Determinants of Infant Mortality in Bangladesh: A Nationally Surveyed Data Analysis

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Abstract: *Background*: It is well established that improving human health has direct obvious payoff on enhancing life expectancy along with economic growth. Infant mortality deliberately used to understand a countries overall public health status particularly child bearing mothers. But the prevalence of child mortality continues to be a prime public health concerns in Bangladesh. This study aims to investigate the impact of some geospatial, socioeconomic, demographic and health factors on infant mortality in Bangladesh.

Methods: The study modeled infant mortality (aged 0-11 months) as the categorical dependent variable using 11 selected covariates from the 2014 Bangladesh Demographic and Health Survey (BDHS-2014) dataset. The Pearson-Chi square test and Binary Logistic Regression methods were utilized for the bivariate and multivariate analyses.

Results: All the selected covariates were significantly associated with infant mortality in bivariate analysis. The results of the logistic regression revealed that illiterate father, household without toilet facility or having hanging toilet, multiple birth and small size at birth appeared at the significant risk factors for infant mortality. In contrast, receiving vitamin A dose and visiting in antenatal care revealed as protective factor for infant deaths.

Conclusion: This study is uniquely addressed some several determinants which are the immediate cause of infant deaths. This evidence based empirical study suggests that more attention needs regarding to eliminate all kinds of child mortality in Bangladesh along with infant mortality.

Keywords: Determinants, Socio-economic variables, Infant mortality, 0-11 months, Bangladesh.

INTRODUCTION

Improving human health is the best important societal objective because of its direct payoff of enhancing life expectancy and economic growth. But obstacles remain towards the way of improving human health. Yet today the infant mortality (IM) is existing all over the world and the prevalence of infant mortality is 10 times higher in poor developing countries compared with developed countries [1]. Infant mortality is called a child death before reaching the first birthday [2]. An estimated 5.4 million under-five children died in 2017, among them 75% (4.1 million) died during their infancy period [3]. Socio-economic indicators and infant mortality is closely linked with each other, consequently it has been used very sensitively because a countries whole public health, health seeking behavior and health services utilization can be determined by the status of infant mortality rate (IMR), in addition, survival of an infant inordinately depends on the family's socio-economic characteristics [4-5].

There have enormous positive achievements in reducing child mortality across the world over the last few decades [6-8]. For instance, globally IMR has declined to 29 deaths per 1000 live birth in 2017 from 65 death per 1000 live births in 1990 [3]. Despite these gains, the IMR is still high in sub-Saharan Africa and South Asia [6-8]. Since, almost 34% of overall child deaths occur only in South Asia; consequently child mortality is a great concern in this region [6]. In South Asia, Bangladesh has witnessed a large decline in infant mortality during the last decade, for example, the IMR was 87 per 1000 live births in 1990 which reached to 37 per 1000 live birth in 2014 [9, 10]. However, infant mortality remains a major public health challenges in Bangladesh despite these commendable success and the rate of infant deaths is much higher compared to developed countries [11, 12]. Background reasons of IM may be differ due to the country's characteristics along with socio-economic status of the family [12, 13]. However, diarrhea [7, 8], pneumonia [7, 8], sex of infant [13-16], birth interval, [4, 13-17] mother's education, [4, 5, 13-15, 18-20] father's education, [15, 16, 19-21] household wealth index, [4, 14, 15, 22-25] size at birth, [2, 17, 26-28] Vitamin A, [29-32] birth status, [33-36] mother's age, [16, 33, 36] birth order, [2, 4, 27, 33, 36] occupation of father, 37 types of latrine, [18, 19, 37] sources of drinking water [37], region of residence [15, 16, 25, 27, 28, 38] and antenatal care (ANC) visit [2, 36, 39] have been significantly associated with infant mortality in previous studies.

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The ambitious Sustainable Development Goals (SDGs) SDG-3 explicitly addressed health, while other at least 10 goals are concerned about health issues. In total at least 50 SDG indicators have been identified and internationally got recognition to measure health outcomes and possible determinants [40]. The People's Republic of Bangladesh is fully determined to abolish all kinds of child mortality in Bangladesh. Since a child is most vulnerable to death in his/her infancy period and every year a large number of children die before completing their first year of life, the chief intention of this study was to ascertain the best possible determinants of infant mortality in Bangladesh that would be conducive to planning and implementing any interventions towards stalling infant deaths.

METHODS

Data Sources

This was a cross-sectional descriptive study based on Bangladesh Demographic and Health Survey (BDHS-2014) which is freely available in online with all identifier information was deleted. The details of this cross-sectional survey as well as data collection procedure have been described elsewhere [10]. We considered every live-born child for this study because available information for all possible exposure variables can be obtained by the respondents which were based on four years of the survey. For this reason, a total 7886 under-5 children data were used to analyze the findings, of these 290 babies died during their infancy period (1-11 months)

Outcome Variables

The outcomes variable for this study was infant mortality. The child who died during their infancy period was identified from his/her date of births and age at death. Each infant death case was coded as 1 while each alive case was coded as 0.

Predictor Variables

Based on an extensive literature review about infant mortality the predictor variables considered in this paper were: division of residence (Chittagomg, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet and Barisal), mother's and father's education (no, primary, secondary/ higher), father's occupation (agricultural sectors, non-agricultural sectors), wealth index (poor, middle, rich), maternal height (<145 cm, ≥145 cm), birth status (multiple birth, single birth), size at birth (small, average, large), toilet facilities (no facilities/hanging toilet, pit toilet/flush toilet), number of ANC visit (0-1, ≥2), delivery by caesarean (no, yes), Vitamin A in 2 months (no, yes)

Statistical Analysis

Descriptive statistics were applied to find out the frequency, percentage of the children's and parent's characteristics. At the bivariate level, inferential statistics Pearson's chi-square test of independence ran to examine the relationship between the outcome variables and the selected independent variables. The variables which had obtained statistically significant those were considered inserted into the multivariate binary regression model. All possible variables were adjusted to reveal the independent determinants of infant mortality. All of these statistical analyses were accomplished using SPSS version 23.

Ethical Consideration

This study was based on BDHS-2014 public domain data which is free and available. The survey was approved by the Ethics Committee in Bangladesh. We were approved to use the data for independent research purposes.

RESULTS

Findings of the Table **1** describe the general socio-economic characteristics of the participants. A total of 7886 participants and their family status were considered for this study where 290 (37 per 1000) children were died before reaching their first birthday. However, among the total samples, 19.2%, 17.5%, 10.9%, 12.2%, 12.1%, 16.6% and 11.5% were from Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet and Barisal division respectively in Bangladesh. More than half of the mother (56.4%) had completed secondary or higher education where approximately 44.4% father of the infant completed same grade of education level. About 27.4% fathers were engaged in agricultural works. The wealth index of the families shows that 3240 (41.1%) participants participated from poor family where 3130 (39.7%) belongs to rich family. Results also denote that more than half of the children did not take vitamin A capsule within two months of the delivery. Results exerts that almost 23% mothers were given birth by cesarean mode. About 1.5% children were multiple birth babies and 13% were small size at their birth time. Around 13.6% mothers' height was less than 145 centimeter and nearly 6% households did not have any sanitary latrine or to some extent they use hanging latrine. As indicated in the table, more than

Table 1: Characteristics of the Study Children and the Prevalence of Infant (<1 Year) Mortality (n = 7886)[1]

Characteristics and categories	No. of infants, n (%)	Infant mortality status, n (%)		X^2	*p*-value[2]
		Dead	Alive		
Geospatial					
Division of residence				15.24	0.018**
Chittagong	1517 (19.2)	54 (3.6)	1463 (96.4)		
Dhaka	1378 (17.5)	41 (3.0)	1337 (97.0)		
Khulna	862 (10.9)	36 (4.2)	826 (95.8)		
Rajshahi	959 (12.2)	34 (3.5)	925 (96.5)		
Rangpur	958 (12.1)	35 (3.7)	923 (96.3)		
Sylhet	1306 (16.6)	68 (5.2)	1238 (94.8)		
Barisal	906 (11.5)	22 (2.4)	884 (97.6)		
Socioeconomic					
Mother's education				5.80	0.055*
No education	1233 (15.6)	55 (4.5)	1178 (95.5)		
Primary	2206 (28.0)	91 (4.1)	2115 (95.9)		
Secondary/Higher	4447 (56.4)	144 (3.2)	4303 (96.8)		
Father's education				10.87	0.004***
No education	2008 (25.5)	94 (4.7)	1914 (95.3)		
Primary	2377 (30.1)	92 (3.9)	2285 (96.1)		
Secondary/Higher	3499 (44.4)	104 (3.0)	3395 (97.0)		
Father's occupation				.s1 6.83	0.009***
Agricultural sectors	2162 (27.4)	99 (4.6)	2063 (95.4)		
Non-agricultural sectors	5724 (72.6)	191 (3.8)	5533 (96.7)		
Wealth index				10.49	0.005***
Poor	3240 (41.1)	145 (4.5)	3095 (95.5)		
Middle	1516 (19.2)	52 (3.4)	1464 (96.6)		
Rich	3130 (39.7)	93 (3.0)	3037 (97.0)		
Demographic					
Maternal Height (cm)				15.64	0.000***
<145	1026 (13.6)	59 (5.8)	967 (94.2)		
≥145	6509 (86.4)	213 (3.3)	6296 (96.7)		
Birth status				172.6	0.001***
Multiple birth	118 (1.5)	31(26.3)	87(73.7)		
Single birth	7768 (98.5)	259(3.3)	7509(96.7)		
Size at birth				16.07	0.000***
Small	616 (13.0)	34 (5.5)	582 (94.5)		
Average	3097 (67.3)	87 (2.7)	3097 (97.3)		
Large	928 (19.6)	42 (4.5)	886 (94.5)		
Health					
Toilet facilities				9.44	0.002***
No facilities/ Hanging toilet	461 (5.8)	29(6.3)	432 (93.7)		
Pit toilet/ Flush toilet	7425 (94.2)	261(3.5)	7164 (96.5)		

(Table 1). Continued.

Characteristics and categories	No. of infants, n (%)	Infant mortality status, n (%)		X^2	*p*-value[2]
		Dead	Alive		
Number of ANC visit				9.27	0.002***
0-1	1695 (37.7)	59 (3.5)	1636 (96.5)		
≥ 2	2799 (62.3)	36 (2.0)	2743 (98.0)		
Delivery by caesarean				6.46	0.011**
No	3645 (77.0)	143 (3.9)	3502 (96.1)		
Yes	1088 (23.0)	25 (2.3)	1063 (97.7)		
Vitamin A in 2 months				24.77	0.000***
No	2410 (53.7)	88 (3.7)	2322 (96.3)		
Yes	2080 (46.3)	27 (1.3)	2053 (98.7)		

[1]Data is presented as number (percentages).
[2]*p*-value is obtained using Chi-square test.
[a]Total number of children may differ because of missing data.
ANC: antenatal care; *p<0.1; **p<0.05; *p<0.01.

62% mothers visited at least two times into antenatal care during their pregnancy period.

Table **1** also illustrates the percentage distribution of children according to the bivariate relationships between the selected characteristics and the outcome variable. In this study, all the selected covariates were statistically significant in bivariate mode. It is found in the analysis that infant deaths were highest in Sylhet (5.2%) and the lowest deaths occurred in Barisal (2.4%). Mothers with no education caused comparatively higher IM to 4.5% while mothers with secondary or higher education the IMR was 3.2%. Results of father's education showed almost similar results of maternal education. IMR was relatively higher among the infants whose fathers were worked in agricultural sectors and in the poor indexed household. Besides, the percentage of deaths was significantly higher among the infants who did not receive vitamin A capsules within 2 months of life compared to those who had received (3.7% vs. 1.3%). It is to be noted that lower death occurred in infants that were delivered in cesarean section than normal mode (2.3% vs. 3.9%). According to the results obtained without toilet facilitation or having hanging toilet households had higher IMR (6.3%) than the households having pit or flush toilet (3.5%). The rate of IM was much higher among the multiple birth children (26.3%) than the single birth children (3.3%). Also, the prevalence of infant deaths was the highest (5.5%) in infants whose size was small at birth and the lowest (2.7%) in average birth size infants. In addition, the IMR was at least 2.5% higher in mothers whose height was <145 cm compared with other mothers. In contrast, the deaths of infants had happened at least 1.5% lesser among the mothers that visited antenatal care at least 2 times compared with their counterparts.

After adjusting all significant factors from bivariate analysis, multivariate binary logistic regression was performed. Results from the multivariate analysis are presented in Table **2**. It has found in the analysis that ten individual factors obtained statistically significant to be being caused of infancy deaths. Results found that infants of Khulna division [OR=3.28; CI=1.05-10.18], Sylhet division [OR=3.51; CI=1.20-10.30], Rajshahi dividion [OR= 2.97; CI=0.97-9.09] and Dhaka division [OR=2.68; CI=0.88-8.13] had higher odds to die compared with Barishal division in Bangladesh. Additionally, infants of illiterate fathers were at higher risk of death [OR=1.95; CI=1.06-3.57] within their first eleven months of life than those infants whose fathers had secondary or higher level of education. Moreover, the families without toilet or having hanging toilet were 1.87 times more likely to have infant mortality incidence in respect of households having pit or flush toilet. Compared with single birth, infant born as multiple birth ran almost 13.68 times higher risk of dying before completing their first year of age. Besides, the risk of infant mortality was significantly higher [OR=2.22; CI=1.41-3.50] among those who did not feed up vitamin "A" dose within first two months than those received vitamin "A". Also, compared with the large birth size infants, the odds of dying were around 1.95 times higher for children who were small size at birth (see, Table **2**). Furthermore, the infants of mothers that did not visit or visited only 1 time in antenatal care during pregnancy were nearly 1.50 times more likely to die than the infant of mothers who visited antennal care more than once (>1).

Table 2: Binary Logistic Regression Analysis for Infant Mortality

Characteristics and categories	B	Infant mortality OR [CI]	*p*-value
Geospatial			
Division of residence			
Chittagong	0.868	2.38 [0.79-7.16]	0.123
Dhaka	0.988	2.68 [0.88-8.13]	0.080*
Khulna	1.189	3.28 [1.05-10.18]	0.039**
Rajshahi	1.089	2.97 [0.97-9.09]	0.056*
Rangpur	0.659	1.93 [0.58-6.39]	0.280
Sylhet	1.257	3.51 [1.20-10.30]	0.022**
Barisal (ref.)			
Socioeconomic			
Mother's education			
No education	-0.099	0.90 [0.47-1.73]	0.764
Primary	0.051	1.05 [0.63-1.74]	0.844
Secondary/Higher (ref.)		-	
Father's education			
No education	0.670	1.95 [1.06-3.57]	0.029**
Primary	0.292	1.33 [0.78-2.98]	0.289
Secondary/Higher (ref.)		-	
Father's occupation			
Agricultural sectors	0.372	1.45 [0.71-2.95]	0.307
Non-agricultural sectors (ref.)			
Wealth index			
Poor	-0.373	0.68 [0.40-1.18]	0.180
Middle	-0.237	0.78 [0.43-1.43]	0.440
Rich (ref.)		-	
Demographic			
Maternal Height (cm)			
<145	0.296	1.34 [0.80-2.25]	0.259
≥145 (ref.)		-	
Birth status			
Multiple birth	2.61	13.68 [5.33-35.07]	0.000***
Single birth (ref.)		-	
Size at birth			
Small	0.669	1.95 [1.09-3.48]	0.024**
Average	-0.246	0.78 [0.47-1.27]	0.326
Large (ref.)		-	
Health			
Toilet facilities			
No facilities/ Hanging toilet	0.631	1.87 [0.95-3.70]	0.068*
Pit toilet/ Flush toilet (ref.)		-	
Number of ANC visit			

(Table 2). Continued.

Characteristics and categories	B	Infant mortality OR [CI]	*p*-value
0-1 (ref.)	0.404	1.49 [0.96-2.33]	0.075*
≥ 2 (ref.)			
Delivery by caesarean			
No	-0.116	0.89 [0.52-1.52]	0.672
Yes (ref.)		-	
Vitamin A in 2 months			
No	0.800	2.22 [1.41-3.50]	0.001***
Yes (ref.)		-	

Reference Category: Alive.
ref.: reference; ANC: antenatal care; *p<0.1; **p<0.05; *p<0.01.
Model fitting information: 2 log likelihood = 917.878, Chi-square value = 83.65, degrees of freedom = 21 and p-value = 0.000.

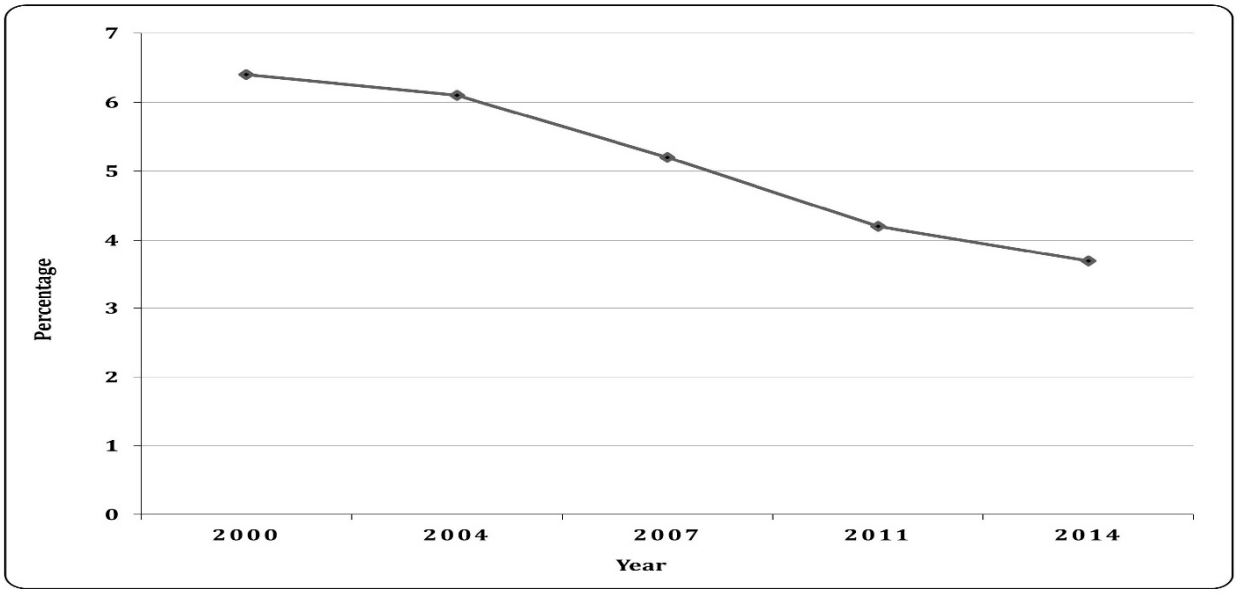

Figure 1: Trends in prevalence of infant mortality in Bangladesh, 2000 – 2014.

DISCUSSION

Following the line chart shows the prevalence of IM in Bangladesh in the years of 2000 to 2014 according to the data of BDHS-2000 to 2014. The rates of IM gradually decreased over the time. The IMR was 6.4% in the initial year (2000) and with a slight declining it came to at 6.1% in 2004. Then a systematic drop is observed and the rate was 5.2% and 4.2% respectively in 2007 and 2011. Again, with a slow reduction IMR reached to 3.7% in 2014.

This study attempted to analyze the BDHS 2014 data to estimate the changes in risk factors of infant mortality in relation to ongoing interventions by the government of Bangladesh. In this study, all the selected covariates were significantly associated with IMR in chi-square association test. Then in adjusted analysis, Khulna, Sylhet, Rajshahi and Dhaka division, illiterate father, household without toilet facility or having hanging toilet, multiple birth, small size at birth, did not feed vitamin A capsule in 2 months, few visit (<2 times) of antenatal care during pregnancy appeared at the individual risk factors for causing of infant mortality.

Findings of the current study were obtained in a large scale population-based data set. Four divisions were found significantly associated to higher risk of infant mortality. It is may be due to these divisions are not having with proper medical facilities to stall infant mortality. Previous studies indicate that geographical or spatial areas with poor facilities may increase the infant's deaths [15, 16, 25, 27, 28, 38].

A recent study in Bangladesh unlocked that mothers and fathers education had a great influence on the survival of infants [15]. Also, there are some studies revealed that lower level of mother's education is an important indicator of infant mortality [4, 5, 13-15, 18-20]. In this study, mothers education was not a significant factor for IM in multivariate analysis. However, this finding is consonant with some previous studies in Bangladesh [16, 21]. The odds ratios of the present study illustrates that children of fathers with no schooling occupy a great risk of dying during their first year of age. This is a constant result of the previous findings [15, 16, 19-21]. It might be possible because in patriarchal society fathers play the most vital role in family [41].

Smaller infant size at birth was closely related to infant death which is endorsed by previous literatures. In line with the previous several studies this study confirms this relationship as well [2, 17, 26-28]. Furthermore, children born multiple birth were found the strong predictor (OR=13.68) which represents that multiple birth children are more likely to die before completing first birthday as those born singletons. This finding is coherent with other studies in Bangladesh, [33, 36] Nepal, [34] and Japan [35]. Multiple births (MBs) contribute around ten percent of all IM despite only 1.5% of all infants are MBs in Bangladesh [10, 33]. Therefore, further studies is required with long term follow-ups to improve the survival rate in multiple birth infants.

Results also strongly denote that vitamin A deficiency has highly significant association to IM. This is also supported by previous studies that supplementation of vitamin A can significantly increase infant survival [29-32]. Besides, households accessibility to proper sanitary latrine and sanitation might be related to infant survival. Our results reveal that infants of households having poor latrine facilities (no facilities or hanging toilet) were 1.87 times higher risk for IM than the infants of households with better latrine facilities (pit or flush toilet). This finding is agreement of some previous studies that accessing proper sanitary latrine is closely linked with infant survival [18, 19, 37]. Further, consonant with some past studies, this study confirms that IM was significantly lower in infants whose mothers' attended at least two antenatal care services during pregnancy. Previous studies in Bangladesh investigated that IM was 48% less likely among the infants whose mothers' attended at least four ANC visits during pregnancy [39]. Another study in Bangladesh revealed that the infants whose mothers attended ANC services were significantly 52% less likely to die compared with the infants of the mothers that did not attended ANC [36]. It could be because mother's visit of ANC can learn them about the existing health services which may later helped to utilize the health services. In addition, literature supports that early ANC facilitated mother to take tetanus vaccines, nutritional foods and child oversee.

To recapitulate aforesaid findings, it has to be said that residential characteristics of the children are have strong influence on infant mortality. Therefore, to remove all kinds of regional inequalities regarding health services need to be addressed and urgent necessary appropriate interventions must be taken into consideration. Further, maternal nutritional and socio-economic status should be developed by providing necessary equipment through government. It is because mother's nutritional or socio-economic status, decision making power, educational status, proper sanitation and antenatal care visit can lead to the reduction of IMR. In addition, body characteristics of the infant and awareness of the family regarding to foster children importantly related to child surviving. Furthermore, multiple birth status also a root reason of IM because it limits the adequate nutritional facilities for the baby. In fine, despite having low infant mortality comparing to past still more attention needs regarding to eliminate all kinds of child mortality in Bangladesh along with infant mortality.

Strengths and Limitations of the Study

The strengths and limitations of this study deserve to be noted. Firstly, this is a wide scale large population-based study so findings confirm the entire situation of the country Bangladesh. Second, after reviewing literatures, different geospatial, socioeconomic, demographic and health related covariates were considered as predictor variables and the most significant risk factors were revealed by adjusting all possible variables. Third, since the data represents the national status of infant mortality, the findings will help the policy makers and government to take some appropriate strategies and policies to diminish the infant mortality. Finally, following the figure based on the World Bank global data among the South Asian Association for Regional Cooperation (SAARC) countries depict lower prevalence of IMR persist in Maldives and the highest in Afghanistan. Bangladesh and India are in almost same position. Therefore, the best policy suggestions would be established by this study is to stall IMR in not only for Bangladesh but also applicable for others.

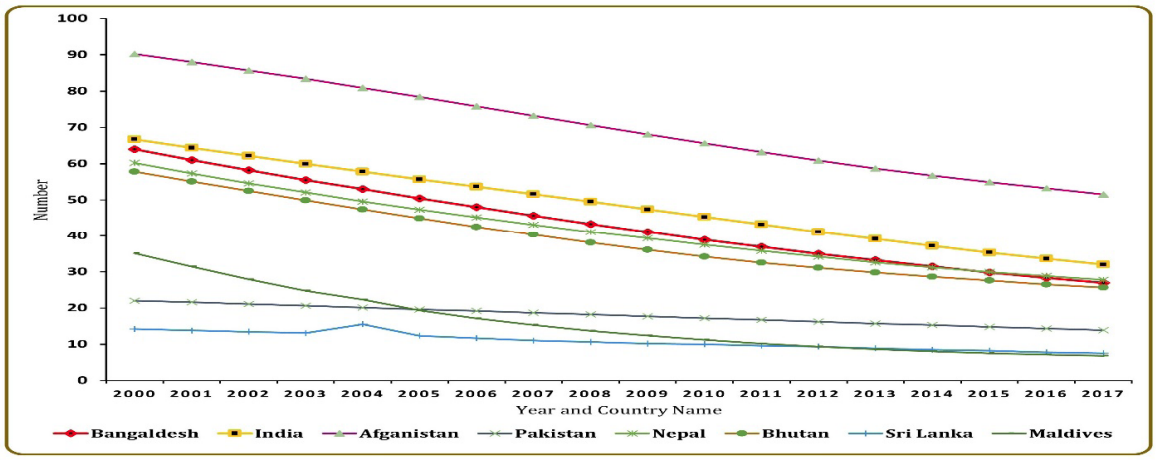

Figure 2: Rate of infant mortality among SAARC countries.

Source: https://data.worldbank.org/indicator/SP.DYN.IMRT.IN (Accessed 29 January 2019).

The study has some limitations or weakness. The foremost limitations would be, the data comparatively old collected in 2014 so it is assumed that the possible explained variables are may be changed. In addition, only some potential predictor variables were examined in the study. Thereafter, some variables had missing values which might influence the results. Also, some possible variables, for example, birth interval, breast-feeding practice, diarrhea, were not inserted due to massive missing cases.

CONCLUSIONS

The entire paper was envisioned to assess and explicate the potential risk factors which are responsible for causing IMR in Bangladesh. Due to several reasons, IM in Bangladesh has been happening for long time. The persistence of IMR in Bangladesh questions the initiatives of government and other organizations. Hence, the findings uphold adequate measures are ineluctable to extinguish the prevalence of IMR in Bangladesh. To elevate and augment the child survival the findings of this study could be an adjuvant framework for further designing future health plans and polices towards obtaining workable health initiatives of Bangladesh. In fine, the undertaken study will be allowed all policy-makers and appropriate authorities to set up decisions to extenuate all kinds of child mortality in Bangladesh. However, these findings may assist for further important policy implications to obliterate IMR, especially by focusing on small area estimation [42-45]. Finally, those variables which were excluded further study are recommended by the authors to include them by incorporating multinational datasets using data science modelling techniques [46-50].

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CONFLICT OF INTEREST

Authors declared no conflict of possible interest.

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