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Determinants of Under-Five Child Mortality in Bangladesh: Findings from Bangladesh Demographic Health Survey 2017-18

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Abstract: **Under-five mortality has remained a significant public health concern in Bangladesh despite a consistent decline over the previous few years. The purpose of this study was to identify the socioeconomic and demographic risk factors for under-five mortality in Bangladesh. Data from the 2017–18 Bangladesh Demographic and Health Survey are used in the study. The study outcome variable was survival time, which was obtained from the variable age at death for the event and the current age of the child for the censored observation. Based on literature assessment, nine covariates were chosen for this study. Product-Limit (P-L) estimator and Log-Rank tests were performed to assess the association between the outcome variables and the selected covariates. The Cox proportional hazard model was also employed in this study to identify potential risk factors for under-five mortality. After fitting the Cox PH model, the factors that significantly affect under-5 mortality include mother's age at birth (< 20), mother's age at birth (> 30), and Sylhet division. Children whose mothers were under 20 and over 30 years old have mortality rates that are 47.5% and 68.7% higher, respectively, than children whose mothers were between the ages of 20 and 30. Regional differences had an impact on child mortality as well. Children in the divisions of Barisal, Rangpur, Khulna, Mymensingh, and Sylhet had death rates that were, in comparison to children in the division of Dhaka, 5.5%, 7.8%, 9.6%, 11.2%, and 55.3% higher.**

Keywords: **Cox PH model, Determinants, Demographic Factors, Product-Limit (P-L) Estimator, Log-Rank test, Under-five mortality, Socio-Economic Factors.**

I. INTRODUCTION

As one of the key indicators of a nation's prosperity and progress, child mortality is a significant public health concern everywhere in the globe. The under-five mortality rates of a nation reveal its level of socioeconomic development and standard of living. The risk of a kid dying before turning five is known as the under-five child mortality rate. In 2018 there were 5.3 million children who died before turning five worldwide [1]. By 2030, the Sustainable Development Goals (SDG) aim to reduce new born mortality (NM) and under-five mortality (U5M) rates to 12 and 25 deaths per 1,000 live births, respectively [2]. In 79 nations throughout the world, the death rate for children under the age of five is currently more than 25 per 1000 live births [3]. Bangladesh's under-five mortality significantly decreased from 133 to 30.2 deaths per 1000 live births between 1990 and 2018 as a result of the MDG's successful implementation [4, 5]. Nevertheless, the percentages are still high in South Asian nations. After Pakistan (69.3 live births per 1000), and India (36.6 live births per 1000), Bangladesh is in third place [6, 1].

Evidence revealed concerning differences in death rates for children under-five within nations owing to residency and geography. If a child from a socioeconomically disadvantaged area is born in a remote rural area, into a poor household, or to a mother with no formal education, their risk of passing away before turning five increases [7]. Child mortality is caused

by various factors, including mother education, economic position, access to healthcare, and more [8, 9, 10, 11]. For child deaths, many demographic factors are also taken into account, such as the age of the mother, any health issues she may have, her BMI, the manner of birth, the baby's size at birth, etc. [8-11]. According to certain research, factors such as birth order, delivery method, access to clean drinking water, and improved restroom facilities have been responsible for child mortality [12, 13, 14].

Even now, inadequate health care resources and expertise have contributed to the death of many children [15]. Acute lower respiratory infections, diarrhoea, malaria, measles, HIV/AIDS, and neonatal disorders, primarily preterm delivery, birth asphyxia are among the causes of infant mortality. These variables have been often studied in relation to child mortality in developing nations [4]. Along with potential effects of typical social and economic development, various health care programs, such as immunization, control of diarrheal diseases, providing vitamin A supplementation, and implementation of family planning programs, are thought to be the most important factors to reduce child mortality [17].

There has been progress in improving access to basic necessities to extend life expectancy, but more work is required to completely remove a variety of obstacles and deal with a multitude of ongoing and new health problems. Prior research had been conducted [5, 12, 14, 17] with a focus on the importance of examining child mortality and its causes in Bangladesh. Policymakers conducted some actions based on numerous research findings that required ongoing evaluation to determine the degree of improvement. Therefore, the goal of the current study was to identify any potential risk factors that could affect the death of children under the age of five in Bangladesh utilizing data from the Bangladesh DHS (2017-18).

II. MATERIALS AND METHODS

A. Data source

The data for this study came from the nationally renowned Bangladesh Demographic Health Survey (BDHS), which was conducted in 2017–18. The sixth national-level Bangladesh Demographic and Health Survey (BDHS) was created to gather data on the country's demographics and maternal and child health. The National Institute of Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare supervised the 2017–18 BDHS. The survey was conducted by Mitra and Associates, a Dhaka-based research company from Bangladesh. The study received technical assistance from ICF International of Calverton, Maryland, USA, as part of its international Demographic and Health Surveys program (MEASURE DHS) and financial support from the U.S. Agency for International Development (USAID).

B. Sample design

The survey used as a sampling frame the list of enumeration areas (EAs) prepared for the 2017-18 population census of the People's Republic of Bangladesh (PCPRB 2017), provided by the Bangladesh Bureau of Statistics (BBS). The primary sampling unit (PSU) for the survey is an EA created to have an average of about 100 households. The survey is based on a two-stage stratified sample of households. In the first stage, 600 EAs were selected with probability proportional to the EA size, with 207 clusters in urban areas and 393 in rural areas. In the second stage of sampling, a systematic sample of 30 households on average was selected per EA to provide statistically reliable estimates of key demographic and health variables for the country. With this design, the survey selected 18,000 residential households, and was expected to result in completed interviews with about 18,000 ever-married women (aged 15-54). Using weighting parameters from the Bangladesh Demographic and Health Survey, the data were weighted for further analysis in order to better reflect the demographic composition of Bangladesh. There were 8759 ever-married women included in this study after weighing and discarding the missing observations.

C. Dependent variable

The outcome variable in the data represents the time to the event. Child who is alive at date of interview is

considered as censored. The censoring indicator is defined as

$$\text{Censoring indicator} = \begin{cases} 1; & \text{if child is death at or before age 5} \\ 0; & \text{otherwise} \end{cases}$$

The time variable (measured in days) is created from the variable age at death for event and current age the child for the censored observation.

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D. Independents variables

All of the covariates in this study were derived from BDHS data. This data included demographic and socio-economic information of the respondents. The independent variables were mother's age at birth, region, mother's education, wealth index, birth order, gender of the child, place of residence, place of delivery and access to media. Mother's age at birth is not directly given in the original data set. This continuous variable is created from the information of the available variables, mother's CMC date of birth and child's CMC date of birth. For the purpose of simplification of the study we divided this variable with 3 categories which are age below 20, age between 20 and 30 and age above 30. Birth order is used as continuous variable in the data. From which, we made 2 categories such as First birth and others. In the data set wealth index is given as categorical variable with 5 categories which are Poorest, Poorer, Middle, Richer and Richest. For the study purpose these 5 categories are converted into 3 categories. The poorest and poorer categories jointly constitute the first category Poor, the middle category remains same and finally the Richer and Richest categories are merged to create the third one Rich. In the original data set there are 16 categories for place of delivery such as Respondent's home, Public sector, Government hospital, Special medical college, District hospital, Maternal and child welfare center (MCWC), Upazilla health complex, Health and family welfare center, Private sector, Private hospital/clinic, Private medical college hospital, NGO sector, NGO static clinic, Other NGO sector and Other. Place of delivery related with health care services is categorized as Hospital and Home and others is categorized as Others. We define two categories for this variable such as exposure and non-exposure. If mothers are reading newspapers or magazine/listening to radio/watching television, then Yes category is used for them. However, no category is used, when mothers are not associated with any of the above activities.

E. Statistical analysis

Descriptive statistics were used in this research, that is, frequency distributions were analysed for all variables. We used bivariate analysis to examine the association between the dependent variable and selected independent variables. This study dealt with time-to-event data. So the appropriate bivariate technique for this type of data is the Product-Limit (PL) estimator, which was used in this study. Additionally, the log-rank test is applied to compare survival probabilities between two or more groups of individuals. The Cox proportional hazard model was applied to examine the determinants of under-5 mortalities in Bangladesh. SPSS (Statistical Package for Social Science) version 25 and R-Programming version 4.0.0 were used for data management and analysis.

III. RESULTS

From **TABLE I** we have observed that 30% of moms gave birth when they were under 20 years old, 55.6% when they were between 20 and 30, and 14.4% when they were beyond 30. The highest percentage of mothers among the 8 divisions resided in Chittagong (16.5%), while the lowest percentage did so in Barisal and Khulna (10.3%). Only a small portion of women (7.3%) had no formal education, while the majority of women (47%) had finished their secondary school. In terms of economic status, 42% of mothers come from poor families, 17.8% from middle-class families, and 40.1% from wealthy families. The firstborn of their mother made up 38.6% of the offspring. Furthermore, 52.1% of the kids are male and 47.9% are female. In comparison to urban areas, around 20% more of them are from rural areas. It is found that 30.3% of births overall have occurred in a hospital or clinic, while a significant portion of moms (33%) do not receive any sort of medical care when giving birth to their kid. Mothers are more likely to be exposed to media (63.9%) than non-exposers.

TABLE I: DISTRIBUTION OF THE DEMOGRAPHIC AND SOCIOECONOMIC VARIABLES

Variables	Frequency	Percentage (%)
Mother's age at birth		
<20	2630	30
20-30	4870	55.6
>30	1259	14.4
Region		
Barisal	906	10.3
Chittagong	1446	16.5
Dhaka	1304	14.9
Khulna	904	10.3

Rajshahi	912	10.4
Mymensingh	1025	11.7
Rangpur	971	11.1
Sylhet	1291	14.7
Mother's education		
No Education	642	7.3
Primary	2548	29.1
Secondary	4115	47
Higher	1454	16.6
Wealth index		
Poor	3683	42
Middle	1565	17.8
Rich	3513	40.1
Birth order number		
1st birth	3383	38.6
Others	5376	61.4
Gender of child		
Female	4192	47.9
Male	4567	52.1
Place of residence		
Rural	5702	65.1
Urban	3057	34.9
Place of delivery		
Hospital/Clinic	2653	30.3
Others	2651	30.3
Access to Media		
Exposure	5601	63.9
Non-exposure	3158	36.1

Fig. 1 reveals that children of mother's aged 20 to 30 at birth have higher survival compared to younger and above 30 age group. From **Fig. 2** it is clear that the probability of dying of children before reaching their fifth birthday is highest for Sylhet. It is also seen that survival probability of the children aged between 0 to 500 days (approximately) is highest for the division Chittagong but after that age children of the division Khulna seem to have highest survival among these seven divisions. In **Fig. 3**, survival probabilities for children of higher educated women is highest whereas those for children of illiterate mothers is lowest. From **Fig. 4**, it is observed that children whose mothers belong to rich family experience higher survival compared to children of poor and middle class family. Under-5 mortality experience is higher for first baby of a mother compared to other birth. **Fig. 6** represents that risk of under-5 mortalities is higher for male child than female child. The difference between the survival experience between these rural and urban areas is not noticeable in above figure. From **Fig. 8**, it is observed that the children who were born in hospital/clinic tend to live shorter life than the children who were born in other places. It is seen from **fig. 9** that the children whose mothers are exposed to media have higher survival than the children whose mothers are not exposed to media.

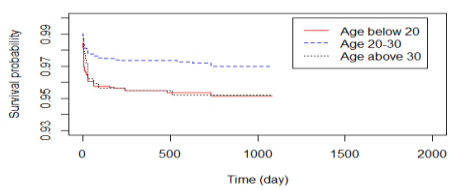

Fig. 1: Survival curve for mother age at first birth

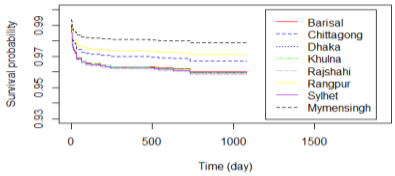

Fig. 2: Survival curve for region

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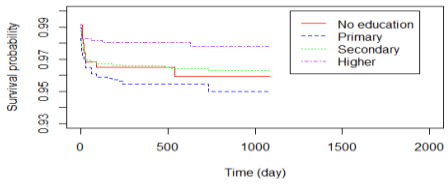

Fig. 3: Figure 1: Survival curve for mother's education

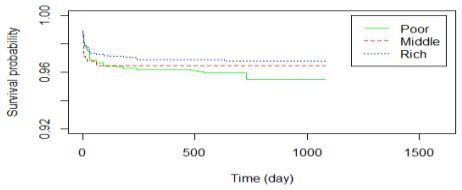

Fig. 4: Figure 1: Survival curve for wealth

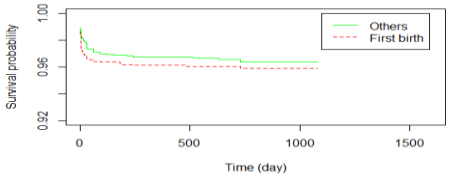

Fig. 5: Survival curve for birth order

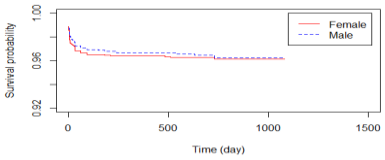

Fig. 6: Survival curve for child sex

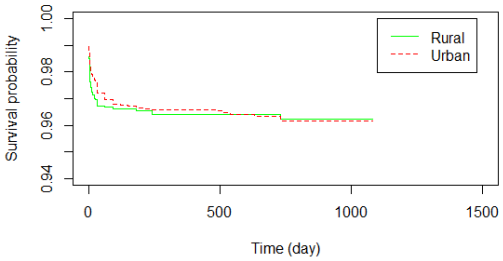

Fig. 7: Survival curve for place of residence

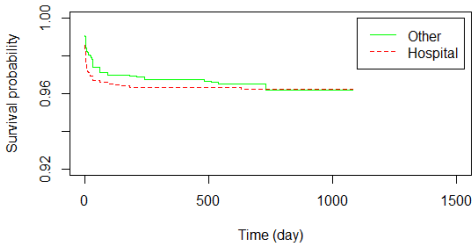

Fig. 8: Survival curve for place of delivery

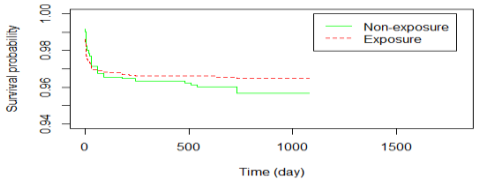

Fig. 9: Survival curve for media access of mother

Table II: Association between survival probabilities and covariates

Variables	Log-run Test
Mother's age at birth	P-value
<20	0.002
20-30	
>30	
Region	
Barisal	0.4
Chittagong	
Dhaka	
Khulna	

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Rajshahi	
Mymensingh	
Rangpur	
Sylhet	
Mother's education	
No Education	0.01
Primary	
Secondary	
Higher	
Wealth index	
Poor	0.01
Middle	
Rich	
Birth order number	
1st birth	0.03
Others	
Gender of child	
Female	0.07
Male	
Place of residence	
Rural	0.9
Urban	
Place of delivery	
Hospital/Clinic	0.6
Others	
Access to Media	
Exposure	0.04
Non-exposure	

The relationship between the survival probability and the chosen covariates is shown in **Table II**. The age of the mother at her first birth, her education, her wealth index, her birth order, and her media exposure are risk factors for deaths in children under the age of five.

Table III: Estimates of parameters for under-5 mortalities by Cox Proportional Hazard Model

Variables	**Category**	***β***	**HR**	**S.E.(*β*)**	**p-value**
Mother's age at birth	<20	0.388989	1.475488	0.202686	0.0500
	20-30	-	-	-	-
	>30	0.523371	1.687707	0.209699	0.0126
Region	Dhaka	-	-	-	-
	Barisal	0.05416	1.05565	0.29391	0.8538
	Chittagong	-0.14537	0.86470	0.26987	0.5901
	Khulna	0.09251	1.09693	0.28953	0.7493
	Rajshahi	-0.26833	0.76465	0.30559	0.3799
	Mymensingh	0.10652	1.11240	0.26164	0.6839
	Rangpur	0.07572	1.07867	0.28751	0.7923
	Sylhet	-0.59218	1.55312	0.35500	0.0953

Mother's education	No Education Primary Secondary Higher	- 0.229078 -0.015697 -0.531998	- 1.257440 0.984425 0.587430	- 0.306946 0.311133 0.386986	- 0.4555 0.9598 0.1092
Wealth index	Poor Middle Rich	0.104726 - -0.025894	1.110406 - 0.974438	0.208166 - 0.219740	0.6149 - 0.9062
Birth order number	1st birth Others	0.177770 -	1.194550 -	0.202776 -	0.3807 -
Gender of child	Female Male	- -0.07276	- 0.92982	- 0.14691	- 0.6204

From **Table III**, we can conclude that children whose mother's age at birth is below 20 and above 30 have 47.5% and 68.7% higher rate of mortality respectively compared to the children whose mothers age at birth is between age 20 and 30. The lower and higher age groups of the mother's age at birth have a significant impact on under-5 mortalities at a 5% level of significance.

In the case of region, children who belongs to Barisal, Rangpur, Khulna, Mymensingh and Sylhet have 5.5%, 7.8%, 9.6%, 11.2% and 55.3% more rate of mortality respectively compared to children who belongs to Dhaka. While children who belong to Chittagong and Rajshahi have 13.5% and 23.5% lower rate of mortality compared to children belong to Dhaka division. It is clear from **Table III** Sylhet region has significant effect on child survival at 10% level of significance.

It is observed that children whose mothers have primary education have 25.7% more rate of mortality compared to children whose mothers have no education. It is seen that primary education has no significant effect on declining under-5 mortalities. Moreover, children whose mothers have secondary and higher education have 1.5% and 41.2% less rate of mortality compared to children whose mothers are illiterate. Higher education has significant effect on under-5 mortalities.

Children from poor family have 11% higher rate of mortality and children from rich family have 2.56% less rate of mortality compared to children of middle class family. A child who is the first baby of his or her mother has 19.4% higher rate of mortality compared to a child who is not the first baby of his/her mother. Male children have 7% higher rate of failure than female child. In this study, the under-5 mortality rate was not potentially influenced by wealth index, birth order, or child gender.

IV. DISCUSSION

This study made an effort to examine the (BDHS 2017–18) data in order to estimate changes in the risk variables of under-five mortality in connection to ongoing government interventions in Bangladesh. The findings from the bivariate analysis of this study revealed an association between the under-five child death rate and the mother's first birth age, education level, wealth index, birth order, and media access. The child death rate was almost 20% higher in rural areas compared to urban areas, despite the fact that the under-five child mortality rate for location of residence was shown to be statistically insignificant in this study. Other research have found similar results [9, 17, 18, 19, 20]. Urban mothers have access to better medical facilities than rural mothers.

The Cox proportional hazard model demonstrated that the mother's age at the time of her first birth had a significant effect on child mortality. In comparison to women in the age range of 20 to 30, mothers who were younger and older at the time of their first birth had greater rates of under-five mortality. These findings are in line with those of earlier studies [17, 18, 21]. Teenage mothers are unaware of the need for maternal care, which could be the cause of child mortality. On the other hand, older moms were more likely to give birth to children who had a variety of heart defects, genital abnormalities, cranial deformities, and esophageal anomalies. A young child might die as a result of this. This study demonstrated that, as compared to children in the Dhaka division, children from the Sylhet division had a higher risk of under-five mortality. The similar outcome was also reported in earlier studies carried out in Bangladesh [5, 17]. The availability of basic medical services may be the cause of geographical variations in child mortality.

Although the under-five child mortality rate for birth order was found to be statistically insignificant in this study, the child mortality rate was found to be higher for the first birth in contrast to other birth orders. However, several research also produced conflicting results [5, 12, 17, 22]. Too many children are less appealing to people in Bangladesh today. The majority of the parents have two kids.

The child of a higher-educated mother had a lower risk of mortality compared to the child of a uneducated mother. This agrees with earlier research. But hazard analysis found a statistically insignificant relationship between child mortality and maternal education. Various research produced conflicting findings [12, 17, 21], as well. Bangladesh has made great progress in female education, which could be the cause.

V. CONCLUSION

Despite a notable decline in the under-5 mortality rate, Bangladesh has not yet achieved the Sustainable Development Goals (SDGs). The results of this study are essential for determining both new strategies and actions along with existing ones for reducing the prevalence of under-five mortality. It is necessary to implement programs that focus on delaying the first childbearing age for younger women. The mortality rate could be decreased by raising the mother's age at the first birth, but it would not exceed 30. Priority should be given to women who are more likely to participate in high-risk reproductive behaviors and who are less likely to access maternal healthcare services under region-specific regulations. In order to meet Bangladesh's realistic health targets for lowering child mortality, the study's findings may be used as an adjuvant framework for further developing future health initiatives and policies.

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