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Risk Factors for Under-Five Child Mortality: Evidence from Bangladesh Multiple Indicator Cluster Survey (MICS) 2019

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ABSTRACT

Every year, millions of children under the age of five deaths for various reasons, and some of these deaths may be avoided if more people were aware of the situation and taken action. Despite the fact that Bangladesh's under-five child mortality rate has decreased significantly over the last decade, and it is still too high to meet the Sustainable Development Goals (SDGs). The major goal of the study was to figure out what risk (socio-economic and demographic) factors influence under-five child mortality in Bangladesh. Nationally representative cross-sectional secondary data from the Multiple Indicator Cluster Survey (MICS) 2019, Bangladesh had been used in this study. The outcome variable was the under-five child survival status (alive or dead). Kaplan–Meier log-rank test and Cox Proportional Hazard (PH) model with a 95% confidence interval (CI) were fitted to identify associated risk factors for under-five child mortality. This analysis was performed using STATA version 16. The study showed that among 5112 under-five children, 170 (3.3%) were dead. Cox proportional hazard model revealed that mother's education [secondary (HR: 0.57, 95% CI: (0.32, 1.01), p=0.045), higher (HR: 0.46, 95% CI: (0.23, 0.90), p=0.024)], higher birth order [HR: 1.43, 95% CI: (1.23, 1.80), p=0.008], size of child at birth [HR: 2.30, 95% CI: (1.23, 4.28), p=0.009], taking antenatal care [HR: 0.83, 95% CI: (0.56, 1.24), p= 0.099] had a significant effect on child mortality. Under-five child mortality rate was varied among divisions and highest mortality rate was found in Sylhet [HR: 1.98, 95% CI: (0.91, 4.17), p=0.088]. This study identified potential risk factors for under-five child mortality, which will help policymakers take appropriate steps to reduce child mortality in Bangladesh, such as community-based educational programs for mothers and public health interventions centered on birth.

Keywords: Under-five child mortality, Determinants, Cox-proportional hazard model, and Bangladesh.

INTRODUCTION:

Under-five child mortality rate is the probability of dying a child before completing his/her fifth birthday. It is one of the important indicators for assessing the quality of a country's healthcare system. It is also the exponent of overall progression of a country, as it reflects the social, economic, and environmental conditions in which children live (McGuire, 2006). All over the world, 5.2 million children were died before completing their fifth birthday in 2019, which was 12.6 million in 1990 (WHO, 2020). A huge reduction in child mortality was observed over time. Under-five child mortality rate is still highest in WHO African region (76 per 1000 live births) and lowest in WHO

European region (9 per 1000 live births). Child mortality rate is high in low-income countries compared to high-income countries. In low-income countries, under-five child mortality rate was 68 per 1000 live births in 2018, which is almost 14 times the average rate in high-income countries (5 per 1000 live births) (WHO, 2018). Under-five child mortality rate has been decreesed by 59% globally, from an estimated rate of 93 per 1000 live births in 1990 to 38 per 1000 live births in 2019 (WHO, 2020). It means that 1 in 11 children dying before their fifth birthday in 1990 and 1 in 27 children in 2019. More than 80 percent of 5.2 mil-lion under-five death occurred in just two regions Sub-Saharan Africa and Central and Southern Asia. Half of all under-five deaths in 2019 occurred in just five countries: India, Nigeria, Pakistan, Ethiopia and the Democratic Republic of the Congo and about a third in India and Nigeria alone (WHO, 2020).

It is recognized that, under-five child mortality is a major challenge of a countries public health care system and included in Sustainable Development Goals (SDGs). Under goal 3 of SDGs aims to reduce under–five mortalities to 25 per 1000 live births by 2030 (WHO, 2020). At present, under-five child mortality rate of 122 countries is less than 25 per 1000 live births and 20 countries are expected to meet the SDGs target by 2030. However, 53 countries will not achieve the target by 2030 on their current trends. Leading causes of under-five deaths are diarrhea, phenomena, malaria, preterm birth complications, pneumonia, birth asphyxia, congenital anomalies, lack of nutrition, unsafe water, etc (WHO, 2020). In developing countries like Bangladesh, under-five child mortality may be a major public health issue. In Bangladesh, child mortality rate was 30.8 deaths per 1000 live births in 2019. A remarkable change of under-five child mortality rate has been experienced for few years, from 224.1 deaths to 30.8 deaths per 1000 live births in the period 1969-2019 (Shaikh *et al*., 2021; World Data Atlas, 2019).

In the meantime, Bangladesh has obtained the Millennium Development Goal-4 with 65% decline rate between 1993 to 2014, but still now a large portion of children have been died due to lack of proper health care facilities and know-ledge (NIPORT, 2014). The under-five mortality rate in Bangladesh has dropped by 79 percent since 1990–2019 (WHO, 2020). Pneumonia remains the leading cause of under-five child mortality and every hour two children die due to pneumonia in Bangladesh. According to National Situation Analysis Report of Pneumonia 2018, around 16% of the total under-five child deaths are caused by pneumonia (Save the children, 2019). Chance of survival of children showed regional disparities in Bangladesh. Child mortality rate was high in rural area 41% compared to urban area 35% because of high coverage of the maternal and newborn health. Regarding the geographical region, the highest mortality was observed in Sylhet division 61% with the lowest in Khulna division 33% in 2019 (MICS, 2019). Bangladesh is expected to meet the SDGs target of 25 death per 1000 live birth by 2030. Progress should be equal for poor and rich, boy and girl, and also rural and urban living child in Bangladesh. To meet the challenges of Sustainable Development Goals (SDGs), the Health and Family Welfare Ministry of Bangladesh is working to implement fourth health sector programs-between 2017 & 2022. Community clinics of one for every 6,000 people are constructed across the country and those clinics are playing an important role in reducing the death rates. Child and mother healthcare services have also improved at union sub-centers, Upazilla health complexes, and satellite clinics. In Bangladesh new initiative as National Newborn Health Program has been launched to reduce the preventable causes of under-five child mortality by focusing on scaling up a package of evidence-based interventions in all 64 districts of the country. Women's empowerment and education, progression in a communication system such as increasing the use of mobile phone and internet, improvement of the socio-economic condition had played an important role to reduce under-five child mortality in Bangladesh (Save the children, 2019).

Child mortality has also been reduced due to the coverage of effective interventions to prevent or treat the disease of mortality and the improvement of the socio-economic condition. Since the rate of child mortality has been decreasing, Bangladesh has faced different challenges towards progression of child survival and improvement of their life such as, low vaccination coverage, low management of diarrhea and pneumonia, lack of nutrition for all children, lack of skilled attendants at birth, cultural barriers, inequalities in

health service utilization in all part of the country, unawareness of maternal and child health care, etc (WHO, 2015). Even though the child death rate is diminishing after some time, Bangladesh needs to additionally reduce child mortality to acquire the Sustainable Development Goals (SDGs) (NIPORT, 2014). Different health care programs such as immunization, control of diarrhoeal diseases, providing vitamin A supplementation, and implementation of family planning programs are considered to be the most important factors to reduce child mortality, alongside the potential impact of typical social and financial development. From the literature review, evidence of an association between child mortality and socio-economic characteristics of a child's parents was found (Chowdhury *et al.,* 2010; Doctor, 2004; Mathews and MacDorman, 2011). Many determinants are responsible for child mortality such as maternal education, economic status, health facilities, child malnutrition, etc (Aheto, 2019; Grepin and Bharadwaj, 2015; Kabir *et al.,* 2001, Islam and Bari 2021). Different demographic variables are also considered for child death such as maternal age, maternal health complications, maternal BMI, type of birth, baby's size at birth, etc (Aheto, 2019; Grepin and Bharadwaj, 2015; Kabir *et al.*, 2001). Media exposure may influence child mortality (Khan and Awan, 2017). Birth intervals less than 2 years have a higher risk of child mortality compared to birth intervals more than 2 years (Abir *et al.*, 2015; Gebretsadik and Gabreyohannes, 2016; Khan and Awan, 2017). Birth order is also an important influential factor for child mortality. From many studies, it was found that child mortality was comparably high for second birth order and more (Abir *et al.,* 2015; Khan and Awan, 2017). Many other factors such as mode of delivery, facility of pure drinking water, facility of the improved toilet was responsible for child mortality (Abir *et al.,* 2015; Gebretsadik and Gabreyohannes, 2016; Rahman *et al.,* 2019). This study examined the socio-economic and demographic factors which are responsible for child mortality and survival outcomes of children and siblings in Bangladesh. In developing countries, under-five child mortality data are collected from the Demographic Health Survey which suggests that the lifetimes of children from the same cluster are correlated. This kind of correlation is frequently found at the family level or community level which causes biased results due to violating the independence of event time assumption. In this situation, the Cox-proportional hazards model is suitable because they allow for the correlation in survival expertise of children and their siblings and are expected to calculate appropriate estimates of risk factors of child mortality.

Some studies had been done previously by considering the necessity of analyzing child mortality and its determinants in Bangladesh (Abir *et al.,* 2015; Khan and Awan, 2017; Rahman *et al.,* 2019). Although different interventional programs and policies had been taken by the government and NGOs throughout the past few years, many of the health care sectors and social conditions have switched if the factors have interchanged over time. This study aimed to find out the socio-economic and demographic factors provoking under-five child mortality in Bangladesh, which will help the policymakers and governments to find out the contention of child mortality for reducing the mortality rate by implementing necessary steps. For this present study, the research questions are as follows: What is the current under-five child mortality rate in Bangladesh? And which factors (socioeconomic, demographic, and maternal) are responsible for the under-five child mortality? This study is motivated to find out the socioeconomic, demographic factors, maternal or birth-related characteristics provoking under-five child mortality in Bangladesh, which will help the policymakers and governments to find out the contention of child mortality for reducing the mortality rate by implementing necessary steps.

MATERIALS AND METHODS:

Data and sample

Our study has been based on the most recent Multiple Cluster Indicator Survey, 2019 data, which is a nationally representative cross-sectional study (MICS, 2019). Information was collected from the individual level (married women at their reproductive age) and community level. The survey was conducted in collaboration with the Bangladesh Bureau of Statistics (BBS) and UNICEF Bangladesh from January to May 2019. A two-stage stratified cluster sampling method was used to select the sampling units and a total of 64400 households were enumerated. Among them, 3220 Primary Sampling Units (PSUs) were selected

for the sample survey. Data were collected from eight divisions and 64 districts in Bangladesh, on demographic or socio-economic characteristics such as marriage, fertility, maternal age, maternal education, child mortality, family planning, breastfeeding, information about HIV/AIDS, maternal health care, etc. In this study, data were collected from 23099 women at their reproductive age (15-49 years). Data on 9748 children aged below 5 years were generated from the interviewed women. Complete birth histories of the children were collected including months and years. These data were used to find out the number of children born in the last 5 years preceding the survey and child age at death (from 2014 to 2019). Among this information, 5112 children were considered for analysis due to incomplete interviews or non-response as well as missing information of antenatal care and prenatal care. Those children who died before their fifth birthday were considered as death/uncensored cases and those who were still alive before their fifth birthday were considered as alive/censored cases.

Outcome variable and independent variables

The primary outcome variable of this study was child survival status classified as being alive (coded as 0) or dead (coded as 1). The primary potential risk factors were considered in this study to include mothers age at first birth (< 20 years, >=20 years), mother's education (pre-primary or no education, primary, secondary and higher), area (urban, rural), division (Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet), sex of child (boy, girl), age of child (<12 months, 12-23 months, 24-35 months, 36-47 months and 48-59 months), babies size at birth (very large/average, very small), place of delivery (home, hospital/clinic), wealth index (poor, middle, rich), received antenatal care (ANC) during pregnancy (yes, no), received perinatal care after delivery (yes, no), cesarean delivery (yes, no), birth order (1, 2-3, 4+), previous birth interval (1st birth, <2 years, <3 years, +4 years), birth status (multiple birth, single birth).

Models

Product-Limit (P-L) method

The Product-Limit method proposed by Kaplan and Meir is widely used in survival analysis for estimating the survival function and can deal with censored lifetime data (Kaplan and Meir, 1958). Suppose the event of interest occurs at k distinct time points t1 < t2 < ... <tj< ... < tk. If nj and dj be the number of individuals at risk of failure and the number of individuals failed at time tj; j = 1,2 ..., k, respectively, then the Product- Limit estimate of the survival function S(t) is given by $\widehat{S(t)} = \prod_{j:tj<t}(1 - \frac{dj}{nj})$.

Cox Proportional Hazard (PH) Model

In this study, the risk of death in childhood was measured in months and it was a time-to-event data. There exist distinguish possible survival model options and for this study, an event history analysis procedure which was proposed by Cox (Cox, 1972). It is usually used to examine the impact of various factors on the risk of death. Cox Proportional Hazard (PH) Model is most commonly used for analyzing censored survival data where the distribution of lifetime is considered as unknown or unspecified. According to Cox PH, the hazard function can be defined as h (t|X) = $h_0(t)$* exp ($\beta'X$); where h (t|X) is the hazard of child death at time t, $h_0(t)$ is the baseline hazard & $\beta = (\beta_1, \ldots, \beta_m, \ldots, \beta_p)'$ being the p*1 vector of regression coefficients associated with in presence of a set of covariates $X = (X_1, \ldots, X_m, \ldots, X_p)'$.

Statistical Analysis

Descriptive statistics were used to summarize the distribution of selected background characteristics of under-five children. In this study, bivariate analyses were accomplished to find out the potential determinants of under-five child mortality. The prevalence of under-five child mortality according to the selected covariates was compared using Kaplan-Meier log-rank test (Swinscow, 1997) and the test has been employed to test whether the survival probabilities in different categories of a covariate are equal or not. Then with the significant factors (at p<0.05) from the bivariate level, the Cox PH model was fitted to assess all possible risk factors for under-five child mortality. The results in adjusted cases were interpreted from the hazard ratios. STATA 16 was employed to analyze the data.

RESULTS:

Descriptive Statistics

Out of the 5112 children below 5 years in the data set, 170 (3.3%) of them were reported dead, 4942 (96.7%) were alive (**Fig. 1**).

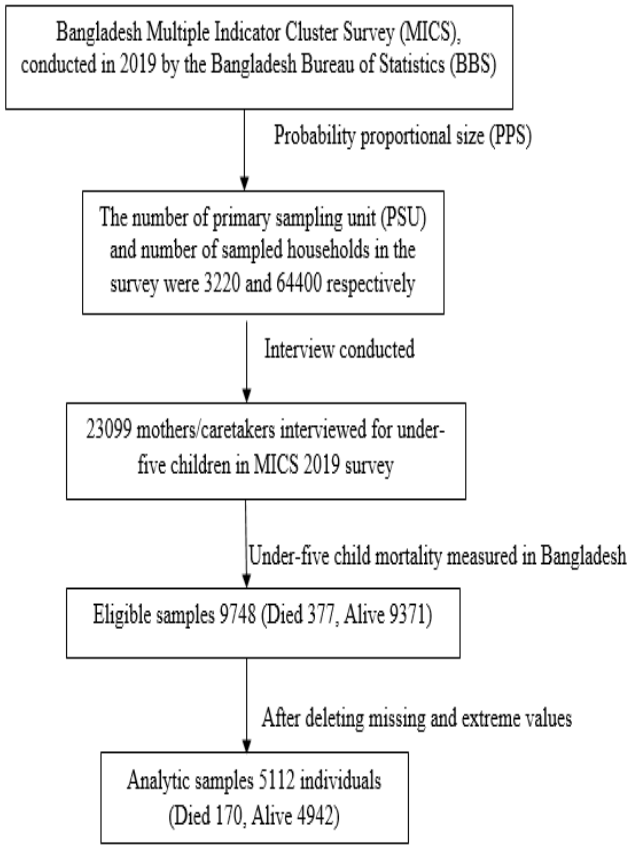

Fig. 1: Flowchart of the analytic sample selection process.

The proportions of children belonging to the urban area were 20.2%. Among all children taken in this study, about two-fifth (41.1%) of the children lived in Chattogram and Dhaka division while boy and girl children proportion were almost the same. About four-fifth (79.4%) of the children age below 2 years. The majority 2408 (47.1%) of the children belonged to 2nd - 3rd birth order and 91 (1.8%) children were twins. About 4974 (97.3%) were very large/average in size and 138 (2.7%) were very small in size at the time of their birth respectively. The proportion of children belonging to women aged at first birth >=20 was 3586 (70.2%). The majority of the children belonged to women with secondary education in 2613 (51.1%). A total of 2094 (41.0%) of the children belonged to the poor wealth index while 966 (18.9%) belonged to the rich wealth index. About 84.3% of children belonged to women who were taking any form of antenatal care during their pregnancy and 57.1% of women gave birth to their child at a hospital/clinic. A total of 1995 (39.0%) children belonged to women who delivered through cesarean section (**Table 1**).

Table 1: Prevalence of under-5 child mortality along with log-rank test p-values using the data set MICS (2019).

Characteristics	Sample Distribution (%)	Prevalence of (%) under-five mortality		P- value
		Uncensored/ Dead (%)	Censored/ Alive (%)	
Overall	5112 (100)	170 (3.3)	4942 (96.7)	-
Area				
Urban	1032 (20.2)	22 (2.1)	1010 (97.9)	0.016
Rural	4080 (79.8)	148 (3.6)	3932 (96.4)	
Division				
Barisal	417 (8.2)	10 (2.4)	407 (9 7.6)	0.019
Chattogram	1108 (21.7)	45 (4.1)	1063 (95.9)	
Dhaka	993 (19.4)	26 (2.6)	967 (97.4)	
Khulna	704 (13.8)	15 (2.1)	689 (97.9)	
Mymensingh	315 (6.1)	16 (5.1)	299 (94.9)	
Rajshahi	518 (10.1)	17 (3.3)	501 (96.7)	
Rangpur	552 (10.8)	19 (3.4)	533 (96.6)	
Sylhet	505 (9.9)	22 (4.4)	483 (95.6)	
Sex of Child				
Boy	2580 (50.5)	90 (3.5)	2490 (96.5)	0.310
Girl	2532 (49.5)	80 (3.2)	2452 (96.8)	
Age of Child				
<12 months	2019 (39.5)	61 (3.0)	1958 (97.0)	
12-23 months	2041 (39.9)	65 (3.2)	1976 (96.8)	

24-35 months	287 (5.6)	17 (5.9)	270 (94.1)	<0.001
36-47 months	346 (6.8)	13 (3.8)	333 (96.2)	
48-59 months	419 (8.2)	14 (3.3)	405 (96.7)	
Birth Order				
1st birth	2019 (39.5)	81 (4.0)	1938 (96.0)	0.012
2nd -3rd	2408 (47.1)	61 (2.5)	2347 (97.5)	
3+	685 (13.4)	28 (4.1)	657 (95.9)	
Previous Birth Interval				
1st birth	2028 (39.7)	81 (4.0)	1947 (96.0)	0.139
<2 years	447 (8.7)	15 (3.4)	432 (96.6)	
<3 years	633 (12.4)	19 (3.0)	614 (97.0)	
3+	2004 (39.2)	55 (2.7)	1949 (97.3)	
Birth Status				
Multiple birth	91 (1.8)	4 (4.4)	87 (95.6)	0.681
Single birth	5021 (98.2)	166 (3.3)	4855 (96.7)	
Size of child at birth				
Very Large/Average	4974 (97.3)	159 (3.2)	4815 (96.8)	0.001
Very Small	138 (2.7)	11 (8.0)	127 (92.0)	
Mother's age at first birth				
< 20 years	1526 (29.8)	54 (3.5)	1472 (96.5)	0.452
>= 20 years	3586 (70.2)	116 (3.2)	3470 (96.8)	
Mother's education level				
Preprimary or No education	264 (5.2)	16 (6.1)	248 (93.9)	<0.001
Primary	939 (18.4)	41 (4.4)	898 (95.6)	
Secondary	2613 (51.1)	83 (3.2)	2530 (96.8)	
Higher	1296 (25.3)	30 (2.3)	1266 (97.7)	
Wealth index				
Poor	2094 (41.0)	80 (3.8)	2014 (96.2)	0.002
Middle	2052 (40.1)	75 (3.7)	1977 (96.3)	
Rich	966 (18.9)	15 (1.6)	951 (98.4)	
Received ANC				
Yes	4312 (84.3)	132 (3.1)	4180 (96.9)	<0.001
No	800 (15.7)	38 (4.8)	762 (95.2)	
Received PNC				
Yes	591 (11.6)	13 (2.2)	578 (97.8)	
No	4521 (88.4)	157 (3.5)	4364 (96.5)	0.078
Cesarean Delivery				
Yes	1995 (39.0)	66 (3.3)	1929 (96.7)	0.484
No	3117 (61.0)	104 (3.3)	3013 (96.7)	
Place of delivery				
Home	2195 (42.9)	82 (3.7)	2113 (96.3)	0.019
Hospital/Clinic	2917 (57.1)	88 (3.0)	2829 (97.0)	

Bivariate Analysis

Under-five mortality was lowest in an urban area (2.6%) while the mortality rate was lowest in the Barisal division (2.4%) and highest in the Mymensingh division (5.1%). The mortality rate of under-five child mortality was almost the same for first birth order and higher birth order. The mortality rate among under-five children who were very small in size was remarkably much higher (8.0%) than the very large/average in size (3.2%). Mothers with no education caused the higher child mortality to 6.1% while for mothers with higher education the child mortality rate were declining trends (2.3%). Furthermore, the prevalence of under-five child mortality in the poor family was significantly

higher (3.8%) compared to the rich family (1.6%). Also, the prevalence of under-five child mortality was significantly lower in the mothers who received antenatal care (ANC) during their pregnancy compared with the mothers who did not receive services from ANC (3.1% vs. 4.8%; p<0.001) and also the prevalence was higher when the mother gave their birth at home compared to hospital/clinic. From **Table 1**, the variables that have been found to have a significant association with under-five mortality at a 5% level of significance using the log-rank test were only considered in the regression analysis.

From **Table 2**, the estimated hazard ratios had been obtained using the Cox PH model along with a 95% confidence interval and corresponding p-values to test whether the variables had a significant effect on under-five mortality or not. It was clear from **Table 2** that the children whose mothers live in Chattogram, Mymensingh, and Sylhet have (1.89-1)*100%=89% higher, (2.06-1)*100% = 106% higher, and (2.09-1)* 100%= 109% higher rate of under-five mortality, respectively compared to the children who belong to Barisal division and these results had been found significant at 10% level of significance.

Semi-parametric survival regression analysis

Table 2: Cox's proportional hazards model analysis: determinants of under-five child mortality in Bangladesh using the data set MICS 2019.

Characteristics	Hazards Ratio (HR) (95% CI)	P-value
Area		
Urban	1	
Rural	1.38 (0.85,2.22)	0.191
Division		
Barisal	1	
Chattogram	1.77 (0.88, 3.55)	0.107
Dhaka	1.23 (0.58, 2.58)	0.584
Khulna	0.98 (0.44, 2.22)	0.971
Mymensingh	1.96 (0.88, 4.37)	0.096
Rajshahi	1.44 (0.65, 3.17)	0.364
Rangpur	1.55 (0.72, 3.34)	0.265
Sylhet	1.98 (0.91, 4.17)	0.048
Age of Child		
<12 months	1	
12-23 months	1.17 (0.82, 1.68)	0.378
24-35 months	2.37 (1.36, 4.11)	0.002
36-47 months	2.69 (1.43, 5.05)	0.002
48-59 months	6.79 (3.53, 13.06)	<0.001
Birth Order		
First birth	1	
2^{nd}- 3^{rd}	0.76 (0.55, 1.03)	0.083
4+	1.43 (1.23, 1.80)	0.008
Size of child at birth		
Very large/ Average	1	
Very small	2.30 (1.23, 4.28)	0.009
Mother's education level		
Preprimary or No education	1	
Primary	0.74 (0.41, 1.34)	0.327
Secondary	0.57 (0.32, 1.01)	0.045
Higher Secondary	0.46 (0.23, 0.90)	0.024
Wealth index		
Poor	1	
Middle	1.17 (0.82, 1.68)	0.391
Rich	0.60 (0.31, 1.14)	0.028

Received ANC		
No	1	
Yes	0.83 (0.56, 1.24)	0.099
Place of delivery		
Home	1	
Hospital/Clinic	0.95 (0.65, 1.27)	0.842

It has been observed that the higher birth order children mortality rate was significantly (1.45-1)*100% = 45% higher (as p-value = 0.007) compared to the lower birth order children. The Size of the child at birth plays an important role to determine under-five child mortality. Very small size children had significantly (2.26-1)*100% = 126% higher rate of under-five mortality compared to the very large/average in size children at the time of their birth. Also, children of a secondary and higher educated mother had (1- 0.53)*100% = 47% lower rate and (1-0.41)*100% = 59% lower rate of mortality compared to the children of illiterate mothers at 5% and 1% level of significance, respectively. Children who belonged to the mother who received antenatal care during her pregnancies have (1-0.77)*100% = 23% lower rate of mortality than whose mother did not receive any kinds of antenatal care at 10% level of significance.

DISCUSSION:

The research questions of this study are as follows: What is the current under-five child mortality rate in Bangladesh? And which factors (socioeconomic, demographic, and maternal) are responsible for the under-five child mortality? The study had been set up to develop a predictive model to identify risk factors for under-five child mortality in Bangladesh. This study observed that the under-five child mortality rate was 33.3 per 1000 live birth in Bangladesh. The rates of under-five child mortality have been a decline over the last few years, which indicate the improvement of the quality of health sectors of the country. Among South Asian countries, the under-five child mortality rate was found lowest in Sri Lanka with 9 deaths per 1000 live births in 2017.

Bangladesh was found in the second position and Nepal was in the third position for the lowest under-five child mortality rate in 2017 among South Asian countries (India Spend, 2018). In Bangladesh, the under-five child mortality rate has been reduced by 63% for the last twenty years and now is expected to meet the SDGs goal by 2030. Bangladesh Government took different steps to reduce the mortality rate such as invested more in the health system, introduce and scale up proven solutions for mothers and children, planned well-designed and equity-oriented programs to achieved high immunization coverage and high rates of treatment for diarrhea and pneumonia across all part of the country (Save the children, 2019). From the result of this study, it was found that the under-five child mortality rate was associated with the mother's education, birth order, and size of babies at birth, taking ANC. Although the under-five child mortality rate for living areas was found statistically insignificant in this study, the child mortality rate was found higher among rural area living child contrast to urban living child. From the report of several countries it was found that the child mortality rate was also high in the rural area (Aheto, 2019; Fikru *et al.,* 2019; Gebremichael SG and Fenta SM, 2020; Gebretsadik and Gabreyohannes, 2016; Kaldewei, 2010; Zewudie *et al.,* 2020). Children living in a rural area did not get proper health care facilities to contrast to an urban area and rural living parents didn't have proper knowledge about child and maternal health, which would be the main reasons for the high rate of child mortality in the rural area. The rate of mortality was not uniform across the country. A significant difference was observed among the administrative parts of the country. Among all the divisions, the mortality rate was found significantly higher in Sylhet compared to others (p=0.05). Cultural activities, religious influence, superstitions may be responsible for the high rate of death in Sylhet. This division was lagging because of insufficient health care providers of maternal and child health, antenatal care service, and vaccination programs among mothers and children (Nath, 2013). According to the report of another study from BDHS data 2014, it was found that the under-five child mortality rate was also high in the Sylhet division (Khan and Awan, 2017). Under-five child mortality was found higher for 4th birth order compared to 1st birth order which was similar to a previous study (Abir

et al., 2015; Khan & Awan, 2017). But contrast results were also found for different studies (Chandrasekhar, 2011; Zewudie *et al.,* 2020). Our findings show that the under-five child mortality rate was found higher among the children who were very small size at their birth compared to very large size. Same results were found for several studies (Alexander *et al*., 2003; Lau *et al.,* 2013). Premature birth, low nutritional status of the mother may be the reason for the small size of birth which is significantly associated with under-five child mortality (Alexander *et al.,* 2003; Lau *et al.,* 2013). A significant association between under-five child mortality and mother's educational level was found in this study. A reduction of mortality was found among the child's mother with secondary or higher education compared to no education. This indicates that improving maternal education will reduce the child mortality rate. It is expected that educated mothers are more likely to understand better health issues for themselves and their children. The educated mother can also play an important role against social and religious superstitions as well as a different family crisis (Adekanmbi *et al.,* 2013; Aheto *et al.,* 2017; Buor, 2003).

Although the wealth index of children's families was not statistically significant in our study, it may have a great impact on child mortality. Poor families had a higher risk for child mortality compared to the rich and middle-income families due to proper nutrition and living standards (Azuike *et al.,* 2019). Under-five mortality was higher among the children whose mothers did not take any antenatal care during their pregnancy, which was statistically insignificant at a 5% level of significance. Although the place of delivery was not significant in our study, it may have a great influence on child mortality (Pal, 2015). According to the result of several studies, it was found that pure drinking water and sanitation have influence on child mortality (Ezeh *et al.*, 2014; Gunther and Fink, 2011; Headey and Palloni, 2019; Kaldewei, 2010).

Improvement of sanitation and pure drinking water predict large reductions in diarrhea, cholera, & another infectious disease which are responsible for child mortality (Headey and Palloni, 2019). In developing countries, household coverage with water and sanitation could lead to a total reduction of 2.2 million child deaths per year (Gunther and Fink, 2011). Under-five child mortality is one of the major public health problems in Bangladesh and this study give fundamental fact to understand child mortality. Government and other non-government institutions and NGOs should play a vital role by implementing different family planning programs among women to reduce under-five child mortality and also by implementing different policies and strategies to improve maternal education. Reducing child mortality rates requires also some interventional strategies those are as follows, access to improved toilet facilities, safe drinking water, improvement of the quality of life of the parents in all aspects such as income, education, health service, etc (Oloo, 2005).

Strong political leadership at the national level among heads of government and key policymakers has played an important role to survive millions of children. Reduction of child mortality also depend on social investment and economic growth; improved planning and implementation for tackling child marriage, reducing poverty, investments in education, livelihoods and community mobilization for change; reducing inequities among sex differentials, poorest and rural quintiles; empowering women and young girls by educating and arranging working sectors for them and implementing new technologies and social media for economic growth, boosting incomes for people from all segments of the country (Save the children, 2019).

Strengths and limitation

The main strengths of this study were that it had been based on the most recent nationally representative population data with children, their household, and communities in which they reside. Since it was nationally representative data, a large sample was used in this study. So, it was easily possible to generalize the results of child mortality in Bangladesh aged below 5 years. In this study, cross-sectional data had been used which restricted any conclusions about the causal effect of the factors. The Socio-economic condition of the house-hold could be different at the time of the survey and at the time of child death, which might lead to a biased result in this analysis. Some important variables were founding insignificant due to a large number of missing values and non-response in the data set. Furthermore, some important variables such as mothers working status, mothers BMI, child nutritional

status as well as diarrhea, cholera, fever were not included in this study due to data unavailability.

CONCLUSION:

Though the under-five child mortality rate has been reducing by a remarkable rate for the last few years in Bangladesh, the rate is still high to reach the expected level according to Sustainable Development Goals (SDGs). This study finding for the risk factors associated with under-five child mortality are very important for the identification of new policies and interventions as well as existing policies and interventions to reduce the rate of mortality at the expected level. Increasing the mother's education level may reduce the mortality rate. Taking ANC during pregnancy may also reduce child mortality. Some important factors which are responsible for child mortality such as maternal nutritional status, child nutritional status, cultural condition, environmental condition was not included in this study due to data unavailability. Further investtigations should be constructed considering these imperceptible factors that are probably going to be related to under-five child mortality to more readily comprehend the relationship between family and community level elements and child mortality in Bangladesh. A proper guideline and new policies as well as interventions such as access to improved toilet facilities, safe drinking water, plan equity-oriented programs across the country for high immunization coverage and treatment for diarrhea, pneumonia or other diseases which causes child mortality should be introduced focusing on those characteristics by government and non-government institutions to reduce the rate of under-five child mortality in Bangladesh to meet the expected level according to SDG.

Availability of data and materials

The data used to support the findings of this study are available from the submitting or corresponding author on request. Data set used in this study is available at https://mics.unicef.org/surveys. Online available as a preprint Preprints and early-stage research may not have been peer reviewed yet at https://www.research square.com/article/rs-855847/v1

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CONFLICTS OF INTEREST:

Authors have no conflict of interest.

REFERENCES:

1) Abir, T., Agho, K.E., Page, A.N., Milton, A.H. and Dibley, M.J., (2015). Risk factors for under-5 mortality: evidence from Bangladesh Demographic and Health Survey, 2004-2011. *BMJ open*, 5(8), p.e006722. http://dx.doi.org/10.1136/bmjopen-2014-006722
2) Adekanmbi, V.T., Kayode, G.A. and Uthman, O.A., (2013). Individual and contextual factors associated with childhood stunting in Nigeria: a multilevel analysis. *Maternal & child nutrition*, **9**(2), pp.244-259. https://doi.org/10.1111/j.1740-8709.2011.00361.x
3) Aheto, J.M.K., Taylor, B.M., Keegan, T.J. and Diggle, P.J., (2017). Modelling and forecasting spatio-temporal variation in the risk of chronic malnutrition among under-five children in Ghana. *Spatial and spatiotemporal epidemiology*, **21**, pp.37-46. https://doi.org/10.1016/j.sste.2017.02.003
4) Aheto, J.M.K., (2019). Predictive model and determinants of under-five child mortality: evidence from the 2014 Ghana demographic and health survey. *BMC public health*, **19**(1), pp.1-10. https://doi.org/10.1186/s12889-019-6390-4
5) Alexander, G.R., Kogan, M., Bader, D., Carlo, W., Allen, M. and Mor, J., (2003). US birth weight/gestational age-specific neonatal mortality: 1995–1997 rates for whites, Hispanics, and blacks. *Pediatrics*, **111**(1), pp.e61-e66. https://doi.org/10.1542/peds.111.1.e61
6) Azuike, E.C., Amah, C.C., Okafor, K.C. and Anene, J.O., (2019). Deter-minants of under-five mortality in South-Eastern Nigeria. *J Community Med Public Health Care*, **6**, p.049. http://doi.org/10.24966/CMPH-1978/100049
7) Chandrasekhar, S., (2012). Infant Mortality, Population Growth and Family Planning in India: An Essay on Population Problems and International Tensions. *Routledge.* https://doi.org/10.4324/9780203839218

8) Chowdhury, Q.H., Islam, R. and Hossain, K., (2010). Socio-economic determinants of neonatal, post neonatal, infant and child mortality. *International Journal of Sociology and Anthropology*, **2**(6), pp.118-125. https://doi.org/10.5897/IJSA.9000074
9) Cox, D.R., (1972). Regression models and life-tables. *Journal of the Royal Statistical Society: Series B (Methodological)*, **34**(2), pp.187-202. https://doi.org/10.1111/j.2517-6161.1972.tb00899.x
10) Doctor, H.V., (2003). The Effect of living standards on childhood mortality in Malawi. http://hdl.handle.net/1807/5820
11) Ezeh, O.K., Agho, K.E., Dibley, M.J., Hall, J. and Page, A.N., (2014). The impact of water and sanitation on childhood mortality in Nigeria: evidence from demographic and health surveys, 2003–2013. *International j. of environmental research & public health,* **11**(9), pp.9256-9272. https://www.mdpi.com/1660-4601/11/9/9256#
12) Fikru, C., Getnet, M. and Shaweno, T., (2019). Proximate Determinants of Under-Five Mortality in Ethiopia: Using 2016 Nationwide Survey Data. *Pediatric Health, Medicine and Therapeutics*, **10**, p.169. https://dx.doi.org/10.2147%2FPHMT.S231608
13) Gebremichael SG, Fenta SM., (2020).Under-Five Mortality and Associated Risk Factors in Rural Settings of Ethiopia: Evidences from 2016 Ethiopian Demographic and Health Survey. Advances in Public Health. Aug 31, 2020. https://doi.org/10.1155/2020/8430246
14) Gebretsadik, S. and Gabreyohannes, E., (2016). Determinants of under-five mortality in high mortality regions of Ethiopia: an analysis of the 2011 Ethiopia Demographic and Health Survey data. *International J. of Population Res.*, 2016. http://dx.doi.org/10.1155/2016/1602761
15) Grépin, K.A. and Bharadwaj, P., (2015). Maternal education and child mortality in Zimbabwe. *Journal of health economics*, **44**, pp.97-117. https://doi.org/10.1016/j.jhealeco.2015.08.003
16) Günther, I. and Fink, G., (2011). Water and sanitation to reduce child mortality: The impact and cost of water and sanitation infrastructure. World Bank Policy Research Working Paper, (5618). https://ssrn.com/abstract=1799842
17) Headey, D. and Palloni, G., (2019). Water, sanitation, and child health: evidence from sub national panel data in 59 countries. *Demography*, **56**(2), pp.729-752. https://doi.org/10.1007/s13524-019-00760-y
18) India Spend, (2018). India's Under-5 Mortality Now Matches Global Average, But Bangladesh, Nepal Do Better. https://www.indiaspend.com/indias-under-5-mortality-now-matches-global-average-but-bangladesh-nepal-do-better/
19) Islam, M.M., Bari, W. (2021). Analyzing malnutrition status of urban children in Bangladesh: quantile regression modeling. *J Public Health (Berl.),* **29,** 815–822. https://doi.org/10.1007/s10389-019-01191-0
20) Kabir, A., Islam, M.S., Ahmed, M.S. and Barbhuiya, K., (2001). Factors influencing infant and child mortality in Bangladesh. *J Med Sci*, **5**, pp.292-5.
21) Kaldewei, C., (2010). Determinants of Infant and Under-Five Mortality-The Case of Jordan. *Technical note,* February 2010. https://www.un.org/en/development/desa/policy/mdg_workshops/jakarta_training_mdgs/desa_mdg4_technicalnote_mar2010.pdf
22) Kaplan, E.L. and Meier, P., (1958). Nonparametric estimation from incomplete observations. *J. of the American statistical association*, **53**(282), pp.457-481. https://www.tandfonline.com/doi/abs/10.1080/01621459.1958.10501452
23) Khan, J.R. and Awan, N., (2017). A comprehensive analysis on child mortality and its determinants in Bangladesh using frailty models. *Archives of Public Health*, **75**(1), p.58. https://doi.org/10.1186/s13690-017-0224-6
24) Lau, C., Chakraborty, H., Wingate, M.S. and Carlo, W.A., (2013). Extremely low birth weight and infant mortality rates in the United States. *Pediatrics*, **131**(5), pp.855-860. https://doi.org/10.1542/peds.2012-2471
25) Mathews TJ, Mac Dorman MF., (2011). Infant mortality statistics from the 2007 period linked birth/infant death data set. Natl Vital Stat Rep. Jun 29, **59**(6), 1-30. PMID: 21957694. https://pubmed.ncbi.nlm.nih.gov/21957694/

26) McGuire, J.W., (2006). Basic health care provision and under-5 mortality: a cross-national study of developing countries. *World Development*, **34**(3), pp.405-425. https://doi.org/10.1016/j.worlddev.2005.08.004

27) MICS (Bangladesh multiple indicator cluster survey), (2019). Bangladesh Bureau of Statistics. *UNICEF*, Bangladesh 2020. https://mics.unicef.org/surveys.

28) Nath, S.R., (2013). Exploring the marginalized: a study in some selected upazilas of Sylhet division in Bangladesh. Dhaka: Research and Evaluation Division, BRAC. https://www.researchgate.net/publication/268442233

29) NIPORT Mitra and Associates and ICF, 2016. Bangladesh demographic and health survey 2014 (policy brief). Technical report, National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. https://dhsprogram.com/publications/publication-fr311-dhs-final-reports.cfm

30) Oloo J. O, (2005). Child mortality in developing countries: challenges and policy options. *Eastern Africa Social Science Research Review*, **21**(2), pp. 1-7. https://doi.org/10.1353/eas.2005.0009

31) Pal, S., (2015). Impact of hospital delivery on child mortality: an analysis of adolescent mothers in Bangladesh. *Social Science & Medicine*, **143**, pp.194-203. https://doi.org/10.1016/j.socscimed.2015.08.003

32) Rahman, M.S., Rahman, M.S. and Rahman, M.A., (2019). Determinants of death among under-5 children in Bangladesh. *Journal of Research and Opinion*, **6**(3), pp. 2294-2302. https://doi.org/10.15520/jro.v6i3.4

33) Save the children, (2019). Global Childhood Report-2019: Changing lives in our lifetime. https://resourcecentre.savethechildren.net/library/global-childhood-report-2019-changing-lives-our-lifetime

34) Shaikh MAK, Ahmed MK, and Haque R. (2021). Consequences of maternal mortality in Bangladesh rural families an experience of Gonoshasthaya Kendra (GK) 2008-2018, *Br. J. Arts Humanit*., **3**(2), 22-47. https://doi.org/10.34104/bjah.021022047

35) Swinscow, T.D.V., (1997). Statistics at Square One. http://publish.uwo.ca/~gzou2/Stats_at__Square1.pdf

36) World Data Atlas. Bangladesh-Under-five Mortality Rate, (2020). https://knoema.com/atlas/Bangladesh/Child-mortality-rate

37) World Health Organization (WHO), (2018). Report, Global health observatory (GHO) data, https://www.who.int/gho/child_health/mortality/mortality_under_five_text/en/

38) World Health Organization (WHO), (2020). Children: improving survival and well-being, https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality

39) World Health Organization (WHO), (2020). Sustainable Development Goal 3: Health. https://www.who.int/topics/sustainable-development-goals/targets/en/

40) Zewudie AT, Gelagay AA, Enyew EF., (2020). Determinants of Under-Five Child Mortality in Ethiopia: Analysis Using Ethiopian Demographic Health Survey, 2016. *International Journal of Pediatrics*. Sep 18, 2020. https://doi.org/10.1155/2020/7471545

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