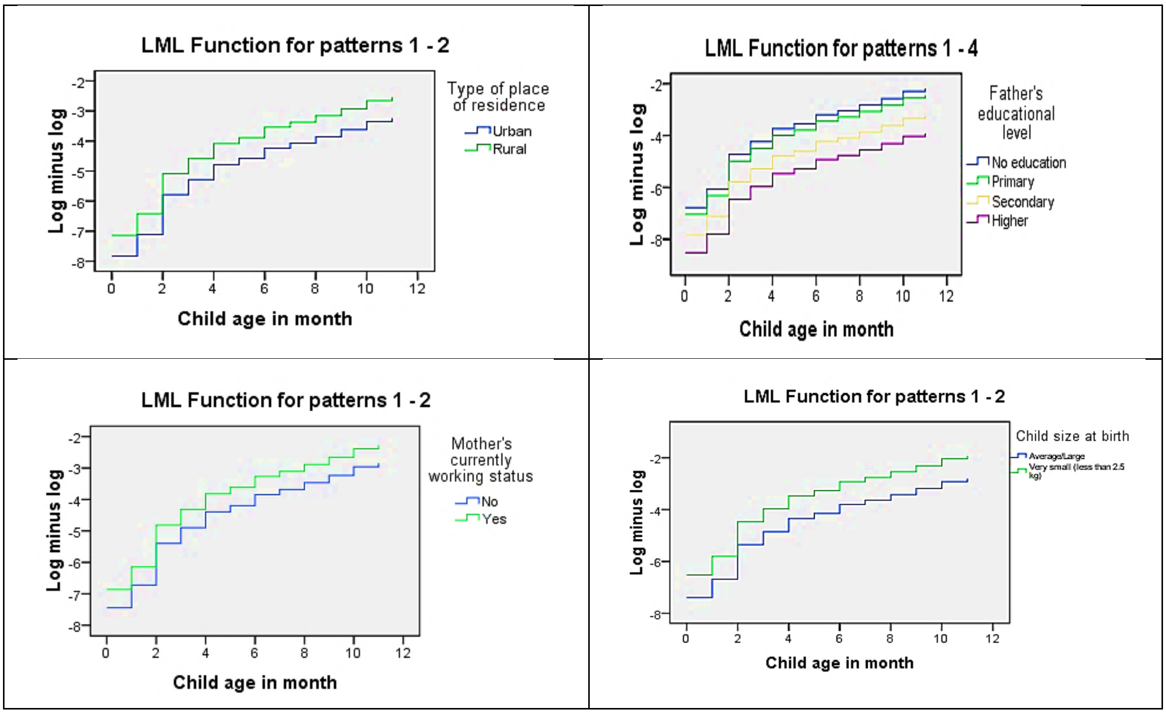


Figure 2: Survival plot and hazard plot for the independent factors



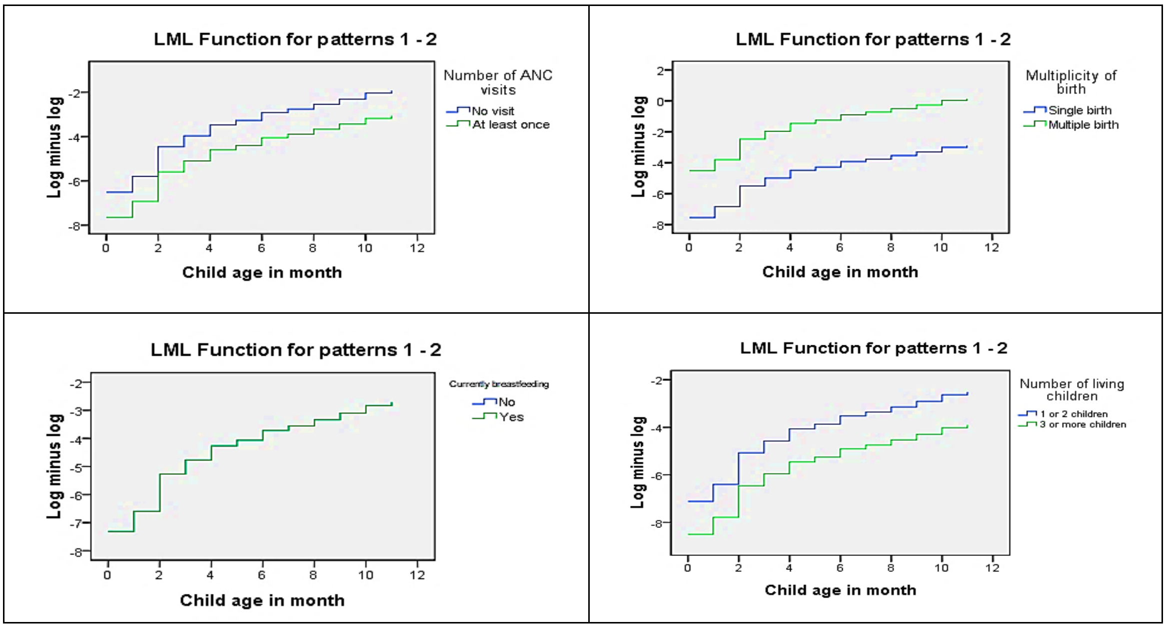


Figure 3: Log-minus-log plots for the covariates of Cox proportional hazard model

Discussion:

The study set out to find the risk factors of infant mortality in Bangladesh according to BDHS-2014. By stepwise analysis we have utilized that, mother's working status, number of ANC visits, the multiplicity of birth and number of living children are associated with infant mortality. Based on the values of variance of frailty term, it is implied that there is an existence of heterogeneity present among children. From the findings of our study, we are most similar to many other previous works. Antenatal care utilization is one of the risk factors for infant mortality, using the Cox proportional hazard model according to BDHS-2014 by Jyoti and Kamlesh5. A work by Nurul Alam, Ginnekan about infant mortality among twins and triples in rural Bangladesh in 1975-2002; found that children born with their siblings have the risk of dying than the singletons during their 0-11 months lifetime6. Multiplicity of birth, small size at birth, antenatal care visiting revealed as potential factors of infant mortality by Azizur Rahman, Md. Sazidur Rahman and Md. Ashikur7. A work by AHMMR Nabeen et al. observed that the children whose mothers did not receive antenatal care are about three times as likely to die during infancy as the children whose mothers received antenatal care visits during pregnancy8. Another work by R. Hong and M. Ruiz-Beltran, results indicate that children of mothers who did not receive prenatal care or antenatal care during pregnancy were more than twice as likely to die as the others (HR= 0.240, 95% CI; 1.74, 3.31)9. By a study of Dr. Belayet Hossain about infant mortality using BDHS-2011 showed that women's employment is associated with the increased mortality of children during their infancy period (0-11 months)10.

Conclusion:

The results of this study showed that infant mortality has a significant relationship with various factors. In the frailty model, frailty terms takes into consideration the situation where some of the children may be exposed to the hazard of death before the age of 1 year more than the others and this brings about the possibility that due to the unobserved or unmeasured causes some children are more likely to experience the death than the others. The frailty term captures the total effects of all factors that influence the child's risk of death that is not included in the Cox proportional hazard model. So, it is found to be that, Cox frailty model is the better model than the Cox proportional hazard model. The causes of infant mortality in resource-poor settings are complex and merit concerted efforts to clarify their implications to reduce infant deaths. Based on the outcome of this research work for infant mortality, the study urges the policymakers to focus on demographic factors and socioeconomic factors and policy aiming at maternal and child health care is needed for increasing the rate of infant survival.

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