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Original Article

Twin Births and Their Survival under Age Five: Evidence from Bangladesh Demographic and Health Survey 2014

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ABSTRACT

Background & Aim: Little is known about twinning in developing countries due to lack of reliable data. However, the large data set from the national level Demographic and Health Surveys (DHSs) in developing countries can fill this gap. This paper examines the level, trends and determinants of twin births, and their risk of survival until age five relative to singletons in Bangladesh.

Methods & Materials: The data for the study were obtained from the 2014 Bangladesh DHS. The analysis was based on birth histories of 43,842 live births, experienced by the 17,863 women between 1978 and until survey date November 2014. Frequency distribution, cross tabulation, univariate and multivariate logistic regression models, and demographic methods such as conventional life table approach were used for data analysis.

Results: About 1.52% of the total live births in Bangladesh were found found to be twins. The twin birth rate has increased by 13.4% over the last 20 years in Bangladesh. Maternal age, parity, region of residence, economic status, father's education, contraceptive use status and religion were identified as significant predictors of twin births. Twinning appeared as a significant predictor of high childhood mortality. Twins were found to have more than eight times higher risk of death during neonatal period than that of singletons.

Conclusion: The increasing trends in twin births in Bangladesh and the associated higher risk of childhood mortality among twins underscores the need for more focused care strategy during pregnancy and after birth. Further studies are needed to identify the reasons for exceptionally high childhood mortality among twins in Bangladesh.

Introduction

Twins are two children born from same pregnancy. Twins that develop from single ovum (egg) are called monozygotic or identical twins, and that develop from two ova (eggs) are called dizygotic or fraternal twins (1). There are high regional variations in twin births rates across the world. The rate was found to be as low as 6-9 twins per 1000 live births in East Asia and Oceania to as high as 18 and above twins per 1000 live births in most African countries (2). Although, twins are charming us by their unique characteristics, but the twin pregnancies and twin births are involved with many health risks, complications and unexpected outcomes.

Twin pregnancies are generally associated with increased complications during pregnancy and at the time of birth, and are associated with the higher risk of low birth weights (i.e. birth weight less than 2.5 kg) as well as premature births (i.e. births before 37 weeks of gestation) (3-5). Stillbirth and infant mortality rates are also

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much higher among twins than among singletons (6, 7). Moreover, twin pregnancies are more likely to lead birth defects and congenital anomalies (8, 9).

Over the period, the rates of twin births have risen across the world (10, 11). For example, between 1975 to 2011 the rate has increased from 9.5 to 16.9 twins per 1,000 deliveries in the United States (12). During same period the rates have increased from 9.9 to 16.1 in England and Wales, 9.2 to 17.2 in Germany, 9.3 to 17.4 in France, 9.6 to 21.2 in Denmark, and 5.0 to 14.6 in South Korea (11). A number of factors have been attributed to the increase in twinning rates. These include advanced maternal age, increased use of contraception and rise in use of medically assisted reproduction (MAR) (11,13). The rise in twin rates often seen as an important public health issue, because twin babies are more fragile than singleton ones. Thus the study of twin births is important because of their increased health risks and accompanying greater health care costs.

The major risk factors of twin births are maternal, genetic and environmental. However, most of these findings are based on data from developed countries due to availability of well-organized birth registration system. Due to lack of good birth registration system and reliable national level data in most developing countries, we know very little about twinning rates, their epidemiology and the prognosis for the health and survival. However, the large national level household survey data available from the Demographic and Health Surveys (DHSs) conducted in a large number of developing countries over the last few decades can be utilized for studying the characteristics of twins in developing countries including Bangladesh. There is no recent national level population-based study in Bangladesh to update our knowledge about the rates, trends and determinants of twinning and their health and survival. In the absence of effective birth registration system in Bangladesh, large national level data set of BDHS provides an opportunity to study about twin births. Thus the present study is an attempt to examine the levels, trends and determinants of twin births in Bangladesh, using the 2014 BDHS data. The study also examines whether twins are associated with higher risk of childhood mortality. The findings of the study may have important policy implications for quality management and care of twin pregnancies and help improve obstetric outcomes.

Materials and Methods

The data for the study were extracted from the 2014 Bangladesh Demographic and Health Survey (BDHS), conducted as part of the global Demographic and Health Survey (DHS) program.. The survey was implemented through a collaborative effort of National Institute of Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare of Bangladesh and ICF International of Calverton, Maryland, USA (14). The 2014 BDHS was a cross-sectional survey. Bangladesh is administratively divided into seven divisions, each with separate urban rural areas. The survey used a sampling frame from the list of enumeration areas (EAs) of the 2011 Population and Housing Census of Bangladesh, provided by the Bangladesh Bureau of Statistics (BBS). 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 enumeration area (EA) size, with 207 EAs in urban areas and 393 EAs in rural areas. A complete household listing operation was then carried out in all of the selected EAs to provide a sampling frame for the second-stage selection of households. 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 as a whole, for urban and rural areas separately, and for each of the seven

divisions. With this design, the survey ultimately covered 17,300 households and 17,863 ever-married women respondents of reproductive age 15-49 years. This indicates that all the eligible women respondents (more than one per household) were interviewed. Due to high prevalence of child marriage among females in Bangladesh, the sample included 2,029 (11.4%) married girls of age 15-19 years at the time of survey.

This study considered live births and their survival status over the age range of 0-59 months as outcome variables, while the maternal, child, and socio-demographic factors were considered as explanatory variables. Live births were considered as a binary outcome variable by categorizing them as twin births and singleton births. In the 2014 BDHS, eligible respondents were asked to provide a detailed history of all their live births, including whether a birth was single or twin, sex of the child, date of birth, survival status, age of the child on the date of interview if alive, and if not alive, age at death of each live birth along with socio-economic and demographic characteristics of mothers. In this study, twins were counted as two live births. Still births, resulting from either twin pregnancy or singleton pregnancy, were excluded. This implies that if one of the outcomes of a twin pregnancy was still birth and another one a live birth, only the live birth was counted.

Maternal factors included mothers' age at birth of their child, and their education, employment, body mass index (BMI), contraceptive use and religion. The child factors included the child's sex, birth cohort and birth order. The socio-demographic factors included household wealth quintiles, father's education, rural/urban residence and region of residence. The wealth quintile is a composite indicator of the economic status of the family which is used by the DHS surveys globally (15). The wealth quintile was generated using the principal components analysis of household asset variables such as possession of TV, refrigerator, car, household construction materials etc.

First we analyzed the characteristics of twin births relative to singleton births across a set of selected explanatory variables. Then we estimated twin birth rate and its differentials across the maternal, child and socio-economic and demographic factors. In this study, the rate of twin births was defined as twin live births per 1000 live births. Many studies employed this definition (2, 16). Then the differentials of twin birth across the maternal, child, socio-economic and demographic factors were analyzed using bivariate (or cross tabulation) technique to identify statistically significant relation between twinning and the selected factors. A P-value less than 0·05 was considered statistically significant. Multiple logistic regression analysis was done to identify the adjusted significant risk factors of twin births and to estimate the adjusted impact of twinning on neonatal, post-neonatal, infant and under-five mortality. Adjustment was done by controlling the effect of the factors that were found to have significant association with twinning risk in bivariate analysis. Similarly the adjusted impact of twinning on childhood mortality was estimated by controlling the effects of potential confounder of childhood mortality including socio-demographic characteristics and birth weight and birth size. The adjusted effects were measured by the odds ratios. Neonatal deaths were defined as those occurring within 28 days of birth among live births, post-neonatal deaths as those occurring between 28 days and one year of life, infant deaths as those occurring within one year of birth and under-five deaths as those occurring within 59 months of age. Neonatal, post-neonatal, infant and under-five mortality rates of twin births and singleton births were estimated by dividing the cumulative number of deaths in each age interval by the number of live births at the beginning of that interval. For analyzing trends in twin birth rates point estimates from different BDHS were

calculated. All the statistical analyses were conducted using IBM SPSS Statistics for Windows Version 21 and statistical software R 3.4.4 version.

Results

Characteristics of twin births

The 2014 BDHS provided record of 43,842 live births experienced by 17,863 married women between 1978 and 2014. Among the total live births, 43,174 were found singletons (98.5%) and 668 were twins (1.5%). Number of triplets were found negligible (only 5 triplets), which we excluded from the analysis. Table 1 presents a comparative analysis of the characteristics of singletons and twin births across a set of maternal, child and socio-economic factors. There exist some systematic differences in characteristics of twins and singletons. The results indicate lower sex ratio at birth for twins than singletons. For example the sex ratio at birth was found to be 94 boys per 100 girls among twins, while for singletons this ratio was found to be 106 boys per 100 girls, indicating more girls among twins than boys. Twins were more likely to occur at a higher age of mothers and at higher order of births than the singletons. Twin birth rate (28.7/1000 live births) was found to be significantly higher among mothers of age group 30-34 years compared to the younger mothers of age less than 20 years (11.2/1000 live births). The mean age of mothers was found to be 24.2 years among twins as oppose to 22.1 years among singletons. The average parity was found to be 3.2 and 2.3 among twins and singletons respectively. Twin birth rates also increase with the mothers BMI status. Among the seven administrative division, twin rate was found to be highest (23.7/1000 live births) in Sylhet division which is 9 percentage point higher than the national average and the lowest (10.84/10000 live births) in Rangpur division. The distribution of twins across the household assets quintile, and mother's contraceptive use status and religion indicate that relatively more twins were born to richest group of mothers, and to those who were ever users of contraceptive methods, and to mothers who were other than Muslim. Twins were more likely to occur to father with higher level of education. However, mother's education showed no significant differential effect on twin birth rates. Twins were less likely to survive during childhood period (under 5 years) as compared to singleton births. For example, at the time of survey, 91% of the singleton live births were found to be alive as oppose to 56% among twins (Table 1).

Table 1. Percentage distribution of singleton and twin births, and twin birth rates by maternal, child and socio-economic characteristics, BDHS 2014.

Factors	Total live births	Singleton births (in %) (n=43,174)	Twin births (in %) (n=668)	Twin birth rate/1000 live births	Unadjusted odds ratio§ of twin births (95% CI)
Sex of child					p=0.135
Male	22535	51.4	48.5	14.39	1.00
Female	21307	48.6	51.5	16.13	1.12 (0.96-1.31)
Mother's age at birth of child					p< .001
< 20	16134	37.0	27.1	11.21	1.00
20-24	14599	33.3	32.2	14.71	1.32 (1.08-1.61)

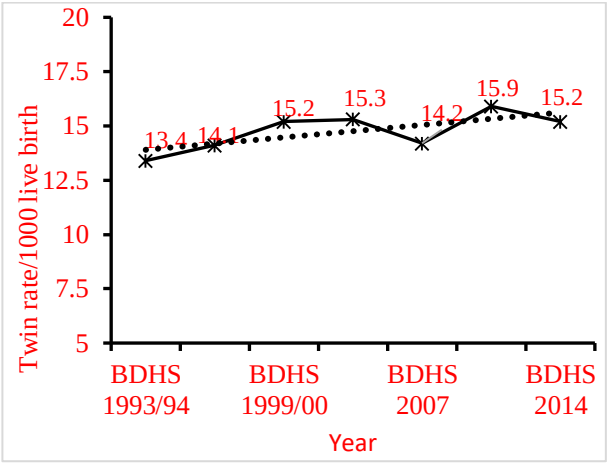
25-29	8242	18.7	21.9	17.74	1.60 (1.28-1.99)
30-34	3639	8.2	15.7	28.70	2.62 (2.05-3.34)
35+	1184	2.7	3.0	16.71	1.52 (1.02-2.41)
Mean (in years)		22.1±5.4	24.2±5.9		
Mother's education					p=0.426
No education	15652	35.7	34.9	14.88	1.10 (0.74-1.65)
Primary	13942	31.8	30.4	14.57	1.08 (0.72-1.63)
Secondary	12320	28.0	30.8	16.74	1.24 (0.83-1.87)
Higher	1973	4.5	3.9	13.31	1.00
Mother's Employment status					p=.052
Not employed/house wife	28147	64.2	67.3	15.95	1.15 (0.97-1.35)
Employed	15695	35.8	32.7	13.90	1.00
Live birth order		0.0			p<0.001
1	16134	37.2	14.2	5.88	1.00
2	12188	27.8	28.0	15.34	2.64 (2.06-3.38)
3	7453	16.9	23.7	21.22	3.66 (2.84-4.73)
4+	8067	18.1	34.1	28.32	4.94 (3.88-6.28)
Mean		2.3±1.5	3.2±1.9		
Mother's BMI					p=0.223
<18.5	8111	18.6	16.6	13.66	1.00
18.5-24.9	25078	57.2	55.9	14.87	1.09 (0.88-1.35)
≥25.0	10303	23.5	26.5	17.18	1.27 (1.01-1.61)
Unknown	351	0.8	0.9	18.02	1.28 (0.55-2.97)
Place of residence					p=0.263
Urban	10873	24.8	26.7	16.38	1.10 (0.92-1.31)
Rural	32969	75.2	73.3	14.83	1.00
Region of residence					p<0.001
Barisal	2806	6.5	5.2	12.40	1.00
Chittagong	8768	20.0	20.2	15.36	1.26 (0.86-1.84)
Dhaka	14643	33.4	31.2	14.21	1.16 (0.81-1.67)
Khulna	4077	9.3	9.3	15.13	1.24 (0.82-1.89)
Rajshahi	4779	10.9	12.6	17.51	1.44 (0.97-2.15)
Rangpur	4910	11.2	7.9	10.84	0.88 (0.57-1.36)
Sylhet	3814	8.6	13.5	23.67	1.95 (1.31-2.89)
Household asset quintile					p=.016
Poor	9514	21.8	18.9	13.22	1.000
Poorer	9251	21.1	23.7	17.08	1.30 (1.03-1.65)
Middle	8856	20.2	19.9	14.99	1.14 (0.89-1.46)
Richer	8549	19.6	16.6	12.97	0.98 (0.76-1.27)
Richest	7629	17.3	20.8	18.23	1.39 (1.09-1.77)
Father's education					p=0.001
No education	16222	37.0	39.0	16.01	1.00
Primary	12363	28.3	23.2	12.52	0.78 (0.64-0.95)
Secondary	10785	24.6	23.8	14.77	0.92 (0.75-1.12)
Higher	4472	10.1	13.9	20.85	1.31 (1.03-1.66)
Contraceptive use					p<0.001
Never user	7234	16.4	21.1	13.32	1.00
Current user	26963	61.6	53.5	17.26	1.30 (1.08-1.56)
Past user	9689	22.0	25.0	19.55	1.47 (1.21-1.79)

Religion					p<.001
Muslim	39852	90.9	87.0	14.58	1.00
Hindu and other	3990	9.1	13.0	21.74	1.50 (1.17-1.87)
Survival status					
Alive	40159	92.1	56.6		
Dead	3683	7.9	43.4		
Total	43,842	100.0	100.0	15.2	

Levels and trends of twin birth rates

According to the birth history data of the 2014 BDHS, the overall rate of twin births was found to be 15.2 births per 1000 live births (95% confidence interval (CI): 12.9, 18.2) in Bangladesh in 2014. Since 1993 there are seven successive standard DHSs conducted in Bangladesh. The data of these surveys can be used for analyzing the time trends in twin birth rates in Bangladesh. Figure 1 presents the estimates of the twin birth rates obtained from all the DHS surveys in Bangladesh to see the time trends over the last 20 years period. The results indicate a general increasing trends in twin birth rates with little fluctuations. The prevalence of twinning has increased from 13.4 per 1000 live births in 1993-94 to 15.2 births per 1000 live births in 2014 – an increase of 13.4% over a period of 20 years and the increase is statistically significant (t= 2.45, p-value < 0.02). However, this change in twinning rates was based on the experience of ever-married women regardless of their timing of marriage or birth.

Figure 1. Trends in Twin birth rates (per 1000 live births) in Bangladesh: 1993/94-2014



Note: Twin rates were calculated by author by downloading BDHS data sets from the Measure DHS+ website with due permission

Correlates of twin births

Table 1 also presents the unadjusted odds ratios obtained through univariate binary logistic regression analysis showing the association between twin births and selected maternal, child and socio-demographic factors. The results indicate that maternal age, birth order, region of residence, household asset quintiles, father's educational level, couple's contraceptive use status and religion were the significant predictors of twin births. Mother's employment status showed marginal (0.05 ≤ p-value < 0.10) effect on twinning.

Table 2. Factors associated with Twin births, BDHS 2014

Risk Factors	B	Odds ratio§§	95% CI		p -value
			Lower limit	Upper limit	
Mother's age at birth of child					<0.001
< 20		1.000			
20-24	0.330	1.391	0.865	2.236	0.173
25-29	0.576	1.779	1.103	2.870	0.018
30-34	1.090	2.975	1.793	4.935	<0.001
35+	0.608	1.836	1.133	2.974	0.014
Mother's Employment status					0.087
Not employed/house wife	.107	1.113	0.941	1.318	0.212
Employed		1.000			
Live birth order					<0.001
1		1.000			
2	1.223	3.396	2.616	4.408	<0.001
3	1.743	5.712	4.260	7.658	<0.001
4+	2.175	8.798	6.415	12.066	<0.001
Region of residence					0.002
Barisal		1.000			
Chittagong	0.189	1.208	0.826	1.766	0.330
Dhaka	0.230	1.259	0.872	1.818	0.219
Khulna	0.320	1.377	0.903	2.100	0.137
Rajshahi	0.520	1.683	1.125	2.517	0.011
Rangpur	-0.040	0.960	0.622	1.484	0.855
Sylhet	0.565	1.759	1.178	2.627	0.006
Household asset quintile					0.002
Poor		1.000			
Poorer	0.311	1.365	1.074	1.735	0.011
Middle	0.197	1.217	0.944	1.569	0.130
Richer	0.074	1.076	0.819	1.415	0.598
Richest	0.411	1.508	1.135	2.004	0.005
Father's education					<0.001
No education		1.000			
Primary	-0.202	0.817	0.665	1.004	0.054
Secondary	0.077	1.080	0.869	1.342	0.488
Higher	0.531	1.701	1.286	2.252	<0.001
Contraceptive use					<0.001
Never user		1.000			
Current user	0.222	1.249	1.036	1.505	0.052
Past user	0.267	1.306	1.068	1.597	0.010
Religion					,0.001
Muslim		1.000			
Hindu and other	0.560	1.751	1.385	2.213	<0.001

§§ All odds ratios are adjusted for clustering of births to the same mother and for all other

variables.The dependent variable was coded as 1 if the live birth was twin, otherwise coded 0.

To obtain the adjusted or net effect of a predictor variable on twinning, multivariate logistic regression model was employed. The results are presented in Table 2. It has been observed that all the unadjusted significant predictors identified in univariate analysis remained significant after adjusting the effects of other predictors in multivariate analysis. This indicates that all these factors have independent significant effects on twinning. Among the risk factors, maternal age showed significant positive association with twin births. Children born to mothers aged 30-34 years had almost three times higher likelihood to be twin than the children born to young mothers of age less than 20 years (AOR= 2.97, 95% CI: 1.79 - 4.94, p<0.001). Birth order appeared as the most significant predictor of twin births. The likelihood of twin birth increased with the increase of birth order. For example, second order births had more than three times higher odds of being twin than that of first order births (AOR=3.4, 95% CI: 2.62 – 4.41, p<0.001). Children born in Sylhet and Rajshahi division had significant higher risk of being twin than the children born in Barisal division. In this regard, the odds of being twin were almost two times higher for the children born in Sylhet (AOR=1.76, 95% CI: 1.18 – 2.62, p=0.006) and Rajshahi (AOR=1.68, 95% CI: 1.13 – 2.52, p=0.001) as compared to children born in Barisal division. Household economic status showed significant association with the twinning rate, but the relation is not monotonic. Twin birth rate was found to be more prevalent among the children born to poorer group of households (AOR=1.37, 95% CI: 1.07 – 1.74, p=0.011) as well as children born to richest group of households (AOR=1.51, 95% CI: 1.14 - 2.0, p=.005). Although mother's education showed no significant association with twinning, however, father's education showed significant positive association with twinning. Children born to father with higher level of education had 1.7 times higher likelihood to be twin compared to children born to father with no education (AOR=1.70, 95% CI: 1.29 – 2.25, p<0.001). Contraceptive use status appeared as significant predictor of twin births. Twin births were found to be more prevalent among the mothers who were past user (AOR=1.31, 95% CI: 1.07 – 1.60, p=0.010). The odds of being twin were 1.75 times higher among the children born to non-Muslim mothers than their Muslim counterparts (AOR=1.75, 95% CI: 1.39 – 2.21, p<.001).

Effect of twin births on childhood mortality

Out of 43,842 live births considered in this study, 3,690 were recorded as dead during their childhood (i.e. aged 0-59 months or under five years of age) (Table 1). Thus the overall percentage of dead children among the total live births during childhood was observed to be 8.4%. The corresponding figures for singletons and twins were observed to be 7.9% and 43.4%, respectively. This indicates that twins have 5.5 times higher risk of mortality during childhood than that of their singleton counterparts. It was found that twin births contributed only 1.5% to the total live births, whereas twin deaths contributed about 8.0% to the total deaths of the children during first five years of age.

Table 3 presents the neonatal, post-neonatal, infant and under-five mortality rate among twin and singleton births. The results indicate that the mortality of twins was higher than that of singletons in all age ranges under the age of 5 years. For example, the infant mortality rate (IMR) was 417.66 deaths per 1000 live births among twins as oppose to 61.89 deaths per 1000 live births among singletons. This indicates that infant mortality rate was 6.7 times higher among twins than that of singletons.

Table 3. Under-five, Infant, Post-neonatal and Neonatal mortality rates of twin and singleton live births and the logistic regression analysis of death rates showing unadjusted and adjusted odds ratio (OR) with 95% confidence interval and p – value.

	Death rate/1000 live birth (n)*		Odds ratio (OR) of Twin/Singleton (95% CI) and p -value	
	Twin	Singleton	Unadjusted	Adjusted ϕ
Neonatal deaths (0-1 months)	357.78 (239)	47.41 (2046)	11.23 (9.53 - 13.240) p <0.001	14.185 (11.919- 16.881) p<0.001
Post-neonatal deaths (2-11 months)	63.69 (40)	15.22 (626)	4.46 (3.22 - 6.17) p<0.001	4.52 (3.242 – 6.302) p<0.001
Infant deaths (0-11 months)	417.66 (279)	61.89 (2672)	10.98 (9.37 - 12.87) p<0.001	13.546 (11.457- 16.016) p<0.001
Under-five deaths (0-59 months)	434.13 (290)	78.75 (3400)	9.32 (7.97 - 10.91) p<0.001	11.014 (9.331 – 12.989) p<0.001

Φ Adjusted for all factors associated with twin births.

*(n) number in the parenthesis indicating the number of deaths

Table 3 also presents the unadjusted and adjusted effects of twinning on different types of mortality under the age 5 years (i.e. neonatal, post-neonatal, infant and under-five mortality), using univariate and multivariate logistic regression models. The objective of this analysis was to determine how strong the effect of type of live births (singleton or twin) is on childhood mortality after controlling the effect of other factors on childhood mortality. The analysis identified type of live births as the most significant determinant of all types of childhood mortality. The results indicate that the odds of all types of childhood mortality were found to be significantly higher among twin births compared to singletons. The highest effect of twinning on death was found during neonatal (age 0-1 month) period. Neonatal deaths was found to be 14 times higher among the twins compared to singletons (AOR=14.18, 95% CI: 11.92 – 16.88, p<0.001). It is interesting to note that the adjusted odds ratios of all types of deaths were found to be higher than the unadjusted odds ratios of deaths, indicating higher significant independent predictive power of type of live births (i.e. twin or singletons) on childhood mortality.

Discussion

The aim of this study was to update our knowledge about levels, trends, determinants and survival status of twin births in Bangladesh, using the latest available large dataset of the

Bangladesh Demographic and Health Survey (BDHS). Twin birth rate observed to be 15.2 twins per 1000 live births (one twin birth in 65 live births) in Bangladesh in 2014. This rate is lower than the average rate of 19.5 per 1000 live births found in the longitudinal study in the rural Matlab area of Bangladesh (16). The estimated twinning rate presented in this study is comparable with the finding from Nepal and India, the two neighboring countries with similar socio-economic and demographic conditions. The twinning rate in Bangladesh is found to be slightly lower than in Nepal (16.1 per 1000 live births) (17), but higher than observed in India (11.7 per 1000 live births) (18). Twin birth rate in Bangladesh was found to be lower than those observed in African and American communities (2,12). However, these variations in twinning rates need to be interpreted cautiously. Some of these variations in twinning rates across different studies, countries or regions are due to variations in the definition of twinning rate; whether stillbirths were included or not and the rates were calculated among pregnancies or live births. Besides variations are also due to variations in the period of observation as well as variations in study design such as population based or hospital based, cross-sectional or longitudinal study and the age distributions of sample respondents. Estimate of twinning rate in this study was based on live births only, excluding still births. Our sample contained a substantial proportion of teen age mothers (37%). Since the proportion of twins is higher among stillbirths than among live births (19), and maternal age has a positive association with twinning (3,11,16,20), the twin birth rate presented in this study is likely to be under estimated.

Over the last few decades, twinning rates show increasing trends in Bangladesh. Twinning rate has increased from 13.4 per 1000 live births in 1993-94 to 15.2 per 1000 live births in 2014, an increase of 13.4% within a period of 20 years between 1993-94 and 2014. This increase in twinning may be due to increasing use of medically assisted reproduction (MAR), increased use of contraception and increasing age at childbearing. In Bangladesh, to our knowledge, there is no study on prevalence of MAR and its effect on multiple births. However, data from the BDHS since 1993 documented an increasing trend in age at childbearing in Bangladesh. Over the last few decades the mean age at childbearing as well as age at marriage rose by at least 2 years in the country (14). Contraceptive use, particularly the oral contraceptive, has been found to increase twinning rate (21). This has been observed in rural Matlab area of Bangladesh, where twinning rates were found to be higher in the family planning intervention area than in the control area (22). Over the last two decades, contraceptive use rate has increased substantially from 40% in early 1990s to 62% in 2014 in Bangladesh(14),and this might be linked with the increase of twinning rates in the country.

This study identified various significant independent determinants of twin births in Bangladesh. Maternal age at child birth, birth order or parity, economic status, contraceptive use status, father's education, geographical region, and religion were found to be associated with twin births.

This study finding corroborate the findings of the previous studies in both developed and developing countries that the incidence of twinning have strong association with increasing maternal age at childbearing and birth order or parity (3,11,16,20). Our analysis shows that the incidence of twinning increases with maternal age up to 35 years and after that the rate declines. The result is consistent with the findings of previous studies elsewhere (17,20,23). The incidence of twinning increases with the birth order or parity. The third order births were found to be about 6 times more likely to be twin compared to first order births (OR=5.71, 95% CI:4.26 – 7.66). Household economic status or wealth quintiles showed significant effect on

twinning. Children born to the richest group of households and children born to poorer household have significant higher risk to be twin than the children born to poorest or middle income group of households. Our findings are consistent with findings of Lilienfeld and Pasamanick (24).

Although mothers' education showed no significant association with twinning rates, but fathers' education appeared as a significant predictor of twinning. Children born to fathers with higher level of education were found to be 1.7 times higher likely to be twin. Our analysis also shows that the incidence of twin births were higher among the contraceptive users, particularly the past users. The higher rate of twinning among past users compared to current users implies that contraceptive discontinuation increased the risk of twin births. Many studies reported that higher incidence of twinning among the pregnancies that took place short after discontinuation of oral contraceptive (10,21,25). We observed significant variation in twinning rates across the region of residence. Children born to mothers from Rajshahi and Sylhet division had higher risk of being twin births than other region. The regional variations in twinning rates are mainly due to ethnical variations among the regions.

This study findings support the claims of the previous studies that children born as twin are more likely to die during childhood than the children born as singleton, irrespective of developing and developed countries (16,17,26-28). It is need to be emphasized here that although twin births represent on average 1.5% of the total live births in Bangladesh, but twin deaths represent about 8.0% of the total deaths of the children during their first five years of age. Our analysis revealed that twins had 5.5 times higher mortality rate during their first five years of age compared to singletons. The infant mortality rate of twins was found to be nearly seven times higher than that of singletons (417.7 vs. 61.9 per 1000 live births in 2014), and it was nearly eight times higher in the neonatal period (357.78 vs. 47.4 per 1000 live births). The results are consistent with the findings of the previous studies in Bangladesh (16,27), but 2-4 times higher than observed in other developing and developed countries (17,26,28). The importance of twin birth as a risk factor of childhood mortality is further emphasized in our adjusted analysis of the determinants of childhood mortality by considering twin births as one of the risk factors after controlling the effect of all other potential determinants of childhood mortality. The adjusted odds ratio of the deaths of twin births in the neonatal period of 14.2 (compared with the risk of the death of a singleton) in Bangladesh was higher than that found in other population-based studies (26,27,29).

The finding of this study that more than one-third (358 per 1,000) of the twins die within first month of their life in Bangladesh is perhaps one of the highest rates of neonatal mortality among the twins in the world. The rate comprises almost 82% of under-5 mortality among twins in Bangladesh. It is worth mentioning here that Bangladesh has made significant progress in reduction of overall childhood mortality over the last two decades and is on track of achieving the Millennium Development Goal (MDG)(4). A 65 percent decline in under-5 mortality from 133 to 46 deaths per 1,000 live births over the period 1993 to 2014 has occurred in Bangladesh (14). Most of these declines in overall childhood mortality occurred during post neonatal period and during one to four years of life, and thus mortality has become increasingly concentrated in the earliest months of life, that is neonatal period.

The time series data from the BDHSs over the last two decades indicate that the proportion of neonatal deaths relative to overall under-5 mortality has increased persistently from 39% in 1993 to 47% in 2003 and further increased to 61% in 2014 (14). Bangladesh is ranked 157 out of

163 countries in the global rank for neonatal deaths (30). The persistent increase in the proportion of neonatal deaths might be linked with the increasing trends of twinning in Bangladesh to some extent. Our finding of very high neonatal mortality among the twins in Bangladesh deserves special attention by the maternal and child health care programme in Bangladesh. The causes of high neonatal mortality among twins need to be identified to help direct appropriate interventions for reduction of twin mortality. However, recent studies conducted in rural Bangladesh identified birth asphyxia, prematurity/low birth weight, sepsis, respiratory distress syndrome and pneumonia as the major causes of neonatal mortality (31,32). Birth asphyxia alone accounted for nearly half (45%) of neonatal deaths in rural Bangladesh (32), compared to the global average of 23-29% (29,33). The higher rate of neonatal deaths due to birth asphyxia in Bangladesh might be related to inadequate prenatal and postnatal care as well as the lack of appropriate resuscitation care for newborns at birth. According to the findings of the 2014 BDHS, among the women who gave birth in the three years preceding the survey, 21.4% mothers never received any ANC, only 31.3% received WHO recommended at least four ANC visits, and 36% mothers received no post-natal care (PNC) visits (34). In addition, more than sixty percent (63%) births were delivered at home under the supervision of traditional birth attendants or relatives or friends, and thus less likely to receive resuscitation care at birth. Thus achieving universal coverage of the WHO recommended maternal and child health practices, such as at least four ANC visit, delivery at health facility with skilled birth attendant and three PNC visits, remains an area for potential intervention to reduce the number of neonatal deaths among the twins and singletons in Bangladesh.

Premature and low birth weight also contributed to higher incidence of birth asphyxia as shown in an earlier study in Bangladesh (35). Bangladesh has one of the highest rates of low birth weight (LBW) in the world. According to the 2003-2004 National Low Birth Weight Survey in Bangladesh, the incidence of LBW was 36% (36), compared to global average of 15.5% for the same period (37). Twins are more likely to be born with low birth weight and/or premature. In addition, twins are usually associated with high risk pregnancies as they occur to mother with higher parities and ages, as well as they are at greater risk of birth defects and/or disabilities38 and, therefore, accounted for larger percentage of deaths in the early days of life. The strong correlation between early childhood mortality and LBW is well documented by many seminal studies (28,39,40).

Conclusion

Our findings of increasing trends in twin births and the associated higher risk of mortality among twins in Bangladesh underscores the need for a more focused newborn care strategy for the twin births, so that appropriate management of twin births can be made universally available at all level of health care services. Since births at home tend to be the norm in Bangladesh, the skilled community health workers and trained birth attendants could be promoted to provide home-based care for both birth asphyxia and premature/low birth weight babies. These types of interventions have been proved effective in reducing the number of deaths due to asphyxia in settings with high rate of home births elsewhere (41,42). There is a need to alert couples about the potential danger and complications of twin pregnancies and counsel them to seek timely, adequate ANC, delivery and PNC care. As delayed childbearing at a higher age increased the risk of twin births and their subsequent survival, young couples need to be discouraged to have children at higher ages, particularly beyond age 35 years. At the same time close monitoring and

care during antenatal and intrapartum period as well as early detection of twin pregnancy during prenatal visits and intensive neonatal care will improve the obstetric outcomes, decrease the complications associated with twin pregnancy and improve the survival of twin births in Bangladesh.

Competing Interest: The authors have no conflict of interest to declare.

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Ethical issues: This study is based on secondary analysis of the publicly available dataset of the 2014 BDHS with all identifier information removed. Request to access datasets from measure DHS website was made and the websites allowed the same before analyses was made. The survey was approved by the Ethics Committee of the ORC Macro at Calverton in the USA and by the National Ethics Committee in the Ministry of Health in Bangladesh. All study participants gave informed consent before participation and all information was collected confidentially.

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