Original article

Determinants of mortality in children aged under two years in Bangladesh using two approaches: an analysis of the Bangladesh Demographic and Health Survey 2014 data

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Abstract

Aims: Mortality in children aged under two years is a severe public health problem in many developing countries. The aims of the study were to reveal the prevalence and factors associated with mortality in children under two years in Bangladesh. ***Methods:*** Data were analyzed using the Bangladesh Demographic and Health Survey 2014. A total of 7886 participant data used in this study. The chi-square test of association was performed with dependent and independent variables to measure the prevalence rate, while the final model binary logistic and log-binomial regressions were used to identify the potential risk factors for under-two mortalities. ***Results:*** The prevalence of under-2 mortalities in Bangladesh was 3.9%. Regression analysis revealed that a lower level of paternal education, succeeding birth interval less than 24 months, multiple birth babies, and smaller than the average size at birth were significantly associated with children's mortality under two years in Bangladesh. ***Conclusions:*** Despite improvements in the reduction of child mortality in Bangladesh, many children died within the first 24 months of life, mostly preventable. Programs towards increasing education levels and pregnancy intervals might help in preventing infant mortality in Bangladesh.

Keywords: Under-2 child mortality; Prevalence; Determinants; Children; Bangladesh

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Introduction

Childhood mortality is considered an indicator of the overall state of public health and socio-economic stability of a nation[1]. The world has achieved positive results in developing child survival in the last few decades. For example, the death rate for children under five years decreased from 10.5 to 5.9 million between 1992 and 2015 at a 53% reduction[2]. However, child mortality remains an urgent concern, especially in sub-Saharan Africa and South Asia, owing to the high prevalence in countries such as Bangladesh[3-4].

Over the last two decades, Bangladesh recorded a notable positive result concerning child survival and achieved Millennium Development Goals 4 successfully, which resulted in a 65 percent reduction in child mortality between 1993[5] to 2014[4]. Increased availability of health resources related to child

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survival, such as health care facilities, qualified birth attendance, antenatal and pre-natal care visits with multiple services such as vitamin supplementation, injection of tetanus, and regular check-up, have contributed to reducing child mortality[6-7].Nonetheless, over 4% of under-five Bangladeshi children died in 2014, which is undesirable[4]. Notwithstanding, a tremendous effort is required to achieve Sustainable Development Goals (SDGs).

In Bangladesh, it is essential to identify factors related to mortality among children to establish a preventive program. Several studies have highlighted that childhood mortality is closely related to different socio-economic, regional, and biological factors such as household wealth index[8-12], paternal education[9,11-16], maternal education[12-13,17-18], sex of the child[10,19-20], region/place of residence[9-10,12,18-19,21], maternal body mass index[19], parent's occupation[19], types of toilet facility[17,21], place of delivery[22], sizes at birth[23-27], birth interval[10,12,17,19,23,26,28], mode of delivery[19,26], antenatal care visit during pregnancy[29], and multiple births[16, 20, 29].

The Bangladesh Demographic and Health Survey from 2000 to 2014 showed that of total under-5 fatalities, approximately 94-97% occurred before reaching the second birthday[4]. Therefore, this study aimed to assess the prevalence and factors associated with under-2 mortalities in Bangladesh that would enable policy-makers to take critical measures to prevent child mortality. In this study, two methods have been used to detect the determinants of under-2 mortality in Bangladesh, namely multiple binary logistic regression and log-binomial regression models.

Methods

Data source

This study's data were retrieved from the Bangladesh Demographic and Health Survey 2014 data (BDHS 2014). The data were collected from June to November 2014 across the country. The data collection methodology has been documented in the final report of BDHS 2014[4]. In the child dataset, which was used in this study, the information was collected from the 7886 ever-married women aged between 15 and 49 years about their latest children.

Variables declaration

Outcome variable

Under-2 mortality was considered the primary outcome variable. If a child died during his or her 0-23 months of age, he or she was coded as (1=died); otherwise, he/she was coded as (0=alive case).

Independent variables

In this study, 17 independent variables were considered to reveal the significant associated factors for under-2 mortalities. They are: division of residence (Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet, Barisal), type of place (rural, urban), maternal education (no education, primary, secondary, higher), paternal education (no education, primary, secondary, higher), maternal occupation (working sectors, housewife), household wealth index (poorest, poorer, middle, richer, richest), type of toilet facilities (no facilities/hanging toilet, pit toilet, flush toilet), maternal exposure to television (no, yes), maternal age at first birth (≤18 years, >years), maternal BMI (<18.50 kg/m2, 18.50-25.00 kg/m2, >25.00 kg/m2), maternal antenatal care visit (no, yes), delivery by cesarean section (no, yes), succeeding birth internal (<24 months, ≥24 months), birth order (1st, 2nd, 3rd, ≥4rth), birth status (multiple births, single birth), size at birth (smaller than average, larger than average, average) and child put to the breast (within 1 hour, >1 hour)

Statistical analysis

We used bivariate and multivariate analyses to reveal the significant factors for under-2 mortalities. The prevalence of under-2 mortalities, according to the selected predictors, was compared using the $\chi 2$ test. Odds ratio (OR) and proportional ratio (PR) were used to measure the association between exposure and outcome variables[30]. The multiple binary logistic model and log-binomial regression model were designed to obtain the odds ratio (OR) and the prevalence ratio (PR), respectively. Factors with a significance level below 0.05 in the chi-squared analysis were included in the multivariable analysis, and both the unadjusted (crude) and adjusted ORs and PRs were reported with a 95% confidence interval (CI). STATA 13 was used to analyze the data.

Results

Table 1 presents the background characteristics of the children included in this study. Of the 7886 participants, 308 (3.9%) children died before reaching their first two years of life. More than two-thirds of children were from rural areas, and around one-fifth lived in the Chittagong division. Approximately 16% of children's mothers and one-fourth of children's fathers were illiterate. About three-fourths of mothers were engaged in domestic work. Over one-fifth of

children belonged to the poorest quartile household, and most families used pit toilets. Most of the children had at least 24 months succeeding birth interval.

Area of residence, maternal education, paternal education, paternal occupation, household wealth index, maternal exposure to television, delivery by cesarean section, succeeding birth interval, birth status, and size at birth were statistically significantly associated with under-two mortalities at $p<0.05$ level. The prevalence of mortality in the children before reaching two years was highest in the Sylhet division (5.44%), while it was lowest in Barisal (2.65%). The prevalence of under-2 mortalities was decreased with an increased level of maternal and paternal education. Additionally, the prevalence of under-2 mortalities was found lower in the children with the average size at birth, of the richest quantile household, whose mothers were exposed to television, who delivered using cesarean section. Furthermore, the prevalence of under-2 mortalities was much higher in multiple birth babies and the children having succeeding birth intervals less than 24 months.

Table 1: Characteristics of the study children and the prevalence of <2 years mortality in Bangladesh, 2014 (n = 7886)

Characteristic	Overall n(%)[a]	Under-2 mortality status n(%)		X^2-value	*p*-value[b]
		Dead	Alive		
Division of residence				15.93	0.014
Chittagong	1517(19.24)	61(4.02)	1456(95.98)		
Dhaka	1378(17.47)	42(3.05)	1336(96.95)		
Khulna	862(10.93)	39(4.52)	823(95.48)		
Rajshahi	959(12.16)	34(3.55)	925(96.45)		
Rangpur	958(12.15)	37(3.86)	921(96.14)		
Sylhet	1306(16.56)	71(5.44)	1235(94.56)		
Barisal	906(11.49)	24(2.65)	882(97.35)		
Type of place				1.32	0.251
Rural	5398(68.45)	220(4.08)	5178(95.92)		
Urban	2488(31.55)	88(3.54)	2400(96.46)		
Maternal education				14.63	0.002
No education	1233(15.64)	60(4.87)	1173(95.13)		
Primary	2206(27.97)	98(4.44)	2108(95.56)		
Secondary	3621(45.92)	135(3.73)	3486(96.27)		
Higher	826(10.47)	15(1.82)	811(98.18)		
Paternal education				21.47	<0.0001
No education	2008(25.46)	101(5.03)	1907(94.97)		
Primary	2377(30.14)	99(4.16)	2278(95.84)		
Secondary	2360(29.93)	88(3.73)	2272(96.27)		
Higher	1141(14.47)	20(1.75)	1121(98.25)		
Maternal occupation				3.44	0.178
Working sectors	1979(25.10)	91(4.60)	1888(95.40)		
Housewife	5905(74.88)	217(3.67)	5688(96.33)		
Household wealth index				14.61	0.006
Poorest	1737(22.03)	86(4.95)	1651(95.05)		
Poorer	1503(19.06)	71(4.72)	1432(95.28)		
Middle	1516(19.22)	54(3.56)	1462(96.44)		
Richer	1602(20.32)	55(3.43)	1547(96.57)		
Richest	1528(19.38)	42(2.75)	1486(97.25)		

Characteristic	Overall n(%)[a]	Under-2 mortality status n(%)		X^2-value	*p*-value[b]
		Dead	Alive		
Type of toilet facilities				2.38	0.304
No facilities/ Hanging toilet	462(6.39)	24(5.21)	437(94.79)		
Pit toilet	5446(75.54)	208(3.82)	5238(96.18)		
Flush toilet	1302(18.06)	55(4.22)	1247(95.78)		
Maternal exposure to television				5.48	0.019
No	4849(61.49)	209(4.31)	4640(95.69)		
Yes	3037(38.51)	99(3.26)	2938(96.74)		
Maternal age at first birth (Years)				0.517	0.472
≤18	4761(60.37)	192(4.03)	4569(95.97)		
>18	3125(39.63)	116(3.71)	3009(96.29)		
Maternal BMI (kg/m²)				0.32	0.851
<18.50	1767(22.60)	65(3.68)	1702(96.32)		
18.50-25.00	4565(58.38)	182(3.99)	4383(96.01)		
>25.00	1487(19.02)	58(3.90)	1429(96.10)		
Maternal antennal care visit				2.26	0.132
No	964(21.48)	43(4.46)	921(95.54)		
Yes	3524(78.52)	121(3.43)	3403(96.57)		
Delivery by caesarean section				7.96	0.005
No	3646(77.02)	151(4.14)	3495(95.86)		
Yes	1088(22.98)	25(2.30)	1063(97.70)		
Succeeding birth interval (months)				369.98	<0.0001
<24	359(4.55)	83(23.12)	276(76.88)		
≥24	7527(95.45)	225(2.99)	7302(97.01)		
Birth Order				6.25	0.100
1st	3094(39.23)	130(4.20)	2964(95.80)		
2nd	2343(29.71)	74(3.16)	2269(96.84)		
3rd	1235(15.66)	47(3.81)	1188(96.19)		
≥4rth	1214(15.39)	57(4.70)	1157(95.30)		
Birth status				159.66	<0.0001
Multiple birth	118(1.50)	31(26.27)	87(73.73)		
Single birth	7768(98.50)	277(3.57)	7491(96.43)		
Size at birth				13.94	0.001
Smaller than average	616(7.81)	34(5.52)	582(94.48)		
Larger than average	4086(51.81)	179(4.38)	3907(95.62)		
Average	3184(40.38)	95(2.98)	3089(97.02)		
Child put to breast				1.18	0.275
Within 1 hour	3950(75.02)	152(3.85)	3798(96.15)		
>1 hour	1315(24.98)	42(3.19)	1273(96.81)		

[a] Total number of children may differ due to missing values; [b]*p*-value is obtained using Chi-squared test.

Table 2 depicts the results of the multiple logistic regression. In the unadjusted cases, the associated factors for under-2 child morality were: Khulna and Sylhet division, lower level of maternal and paternal education, poorest and poorer indexed household, mother without exposure to television, childbirth without using cesarean section, succeeding birth interval less than 24 months, multiple birth babies and smaller than the average size at birth. However, in the adjusted cases, lower maternal education, the

poorest, and the poorer indexed household, maternal without exposure to television, childbirth without using cesarean section no longer showed significant factors for under-2 mortalities.

Child mortality before two years of age was higher in the children who lived in Khulna (AOR: 2.30, 95% CI: 1.10-4.79; APR: 1.77, 95% CI: 0.88-3.55) or Sylhet division (AOR: 2.66, 95% CI: 1.34-5.27; APR: 2.40, 95% CI: 1.23-4.67) compared to Barisal division. Also, compared to children of the higher educated father, the odd and prevalence of dying before reaching age two years were higher in the children of uneducated fathers (AOR: 2.91, 95% CI: 1.23-6.85; APR: 2.75, 95% CI: 1.20-6.28), of the primary level educated father (AOR: 2.57, 95% CI: 1.13-5.84; APR: 2.48, 95% CI: 1.11-5.50) or in the children of a secondary level educated father (AOR: 2.23, 95% CI: 1.01-4.91; APR: 2.15, 95% CI: 0.99-4.64). Besides, the odd and prevalence of mortality in the children before two years of age were respective 9.55 times and 7.44 times higher among the children whose succeeding birth interval was less than 24 months compared to the children with 24 or more moths of succeeding birth interval (AOR: 9.55, 95% CI: 7.18-12.70; APR: 7.44, 95% CI: 5.90-9.40). Additionally, the children with smaller than the average size at birth were more likely to die before completing their first two years of age than that the children with the average size at birth (AOR: 1.94, 95% CI: 1.29-2.93; APR: 1.84, 95% CI: 1.25-2.69). Furthermore, multiple birth children had almost eight times higher odd and about six times higher prevalence to die in their first two years of life than single birth children (AOR: 7.99, 95% CI: 4.16-15.34; APR: 6.05, 95% CI: 3.62-10.13).

Table 2: Log-binomial and logistic regression analysis of under-2 mortality in Bangladesh, 2014

Characteristic	COR(95% CI)	CPR(95% CI)	AOR(95% CI)	APR(95% CI)
Division of residence				
Chittagong	1.53(0.95-2.48)	1.52(0.95-2.42)	1.63(0.80-3.33)	1.56(0.78-3.12)
Dhaka	1.15(0.69-1.92)	1.15(0.70-1.88)	1.85(0.90-3.80)	1.77(0.88-3.55)
Khulna	1.74*(1.03-2.92)	1.70*(1.03-2.81)	2.30*(1.10-4.79)	2.26*(1.11-4.59)
Rajshahi	1.35(0.79-2.29)	1.33(0.80-2.23)	1.70(0.80-3.62)	1.58(0.76-3.28)
Rangpur	1.47(0.87-2.48)	1.45(0.87-2.41)	1.44(0.66-3.14)	1.45(0.68-3.08)
Sylhet	2.11**(1.31-3.38)	2.05**(1.30-3.23)	2.66**(1.34-5.27)	2.40**(1.23-4.67)
Barisal(ref.)	1.00	1.00	1.00	1.00
Maternal education				
No education	2.76**(1.55-4.90)	2.68**(1.53-4.68)	1.35(0.53-3.41)	1.36(0.56-3.32)
Primary	2.51**(1.45-4.35)	2.45**(1.42-4.18)	1.34(0.56-3.21)	1.29(0.55-3.00)
Secondary	2.09**(1.22-3.58)	2.05**(1.21-3.48)	1.29(0.57-2.93)	1.28(0.57-2.83)
Higher(ref.)	1.00	1.00	1.00	1.00
Paternal education				
No education	2.97***(1.82-4.82)	2.86***(1.78-4.61)	2.91*(1.23-6.85)	2.75*(1.20-6.28)
Primary	2.43***(1.49-3.95)	2.37***(1.47-3.82)	2.57*(1.13-5.84)	2.48*(1.11-5.50)
Secondary	2.17**(1.32-3.54)	2.12**(1.31-3.43)	2.23*(1.01-4.91)	2.15(0.99-4.64)
Higher	1.00	1.00	1.00	1.00
Householdwealth index				
Poorest	1.84**(1.26-2.68)	1.80**(1.25-2.58)	0.90(0.46-1.75)	0.94(0.52-1.68)
Poorer	1.75**(1.18-2.58)	1.72**(1.18-2.50)	1.03(0.54-1.95)	1.09(0.61-1.95)
Middle	1.30(0.86-1.96)	1.29(0.87-1.92)	0.84(0.45-1.55)	0.88(0.50-1.55)
Richer	1.25(0.83-1.89)	1.24(0.84-1.85)	1.03(0.59-1.80)	1.08(0.64-1.81)
Richest(ref.)	1.00	1.00	1.00	1.00
Maternal exposure to television				
No	1.34*(1.04-1.70)	1.32*(1.04-1.67)	1.18(0.78-1.80)	1.17(0.80-1.71)

Characteristic	COR(95% CI)	CPR(95% CI)	AOR(95% CI)	APR(95% CI)
Yes(ref.)	1.00	1.00	1.00	1.00
Delivery by caesarean section				
No	1.83**(1.19-2.82)	1.80**(1.18-2.73)	1.38(0.86-2.19)	1.37(0.88-2.14)
Yes(ref.)	1.00	1.00	1.00	1.00
Succeeding birth interval (months)				
<24	9.75***(7.38-12.89)	7.73***(6.15-9.71)	9.55***(7.18-12.70)	7.44***(5.90-9.40)
≥24(ref.)	1.00	1.00	1.00	1.00
Birth status				
Multiple birth	9.63***(6.28-14.77)	7.36**(5.33-10.18)	7.99***(4.16-15.34)	6.05***(3.62-10.13)
Single birth(ref.)	1.00	1.00	1.00	1.00
Size at birth				
Smaller than average	1.89**(1.27-2.83)	1.84**(1.26-2.71)	1.94**(1.29-2.93)	1.84**(1.25-2.69)
Larger than average	1.54**(1.06-2.23)	1.46**(1.15-1.87)	1.35(0.93-1.97)	1.28(0.90-1.83)
Average (ref.)	1.00	1.00	1.00	1.00

Reference Category: Alive

COR: crude odds ratio; CPR: crude prevalence ratio; AOR: adjusted odds ratio; APR: adjusted prevalence ratio; CI: confidence interval; ref.: reference.

*p<0.05; **p<0.01, ***p<0.0001.

Discussion

The study was planned to identify possible risk factors for under-two mortality in Bangladesh. In this study, factors such as division of residence, maternal education, paternal education, paternal occupation, household wealth index, maternal exposure to television, delivery by cesarean section, succeeding birth interval, birth status, and size at birth were significantly associated with under-two mortalities at p<0.05 level. Results of both the log-binomial logistic regression and binary logistic regression show that lower level of paternal education, succeeding birth interval less than 24 months, multiple birth babies were significant determinants of child mortality at the age of two.

In the factor of residence, variations in under-2 deaths were found.Previous studies in Bangladesh also documented that childhood mortality rates vary from region to region[9,12,19,21]. There are gaps in vital medical facilities, economic status, school access, and population size in different areas of Bangladesh[31]. There is also a regional difference in childhood nutritional status in Bangladesh[32-33]. Therefore, appropriate medical facilities must ensure that additional treatment is paid consistently across the country or elsewhere; for instance, Khulna and Sylhet divisions require extra care and help enhance children's survival.

The study found that the children of a father with lower-level education were more likely to die than children of a father with a higher education level. In many studies in Bangladesh and other developing countries, fathers' schooling was also closely correlated with child mortality[9,11-16]. Education can consider a prerequisite for achieving a good job and economic solvency, ensuring the required health care for pregnant mothers and children, and adequate food supplies for families that improve maternal nutrition and prevent the child's death. Besides the household economic capital, paternal education may also affect improved health outcomes through his expertise and experience gained through schooling, decision-making capacities, and an approach that utilizes health services such as nutritious food intake of children[34-35]. Therefore, the increase in fathers' educational standards would be an essential factor in reducing child deaths.

In this research, multiple births and under-two mortality were found to be closely related. Concerning single birth babies, before reaching two-year-old, multiple birth babies had an eleven times greater chance of dying. This finding is consistent with other previous results from Bangladesh, where multiple births have been reported as a dominant

factor in child mortality[16,20,29]. The outcome could be due to mothers can lose nutritional capability due to multiple births, preventing their babies from having enough nutrition, which may result in death from childhood.

In line with previous findings in Bangladesh[24], Nepal[26], India[23], Indonesia[27], and Ethiopia[25], children below the average size at birth were more likely to die than those who were average or larger than average at birth. Size at birth is often used as a proxy of birth weight. Low birth weight or small size at birth infants have a considerably higher mortality rate than the other children during the neonatal and infancy periods[37]. Infectious diseases, pneumonia, diarrhea, malnutrition, poor development, neurological injury, and fever are most vulnerable to babies with low birth weight or small size at birth[24,36]. These diseases may increase the chance of dying during the first two years of life. Therefore, reducing the prevalence of small size at birth is essential in reducing neonatal and infant mortality. Since low maternal nutritional status, quality of the mother's care, and lack of prenatal care is crucial to a small birth size[36]; we can suggest better access to health care and nutritional status for pregnant mothers.

It was found that the length of the subsequent birth interval was correlated with under-2 deaths. The succeeding birth interval of fewer than twenty-four months had a higher risk of child mortality than their counterparts. This finding similar to other previous studies[10,12,17, 19,23,26]. A short succeeding birth interval can lead to child mortality because of the mother's low nutrition status due to repeated pregnancy with a short time, lack of adequate care and attention given to the old child, and resource competition with the latest sibling. However, a significant number of child mortality could be avoidable if birth spacing (both the preceding and succeeding) were more than two years[26,38-39], because longer birth intervals can improve nutritional status for both mothers and newborns[40], which would help child survival. Hence, the study suggests that promoting increasing birth spacing can be a useful and protective initiative to prevent child mortality.

The strengths and limitations of this study are acknowledged. First, the analysiswas based on a nationally representative dataset generalized for all the children in Bangladesh. Second, the sample size was relatively large to provide a precise result. Third, the proportion of missing values in the selected covariates were relatively low. Hence it might not influence our results. Forth, multiple binary logistic regression and log-binomial regression modelswere used, which are the best-fitted model for this analysis. The limitations are as: First, some variables which were previously found to be associated with child mortality, for instance, diarrhea[41-42],measles vaccination[43], preceding birth interval and breastfeeding practices, were not included due to a more significant number of missing numbers. Besides, pneumonia[41-42]and malaria[44], which may be important determinants of mortality in children aged under two years, could not be included in this study due to a lacking in information in BDHS 2014 dataset. Finally, in this study, we used cross-sectional data that limits drawing any conclusions about the causality of the factors we have examined.

Conclusion

Despite success in reducing child mortality, the prevalence of under two mortalities in Bangladesh remains high. Factors associated with under-two mortalities were paternal education, succeeding birth interval less than 24 months, multiple birth babies, and smaller than the average size at birth. The study findings have more important policy implications, especially in designing programs or policies to reduce under-2 mortalities in Bangladesh.

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Ethical consideration

This study was based on an analysis of existing public domain survey datasets that are freely available online with all identifier information removed. The survey was approved by the Ethics Committee in Bangladesh. The authors were granted permission to use of the data for independent research purposes.

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